AD NUMBER: AD0003318

LIMITATION CHANGES

TO:

Approved for public release; distribution is unlimited.

FROM:

Distribution authorized to U.S. Government agencies and their contractors; Administrative or operational use; 25 Nov 1952. Other requests shall be referred to Personnel and Training Branch, Office of Naval Research, Department of the Navy, Arlington VA, 22217.

AUTHORITY

ST-A PER ONR NOTICE, 24 AUG 1970

RESEARCH ON THE DEVELOPMENT OF SHIPBOARD PERFORMANCE MEASURES

FINAL REPORT
(IN FIVE PARTS)

PART I

THE USE OF PRACTICAL PERFORMANCE TESTS IN THE MEASUREMENT OF SHIPBOARD PERFORMANCE OF ENLISTED NAVAL PERSONNEL

PREPARED FOR

PERSONNEL AND TRAINING BRANCH
OFFICE OF NAVAL RESEARCH
DEPARTMENT OF THE NAVY

BY

MANAGEMENT AND MARKETING RESEARCH CORPORATION
LOS ANGELES, CALIF.

RESEARCH ON THE DEVELOPMENT OF SHIPBOARD PERFORMANCE MEASURES

FINAL REPORT
(In Five Parts)

PART I

THE USE OF PRACTICAL PERFORMANCE TESTS IN THE MEASUREMENT OF SHIPBOARD PERFORMANCE OF ENLISTED NAVAL PERSONNEL

By

Clark L. Wilson
and
Robert R. Mackie

25 November 1952

Prepared for
Personnel and Training Branch
Office of Naval Research
Department of the Navy
Washington 25, D. C.

Contractor
Management and Marketing
Research Corporation
3004 South Grand Ave.
Los Angeles 7, Calif.
for
Psychological Research Center
Los Angeles, Calif.

Contract N8 onr 70001

RESEARCH ON THE DEVELOPMENT OF SHIPBOARD PERFORMANCE MEASURES

FINAL REPORT
(In Five Parts)

PART I

THE USE OF PRACTICAL PERFORMANCE TESTS IN THE MEASUREMENT OF SHIPBOARD PERFORMANCE OF ENLISTED NAVAL PERSONNEL

By

Clark L. Wilson
and
Robert R. Mackie

25 November 1952

Prepared for
Personnel and Training Branch
Office of Naval Research
Department of the Navy
Washington 25, D. C.

Contractor
Management and Marketing
Research Corporation
3004 South Grand Ave.
Los Angeles 7, Calif.
for
Psychological Research Center
Los Angeles, Calif.

Contract N8 onr 70001

ACKNOWLEDGEMENTS

We wish to express our sincere thanks for the cooperation of many Naval personnel, afloat and ashore. Particularly, we wish to thank Capt. G R. Donaho, USN, for permission to begin the work afloat in Submarine Flotilla One, U. S. Pacific Fleet. Subsequent Commanders of Submarine Flotilla One have been most helpful in the continuing research.

Force, Squadron, Division, and Tender staffs in both Pacific and Atlantic Fleets have contributed greatly to the progress of the work, and our especial appreciation goes to the Officers and leading Petty Officers aboard the more than thirty submarines where the work was done.

Capt T. L. Willmon, MC, USN, and Commander Gerald J. Duffner, MC, USN, as Officers-in-Charge, Medical Research Laboratory, U. S. Naval Submarine Base, New London, have both done much to further the work of this project.

We wish to acknowledge the original contributions and field work of Harry L. Wolbers, Harrison G. Mahoney, Irwin L. Rodman, James H Myers, and Robert F. Simmons, and the editorial assistance of Forrest K. Strayer.

TABLE OF CONTENTS

ABSTRACT

Research has been conducted to determine if objective and reliable measures can be developed to evaluate shipboard performance of Navy enlisted men. Adequate measures of performance are necessary to determine proper qualifications for advancement and to determine the effectiveness of selection and training programs.

A series of Practical Performance Tests, designed to measure the practical factors of shipboard performance, has been developed. These tests have been administered to Electrician's Mates and Enginemen serving aboard submarines. They have been shown to be valuable additions to existing performance measures.

Information about the usefulness and importance of performance tests is presented in this report. The reliabilities and inter-relationships of the tests are discussed, and observations are made on the construction of performance tests. Results of correlational studies with other measures of shipboard performance are also given.

This is Part I of the Final Report on a study of shipboard performance and its relation to selection and training procedures. Parts II through V will describe the development of shipboard Performance Check Lists and a shipboard Performance Rating Scale, and the administration of experimental aptitude tests to candidates at the Enlisted Submarine School in New London.

Chapter I

SUMMARY AND OPERATIONAL IMPLICATIONS

Research conducted under this project has shown that practical factor performance tests measure abilities that are not being measured by other currently available means.

It has been the common practice in industry as well as the military to evaluate job performance with some form of supervisory rating. In the Navy these have been Quarterly Marks. It has been felt by many, in the Navy and out, that the Quarterly Marks do not reflect sufficiently the true abilities of the men being marked.

The practical factor performance test approach, sometimes called the job-sample test approach, was studied to determine its practicability for use in measuring the quality of shipboard performance of Navy enlisted men.

This report describes the development of two series or batteries of Practical Performance Tests. These tests were designed to measure the abilities of Electrician's Mates (EM's) and Enginemen (EN's) serving aboard submarines to perform the practical factors of their jobs.

Practical factors need to be measured for two reasons:

1. Advancement in rate examinations should include on-the-job measurements of practical or technical skills as well as written job knowledge tests. It is important to know if a man can actually perform the tasks of a job.

2. The only way to evaluate selection and training procedures is to measure properly the men's abilities to actually perform the jobs for which they have been selected and trained. This necessitates measuring the performance of practical factors of those jobs aboard ship.

Quarterly Marks of proficiency in rate and mechanical ability, and written examinations for advancement in rate, are meant to give some indication of enlisted men's practical or technical skills, but they do not provide an opportunity for men being tested or marked to demonstrate their ability to perform the actual

tasks of their jobs. For this reason, the Practical Performance Tests were developed.

The Practical Performance Tests were short (five to fifteen minutes) job samples. They simulated actual job situations and made use of standard Navy equipment. The following general kinds of tests were used:

1. Operational. (Using and operating tools, instruments, and mechanical and electrical equipment of all kinds.)

2. Identification. (Identifying tools, valves, instruments, etc.)

3. Procedural. (Going through the steps of a task where a certain sequence of operations has to be followed; e.g., lighting off a main engine.)

4. Diagnostic. (Trouble-shooting for casualties in electrical and mechanical gear.)

In addition to these job-sample performance tests, written job-knowledge and safety tests were included in the composite test batteries. These written tests were added both to increase the coverage of the batteries and to provide data for subsequent correlations with performance tests.

It should be pointed out here that the job-sample performance tests measured a man's ability to do his job without requiring him to express himself either orally or on paper. Many men can operate very complicated machines without being able to explain how the machine works or how they know where to look for trouble. Scores on written tests, in contrast to scores on performance tests, reflect not only relative job knowledge but different levels of verbal ability as well. The Practical Performance Tests were designed to measure a man's ability to do his job without introducing this verbal element. They were, as far as possible, non-verbal tests.

The EM and EN composite batteries (performance tests plus written tests) were administered to 321 EM's and 404 EN's. Scores made on the tests were tabulated and statistically analyzed. Test reliabilities and inter-relationships

were computed.

The individual tests were found to be adequately reliable for practical measuring purposes. Consequently, both the EM and EN composite batteries were reliable measuring devices.[1]

The inter-test relationships were found to be moderate to low.[2] That is, men who scored high on one test did not necessarily score high on another.

In addition to the Practical Performance Tests described here, shipboard Performance Check Lists and a shipboard Performance Rating Scale were developed in the over-all study of performance measures of which this performance testing program was a part. An aptitude testing program was also carried out at the Enlisted Submarine School in New London in conjunction with the above studies.[3]

This over-all study of the relationships of shipboard performance measures and selection and training methods resulted in the following findings:

1. Rated performance (as indicated by the Rating Scale or Check Lists) is, at best, moderately related to actual performance (as measured by the Practical Performance Tests).

2. Scores on some of the aptitude tests given at the submarine school can be used effectively to predict subsequent shipboard performance (as measured by the performance tests).

3. Submarine school grades are moderately related to subsequent shipboard performance (as measured by the performance tests).

---

[1]Reliability coefficients for the individual tests (first half-second half or odd-even, corrected) ranged from .50 to .93. The reliabilities of the composite batteries were estimated to be .88 and .90 for the EM's and EN's, respectively.

[2]Coefficients of correlation between tests in the EM battery ranged from -.05 to .47, with the median at .21; between tests in the EN battery, coefficients ranged from .04 to .69, with the median at .26.

[3]The Performance Rating Scale and Performance Check Lists are described in Parts II and III of this Final Report. The aptitude testing program is described in Part V.

It is concluded from this study that the performance test approach to the problem of measuring shipboard performance is a valuable supplement to existing methods and measures.

Practical factor performance tests should receive increasingly wider application in training, testing, and rating programs for the following reasons:

1. They measure performance factors not generally measured by rating methods and written tests.

2. They are reliable measuring devices.

3. They are easily administered.
   Job-sample tests can be short and still be adequately reliable. They can be compactly built and easily carried. (Many possibilities also exist for building performance tests around actual operational equipment aboard ship.)

4. They are objectively scored.
   Performance can be recorded on answer sheets in such a way that subjective evaluations on the part of the scorer are held to a minimum.

These factors of unique measurement, reliability, ease of administration, and objectivity are the demonstrated practical contributions of the performance test approach to the problem of evaluating shipboard performance.

It is considered that job-sample performance tests can be used by the Navy in the following ways:

1. They can be made a part of advancement in rate examinations.
   It is necessary to know if a man can perform the practical factors of his prospective pay grade. Objective performance tests can be used to standardize the measurement of practical requirements for advancement.

2. They can be included in training programs.
   a. To test the ability of men to apply the lessons they have learned.
   b. To point out possible areas of weakness in training courses.
   c. To provide training aids which closely approximate actual shipboard jobs.

3. They can be used as criterion measures of shipboard performance to validate selection and training procedures. The purpose of aptitude tests and training programs is to select and prepare men for various shipboard jobs. These selection and training procedures can only be evaluated and improved by measuring how well the men can perform their shipboard duties. Performance tests can provide objective measures of shipboard performance against which aptitude tests and training methods can be validated.

The usefulness and importance of job-sample performance tests in the Navy should be found to be great.

Chapter II

DESCRIPTION OF THE STUDY

Introduction

Shipboard performance of Navy enlisted men is regularly measured by assigning Quarterly Marks. These marks indicate the level of performance as appraised by Division Officers or Department Heads of men serving under them. Marks are given for conduct and proficiency in rate, and (depending on rate and pay grade) for leadership, mechanical ability, and seamanship.

The Quarterly Marks give a general impression of each enlisted man as seen through the eyes of his Division Officer or Petty Officer. They do not, however, adequately reflect the differences among men,[1] especially with regard to practical or technical abilities.

This research project set for itself the problem of determining if "job-sample" tests could provide reliable measures of enlisted men's abilities to perform the practical factors of their shipboard jobs. Two series or batteries of Practical Performance Tests were developed. These tests utilized standard Navy tools, instruments, and machinery, or mock-ups thereof. They were job samples of representative tasks which Electrician's Mates (EM's) or Enginemen (EN's) serving aboard submarines are expected to perform.

The Selection of the Tasks for the Practical Performance Tests

It was first necessary to go aboard ship and find out what submarine EM's and EN's do in their jobs. The techniques of shipboard job analyses were worked out in a preliminary investigation of EM jobs only. (The same techniques were

---

[1]There is a tendency for the marks to be bunched at or near the top of the 4.0 scale. A detailed discussion of this tendency will be found in Part II of this report.

later employed to develop the EN performance test battery.) The particular jobs studied were those of Third Class Petty Officers (3rd Class PO's).[2]

A tentative list of tests was made up using information gathered from the following sources:

1. Interviews with experienced shipboard personnel.
2. Shipboard job analyses.
3. Job breakdowns included in NavPers training manuals.
4. Performance tests developed for use in Class A Electrical Schools by the Applied Psychology Panel, NDRC (OSRD Report No. 5666).

Verbal descriptions and proposed scoring sheets of these tentative EM tests were taken to twenty Officers and Petty Officers[3] who were asked: "Is this test one which represents a regularly required job of a shipboard EM? About what level of difficulty does this test represent? Could a Striker perform it, or is it one that requires more experience and training? Is the task represented in this test an important one in the job of an EM? Are there other tasks which you think should be included?" In addition to these questions, the

---

[2] The study was confined to the 3rd Class PO level because:
a. The research could thus be concentrated within relatively homogeneous ranges of experience.
b. Jobs of pay grades higher than 3rd Class are broader in scope and require administrative functions as well as technical duties.
c. Tests designed for 3rd Class PO's could be administered to Strikers (potential 3rd Class PO's) thus increasing the number of men available for testing.
d. At the 3rd Class and Striker levels, men have not become over-specialized in their work.
e. As another part of this over-all study, aptitude tests were administered to the submarine school candidates at New London. Men taking these tests and subsequently becoming shipboard EM's and EN's would have, for the most part, advanced no further than the pay grade of 3rd Class PO.

[3] The sample of judges was made up as follows: 3 Lieutenant Commanders, 3 Lieutenants, 2 Lieutenants (jg), 4 Warrant Officers (electrician), 8 Chief EM's. These men were either stationed aboard submarines, aboard the submarine tender U.S.S. Sperry, or at the EM School at San Diego. All commissioned officers were either serving in engineering billets or were former enlisted EM's, or both.

Officer in Charge and the Head of Curriculum at the EM School at San Diego were asked whether or not the tests represented tasks which a school graduate should be able to perform.

An experimental series or battery of performance tests was constructed around the tasks selected and recommended by the judges. It included the following tests:

1. Fuse Testing
2. Identification of DC Motor Parts
3. Testing a Cable with a Megger
4. Ringing out a Cable
5. Connecting DC Motors
6. Identification of Motors
7. Identification of Cable Coding
8. Analysis of DC circuits

These tests were administered to 116 EM's serving either aboard submarines, aboard the submarine tender U.S.S. Sperry, or at the EM School, San Diego. The resulting scores were tabulated and analyzed.

This preliminary administration resulted in further revisions and refinements in the EM performance test battery, and pointed the way towards the development of the EN battery.[4] These two batteries are listed below in their final form. More complete descriptions of each test appear in the next chapter.

The EM Performance Test Battery

1. Control Cubicle Operation. (Testing knowledge of routine operations by paralleling generators.)

2. Use of a Megger:
   a. Ringing Out DC Motors. (Finding motor casualties with the use of a megger.)
   b. Ground Reading Test. (Determining resistance to ground readings.)

3. Circuit and Fuse Testing:

---

[4]Tests were dropped from the battery if their difficulty level was too high, if they were impractical from an administrative standpoint, or if there was no correlation between scores made on the test and the pay grades of the men making the scores. Tests were added to cover tasks suggested by Officers and Petty Officers helping in the administration of the tentative battery.

a. Circuits. (Determining if circuits are energized.)
b. Fuses (Determining if fuses in energized circuits are good.)

4. Repairing Sound-Powered Phones.

5. Storage Battery. (Checking specific gravity, temperature, etc.)

6. Use of Common Hand Tools. (Selecting tools for specific jobs.)

Also included in the EM battery were a test on safety precautions (photographs of safe and unsafe working procedures), and a written job-knowledge test (multiple-choice questions about the EM's job).

The EN Performance Test Battery

1. Use and Identification of Hand Tools:
   a. Use of Wrenches.
   b. Tool Naming.
   c. Drilling and Threading a Hole to Fit a Bolt.

2. Identification and Function of Valves:
   a Globe and Gate Valves.
   b. Air Compressor Valves.

3. Instrument Panel Analysis. (Taking readings from dial faces, and indicating maximal and minimal operating ranges.)

Written job-knowledge and safety tests, similar to the EM written tests, were included in the EN battery.

The EN performance tests were generally of the identification type. This was necessitated by the nature of the EN's job. He maintains and operates heavy and bulky machinery. Most maintenance tasks require coordinated effort; teamwork and adequate supervision are essential. Most operational tasks require the starting up of engines and various power plants, an undertaking which the project staff hesitated to request of the ships' commanding officers. For these reasons, there are not many individual operational, procedural, or diagnostic tasks upon which EN's could be tested. It is considered likely, however, that tests of these latter types could be developed and administered

in the everyday aboard ship situation.

All the tests in the EM and EN performance test batteries made use of standard Navy equipment to make each test as much like the real task as possible.

The Men Who Were Tested

The final forms of the Practical Performance Tests were administered to EM's and EN's serving aboard submarines in the Atlantic and Pacific Fleets. In San Diego there were 179 EM's and 211 EN's tested, while in New London 142 EM's and 193 EN's were tested, making totals of 321 EM's and 404 EN's. All pay grades were represented.

Tests were administered by staff members of the project. At capacity, two test administrators were able to test 20 men in a two hour period, running both EM's and EN's concurrently.

The men were told that the testing was experimental. Motivation in taking the tests was considered to be very good with most men finding the experience interesting.

Treatment of the Results

Frequency distributions of the raw scores made on each test were drawn up so that the raw scores could be converted into standard scores which would be comparable from test to test.[7] (The methods of scoring the individual tests are covered in detail in the next chapter.)

The reliabilities of the tests were computed in terms of the correlations between scores made on odd and even items or between scores made on the first

---

[7]The standard scores were expressed in terms of the Sten-scale. Sten-scores have values ranging from 0 to 9 inclusive, with the mean at 4.5; each score value covers an interval of one-half standard deviation.

and second halves of each test.

The standard scores made on each test were correlated with one another and with the average standard scores made on all tests. Correlations were also run between the scores made on each test and the pay grades of the men making the scores.[8]

[8] Where tetrachoric coefficients of correlation were computed in any of the analyses made, standard scores were split at the median in all cases.

Chapter III

DESCRIPTION OF THE PERFORMANCE TESTS AND THE RESULTS OF THEIR ADMINISTRATION

This chapter contains detailed descriptions of the tests in the EM and EN performance batteries. On pages 16 through 46, the EM job-sample and written tests are pictured and described. With each test the following information is presented.

1. Description: A verbal description of the equipment used in the test and the purpose of the test.
2. Directions: The directions given to each man who took the test.
3. Time: The time limit on the test. (Time limits were sufficiently long so that speed was not considered a factor in test completion.)
4. Number of items. Usually the same as the maximum raw score.
5. Scoring: The number of points per correct answer along with the maximum possible raw score.
6. Raw Score Results: The mean and standard deviation, or the median and quartile values, computed from the raw scores.
7. Correlation with Pay Grade: The relationship between scores made on the test and the pay grades of the men making the scores.
8. Reliability: Either an odd-even or split-half indication of test stability where such measures were appropriate.

Also presented with each test is a graph indicating the distribution of standard scores listed according to the pay grades of the men tested. The median standard scores and inter-quartile ranges of scores for Strikers, 3rd Class PO's, 2nd Class PO's, and 1st Class PO's are marked off, and the gradually ascending lines indicate graphically the correlation between performance level and pay grade.

Following the description of each test, the record or answer sheet (also called the "test sheet") used by the men taking the test is re-produced. If these sheets are read in conjunction with the tests to which they refer, a

fairly complete picture of the testing situation will be obtained.

On pages 49 through 73, the EN tests are pictured and described in the same manner as the EM tests.

On pages 47 and 74 are composite graphs showing the median standard scores and inter-quartile ranges of average standard scores on all tests for EM's and EN's in each pay grade.

On pages 75 and 76 are correlation matrices showing the coefficients of correlation computed between scores made on individual tests in the EM and EN batteries and between individual test scores and average composite battery scores.

The individual test results and the inter-test relationships are discussed in Chapter IV.

ELECTRICIAN'S MATE PERFORMANCE TEST BOOKLET

PRC n8 onr 70001

TEST RF 109

Name _____ Rate _____

Serial Number _____ Ship _____

Length of time on board _____ months

Length of time in rate _____ months

Length of time in Navy _____ months

Regular _____ Reserve _____ (Check one)

I

CONTROL CUBICLE

DESCRIPTION

The actual control cubicle aboard a submarine was utilized in this test. Controls used in specified operations were to be pointed out but not manipulated by the men taking the test.

DIRECTIONS:

"Show the exact operations you would go through to add generator No. 1 on the line while generator No. 3 is cut in. Generator No. 1 is running. Point out, in order, each knob and switch you would use. Tell what you are doing and what readings you are setting. Do not manipulate the controls.

"Now, secure No. 3 generator, leaving generator No. 1 cut in.

"Next, show how you would start a charge on the forward battery. Use generator No. 1, which is running but is not on the line. Engine No. 1 is running at 550 r.p.m. Battery temperature is 95 degrees."

TIME: 10 minutes

NO. ITEMS: 19

SCORING:

One point for each step on the check list of the proper procedure which was correctly carried out. Maximum possible raw score was 19.

RAW SCORE RESULTS:

Q_3	13.8
Median	12.2
Q_1	9.8

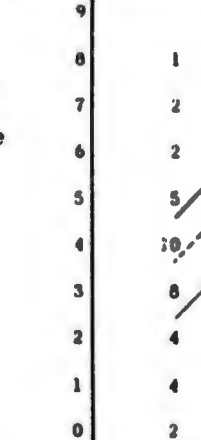
CORRELATION WITH PAY GRADE: .36

RELIABILITY:

.70 (odd-even, corrected), based on 111 cases.

DISTRIBUTION OF STANDARD SCORES BY PAY GRADE

Standard Scores	Strikers	3rd Class	2nd Class	1st Class	Totals
9			1	1	2
8	1	4	4	2	11
7	2	5	4	2	13
6	2	11	2		15
5	5	6	6		17
4	10	8	6		24
3	8	6	1		15
2	4	1	1		6
1	4		2		6
0	2				2
N	38	41	27	5	111
Median	3.6	5.4	5.1	7.	4.6



RECORD SHEET

TEST RF 109-1

CONTROL CUBICLE OPERATIONS

Directions (to be read to subject): THIS IS A TEST OF YOUR ABILITY TO CONDUCT CERTAIN OPERATIONS IN THE MANEUVERING ROOM. IN THIS TEST YOU WILL NOT ACTUALLY DO A JOB, BUT ONLY GO THROUGH THE MOTIONS OF DOING IT. YOU MAY POINT OR PLACE YOUR HANDS ON THE SWITCHES AND CONTROLS AND TELL ME WHAT YOU ARE DOING AND WHAT METER READINGS YOU WOULD BE SETTING. DO NOT ACTUALLY CUT IN THE SWITCHES OR ADJUST THE CONTROLS.

FIRST, SHOW ME THE EXACT OPERATIONS YOU WOULD GO THROUGH TO ADD GENERATOR NUMBER ONE ONTO THE LINE WHILE GENERATOR NUMBER THREE IS CUT IN. GENERATOR NUMBER ONE IS RUNNING.

POINT OUT EACH KNOB AND SWITCH THAT YOU WOULD USE IN THE PROPER ORDER, AT THE SAME TIME TELL ME WHAT YOU ARE DOING AND WHAT READINGS YOU ARE SETTING ON THE METERS.

DO YOU HAVE ANY QUESTIONS?

		Encircle one	
1.	Cut in Engine Governor for ENGINE NO. ONE	YES	NO
2.	Matched engine speeds with GOVERNOR NO. ONE	YES	NO
3.	Cut in the field of GENERATOR NO. ONE (Sel. sw. or Rheostat)	YES	NO
4.	Set voltage on GENERATOR NO. ONE 2-5 volts above generator no. three voltage	YES	NO
5.	Threw GENERATOR NO. ONE onto the line	YES	NO
6.	Matched amperage for generators one and three using RHEOSTAT NOS. ONE AND THREE	YES	NO
7.	Clutched NO. ONE AND THREE GENERATORS together	YES	NO

NOW, SECURE NUMBER THREE GENERATOR LEAVING GENERATOR NO. ONE CUT IN.

1.	Unclutched NO. ONE AND THREE GENERATORS	YES	NO
2.	Decreased amperage on GENERATOR THREE with RHEOSTAT NO. THREE	YES	NO
3.	Simultaneously adjusting GENERATOR NO. ONE AMPERAGE with RHEOSTAT NO. ONE	YES	NO
4.	Brought GENERATOR NO. THREE SELECTOR SWITCH to OFF when load dropped to 1-200 amperes	YES	NO
5.	With GOVERNOR NO. THREE, brought engine no. three to idling speed (450-550 RPM)	YES	NO
6.	Turned GOVERNOR NO. THREE OFF	YES	NO

NOW SHOW ME HOW YOU WOULD START A CHARGE ON THE FORWARD BATTERY. USE GENERATOR NUMBER ONE WHICH IS RUNNING BUT NOT ON THE LINE. ENGINE NUMBER ONE IS RUNNING AT 550 RPM. BATTERY TEMPERATURE IS 95 DEGREES.

		Encircle one	
1.	Threw battery selector lever to FWD. BATTERY ON	YES	NO
2.	Cut in field current on generator number one	YES	NO
3.	With RHEOSTAT ONE, brought generator number one voltage 2-5 volts above battery voltage	YES	NO
4.	Threw generator SELECTOR SWITCH to battery bus	YES	NO
5.	Used TVG calculator or chart to tell what voltage to use to keep from gassing (cutting voltage)	YES	NO
6.	Simultaneously used RHEOSTAT NUMBER ONE and GOVERNOR NUMBER ONE to bring generator number one ammeter to 3600 without exceeding 294 volts	YES	NO

II-A

USE OF A MEGGER:

RINGING OUT D.C. MOTORS

DESCRIPTION

A megger was used to find open circuits and grounds in series-wound and compound-wound DC motors. Casualties had been built into the motors.

DIRECTIONS:

"Using a megger, ring out the two DC motors in front of you. Locate any grounds or opens which may exist in either motor. Indicate the condition of the field and armature circuits."

TIME: 10 minutes.

NO. ITEMS: 7

SCORING:

One point for each field and armature circuit condition correctly determined, except in one case where a partially correct determination received half credit. Maximum possible raw score was 7.

RAW SCORE RESULTS:

Q_3	3.1
Median	2.1
Q_1	1.2

CORRELATION WITH PAY GRADE: .25

RELIABILITY:

.58 (split half, corrected), based on 208 cases.

DISTRIBUTION OF STANDARD SCORES BY PAY GRADE

Standard Scores	Strikers	3rd Class	2nd Class	1st Class		Totals
9	1	2	3	1		7
8	9	5	8	6		28
7	1	6	3	9	Q_3	19
6	16	22	19	5		62
5	15	20	7	7	Mdn.	49
4	31	29	13	6	Q_1	79
3	20	12	10	8		50
2	2	3	1			6
1	7	7	2	1		17
0						
N	102	108	66	43		317
Median	4.2	4.6	5.5	5.4		4.6

Raw Score _____
Time Started _____
Time Finished _____

RECORD SHEET

TEST RF 109-2

USE OF A MEGGER

A. Ringing Out D.C. Motors

Directions: USING A MEGGER, RING OUT THE TWO D.C. MOTORS IN FRONT OF YOU. LOCATE AND IDENTIFY ALL GROUNDS OR OPENS WHICH MAY EXIST IN EACH MOTOR.

PLACE AN X IN THE TABLE BELOW TO INDICATE THE CONDITION OF THE RESPECTIVE FIELD AND ARMATURE CIRCUITS. IF, USING THE MEGGER ALONE, YOU ARE UNABLE TO DETERMINE THE CIRCUIT ELEMENT IN WHICH A CASUALTY OCCURS, PLACE A QUESTION MARK IN ALL PLACES WHERE THE CASUALTY MIGHT BE.

TIME LIMIT: TEN MINUTES

Condition	Compound D.C. Motor			Series D.C. Motor	
	Shunt Field	Series Field	Armature Circuit	Series Field	Armature Circuit
Grounded					
Open					
Good (None of above)					

II-B

USE OF A MEGGER:

GROUND READING TEST

DESCRIPTION

A standard Navy lighting distribution box had grounds and resistances inserted into some of its subcircuits. A megger was used to obtain ground readings on all of the lighting branches coming out of the box.

DIRECTIONS:

"Measure the insulation to ground reading on all lighting branches coming out of this distribution box. Record the readings of each circuit lead in the space provided."

TIME: 10 minutes.

NO. ITEMS: 21

SCORING:

One point for each correct reading. Maximum possible raw score was 21.

RAW SCORE RESULTS:

Q_3	14.2
Median	10.8
Q_1	.1*

CORRELATION WITH PAY GRADE: .41

RELIABILITY:

Not determined. Only test-retest or alternate forms methods were applicable because of the distribution of scores.

*There were 125 scores of zero on the test. This was a result of the serialization of items in the test. See Chapter VI for a discussion of this factor in test construction.

PROPORTION PASSING BY PAY GRADE

Standard Scores*	Strikers	3rd Class	2nd Class	1st Class	Totals
9					
8					
7					
6	Pass .34	.53	.72	.69	
5					
4					
3	Fail .65	.47	.28	.31	
2					
1					
0					
N	99	104	67	42	312

*Shape of distribution was U-shaped so the scale was cut at the midpoint and the subject was scored as "Pass" or "Fail".

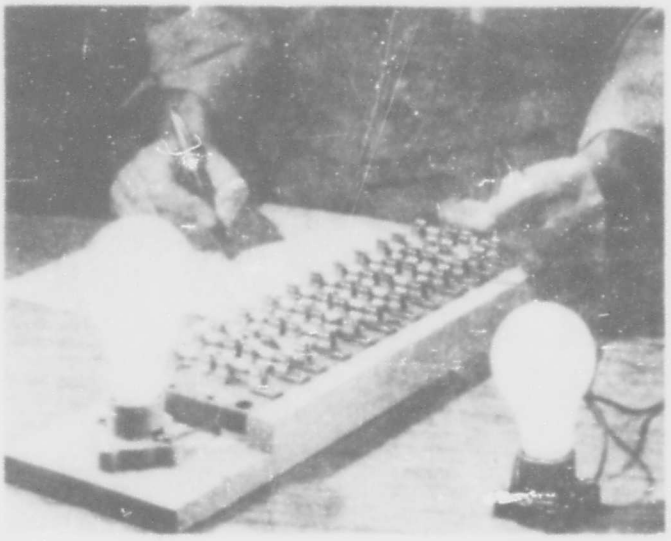
Raw Score _____
Time Started _____
Time Finished _____

B. Ground Tests with a Megger:

Directions: SUBMAIN 3FB 101 IS ENERGIZED. YOU ARE TO MEASURE THE INSULATION TO GROUND READING ON ALL LIGHTING BRANCHES COMING OUT OF THIS PANEL. RECORD THE READINGS OF EACH CIRCUIT LEAD IN THE SPACE BELOW. IF THE READING INDICATES A GROUND IS PRESENT, PLACE AN X IN THE SPACE PROVIDED IN THE TABLE.

TIME LIMIT: TEN MINUTES

	First Branch of Circuit		Second Branch of Circuit	
Circuit	Reading	Ground Indicated	Reading	Ground Indicated
3FB 101 A				
3FB 101 B				
3FB 101 C				
3FB 101 D				
3FB 101 E				
3FB 101 F				
3FB 101 G				
3FB 101 H				



III-A

CIRCUIT AND FUSE TESTING: CIRCUITS

DESCRIPTION

A standard Navy twelve circuit fuse panel was modified so that some of the circuits were not energized and some of the fuses were blown. In this part (A) of the test, only the circuits were to be tested. Wiggins Testers or test lamps were used.

DIRECTIONS:

"Using the voltage tester, check each of the twelve circuits on the test board and indicate on your answer sheet whether or not each of the circuits is energized."

TIME: 5 minutes.

NO. ITEMS: 12

SCORING:

One point for each correct answer. Maximum possible raw score was 12.

RAW SCORE RESULTS:

Q_3	11.6
Median	11.2
Q_1	10.4

CORRELATION WITH PAY GRADE: .40

RELIABILITY:

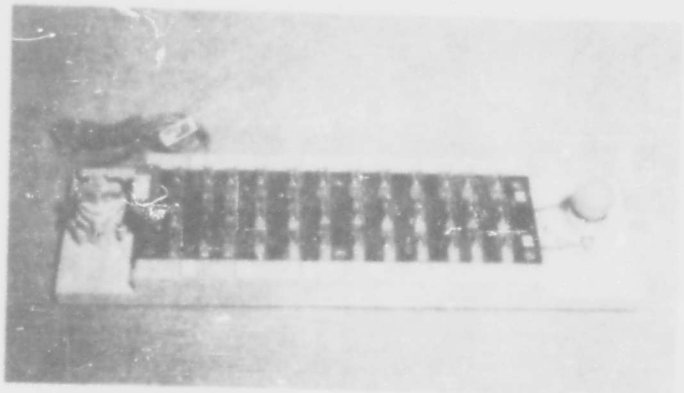
.93 (split half, corrected), based on 321 cases.

DISTRIBUTION OF STANDARD SCORES BY PAY GRADE

Standard Scores*	Strikers	3rd Class	2nd Class	1st Class	Totals
6	46	66	50	35	199
5					
4	26	19	10	2	57
3	7	3	2		12
2	4	3	1	1	9
1	15	14	3	4	36
0	2	1	1		4
N	102	106	67	42	317
Median	4.4	5.7	5.8	5.9	5.7

Q_3 Mdn. Q_1

*Shape of distribution was skewed. A standard score of 6 is the moment this portion of the sample represents.



III-B

CIRCUIT AND FUSE

TESTING: FUSES

DESCRIPTION

The same standard fuse panel used in III-A was used here. In this part (B) the condition of the fuses in each energized circuit was to be determined. The same test sheet (see next page) was used in both III-A and III-B.

DIRECTIONS:

"If you have found a circuit to be energized (see Part A), test both of the fuses in that circuit and indicate whether or not each fuse is good."

TIME: 5 minutes.

NO. ITEMS: 24 (this is the total possible number of items; the number of fuses tested depended on the number of circuits an EM thought to be energized).

SCORING:

Final score was the proportion of correct answers to the total number of answers given. Maximum possible raw score (proportional) was 1.0.

RAW SCORE RESULTS:

Q_3	.96
Median	.91
Q_1	.79

CORRELATION WITH PAY GRADE: .20

RELIABILITY:

.84 (split half, corrected), based on 208 cases.

DISTRIBUTION OF STANDARD SCORES BY PAY GRADE

Standard Scores*	Strikers	3rd Class	2nd Class	1st Class	Totals
9					
8					
7					
6	52	76	47	31	206
5					
4	17	8	9	4	38
3	21	12	6	5	44
2	7	8	2	1	18
1	3		2		5
0	2	2	1	1	6
N	102	106	67	42	317
Median	5.5	5.8	5.8	5.8	5.8

Q_3 Mdn. Q_1

*Shape of distribution was skewed. A standard score of 6 is the moment this portion of the sample represents.

Raw Score _____
Time Started _____
Time Finished _____

RECORD SHEET

TEST RF 109-3

FUSE TESTING

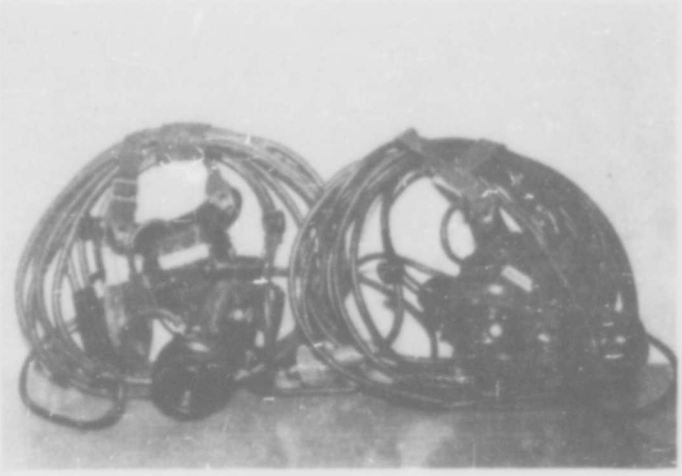
Directions: USING THE VOLTAGE TESTER, SEE IF CIRCUIT NO. 1 IS ENERGIZED. IF IT IS ENERGIZED, WRITE PLUS (+) TO THE RIGHT OF "A" AND UNDER "1" IN THE TABLE BELOW; IF THE CIRCUIT IS NOT ENERGIZED, WRITE ZERO (0).

IF THE CIRCUIT IS NOT ENERGIZED, OMIT QUESTIONS "B" AND "C" BELOW. IF IT IS ENERGIZED, TEST FUSE A AND WRITE PLUS (+) IN THE CORRECT SPACE IF IT IS GOOD, OR ZERO (0) IF IT IS OPEN. DO THE SAME FOR FUSE B.

FOLLOW THE SAME PROCEDURE FOR EACH OF THE 12 NUMBERED CIRCUITS.

TIME LIMIT: TEN MINUTES

	CIRCUIT NUMBER											
	1	2	3	4	5	6	7	8	9	10	11	12
A. Is the circuit energized?												
B. Is Fuse A good?												
C. Is Fuse B good?												



IV

REPAIRING SOUND-POWERED TELEPHONES

DESCRIPTION

Open circuits and shorts were inserted at various points in each of two sets of regulation sound-powered telephones. All casualties could be found without special test equipment.

DIRECTIONS:
"Find out what parts in each of these two telephone sets have casualties and place a checkmark in the appropriate place on the answer sheet. Then choose from the list of Repair Methods the one you would use to correct each casualty."

TIME: 15 minutes.

NO. ITEMS: 8

SCORING:
One point for each casualty found, and one point for each correct repair method chosen. Maximum possible raw score was 8.

RAW SCORE RESULTS:
Mean 2.8
S.D. 1.8

CORRELATION WITH PAY GRADE: .13

RELIABILITY:
.52 (split half, corrected), based on 206 cases.

DISTRIBUTION OF STANDARD SCORES BY PAY GRADE

Standard Scores	Strikers	3rd Class	2nd Class	1st Class	Totals
9	6	9	2	6	23
8					
7	7	10	4	5	26
6	18	16	17	12	63
5	19	23	17	7	66
4	25	21	12	9	67
3	13	15	12	3	43
2	13	11	3		27
1					
0					
N	101	105	67	42	315
Median	4.5	4.7	4.9	5.7	4.8

Q_3 Mdn. Q_1

Raw Score _____
Time Started _____
Time Finished _____

RECORD SHEET

TEST RF 109-4

REPAIRING SOUND-POWERED TELEPHONES

Directions: THESE TELEPHONES HAVE CASUALTIES AND NEED TO BE REPAIRED. FIND OUT WHAT PARTS OF EACH TELEPHONE SET HAVE CASUALTIES. PLACE A CHECKMARK IN THE BOX BELOW BY EACH PART WHICH HAS A CASUALTY. DO THIS FOR EACH SET OF TELEPHONES.

THEN CHOOSE FROM THE LIST OF POSSIBLE REPAIR METHODS THE ONE THAT COULD BEST BE USED TO REMEDY THE CASUALTIES YOU FOUND AND PLACE ITS NUMBER IN THE APPROPRIATE BOX UNDER "REPAIR METHODS."

TIME LIMIT: FIFTEEN MINUTES

Telephone Part	Casualty		Repair Method	
	Set 1	Set 2	Set 1	Set 2
Earpiece 1				
Earpiece 2				
Transmitter				
Earpiece 1 lead				
Earpiece 2 lead				
Transmitter lead				
Transmitter switch				
Connection box				
Main lead				
Jack				

REPAIR METHODS

1. Replace earpiece
2. Replace transmitter
3. Shorten lead and make a new connection
4. Solder-splice lead at break
5. Replace with a new lead
6. Replace switch
7. Repair switch
8. Replace connection box
9. Resolder connection in connection box
10. Replace jack
11. Locate and remove ground in jack

DIRECTIONS:
"The small portable storage battery on the table is identical in principle with the much larger submarine storage battery. Using the tools and equipment on the table as needed, answer the questions on the test sheet."

TIME: 5 minutes.

NO. ITEMS: 8

SCORING:
One point for each question answered correctly. Maximum possible raw score was 8.

RAW SCORE RESULTS:

Mean	4.9
S.D.	1.9

CORRELATION WITH PAY GRADE: .43

RELIABILITY:
.57 (split half, corrected), based on 176 cases.

V

STORAGE BATTERIES

DESCRIPTION

A small portable storage battery was filled with a non-corrosive electrolyte, the specific gravity of which was so adjusted as to indicate that the battery needed charging. The test sheet contained questions to be answered concerning the condition of the battery and the kind of equipment used in testing it.

DISTRIBUTION OF STANDARD SCORES BY PAY GRADE

Standard Scores	Strikers	3rd Class	2nd Class	1st Class	Totals
9		3	3	2	8
8	4	8	8	9	29
7					
6	6	8	10	11	35
5	13	12	3	6	34
4	13	14	3	3	33
3	4	3	4	6	17
2	8	3			11
1	4	3			7
0	1			1	2
N	53	54	31	38	176
Median	4.2	4.8	6.0	5.8	5.0

Raw Score _____
Time Started _____
Time Finished _____

RECORD SHEET

TEST RF 109-5

STORAGE BATTERIES

Directions: THE SMALL PORTABLE STORAGE BATTERY WHICH IS ON THE TEST TABLE IN FRONT OF YOU, IS IDENTICAL IN PRINCIPLE WITH THE MUCH LARGER SUBMARINE STORAGE BATTERY. USING THE TOOLS AND EQUIPMENT ON THE TABLE IN FRONT OF YOU AS NEEDED, ANSWER THE FOLLOWING QUESTIONS.

TIME LIMIT: FIVE MINUTES

---

1. Which of the hydrometer floats on the table in front of you would you use in a hydrometer, to measure the specific gravity of a submarine storage battery?

   A. _____
   B. _____
   C. _____

2. What is the uncorrected specific gravity of the small portable storage battery? . . . . . _____

3. What is the temperature of the electrolyte? . . . _____

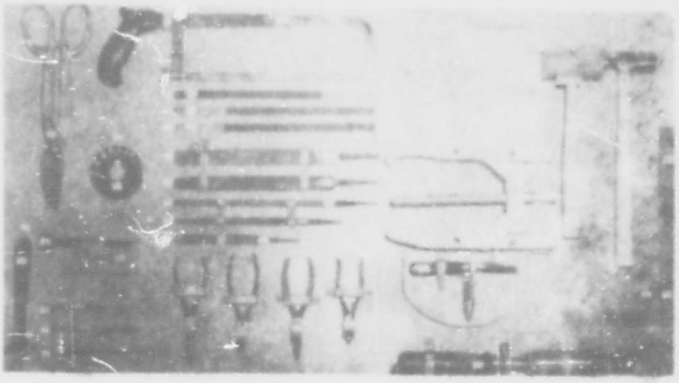
4. What is the temperature correction in points of gravity? . . . . . _____

5. What is the maximum voltage that may be applied at this temperature without the battery gassing while charging? . . . . . _____

6. What is the corrected Specific Gravity of the battery? . . . . . _____

7. If this were actually a submarine storage battery, and you had secured these readings, would the battery need charging? . . . . . _____

8. Does this battery need water? . . . . . _____



VI

USE OF COMMON HAND TOOLS

DESCRIPTION

Common hand tools were arranged on a board and numbered. Tasks requiring the use of tools were listed on the test sheet. EM's indicated, by number, the tool or tools they would use for each task. The same tool boards were used in certain EN performance tests.

DIRECTIONS:

"In the blank appearing after each question, place the number of the tool on the tool board that you would use in doing the specified task. If the task calls for more than one tool, list the number of every tool which you would use."

TIME: 15 minutes.

NO. ITEMS: 20

SCORING:

Two points for each correct answer. If more than one tool was called for, fractional scores were given for each tool correctly named. If a tool other than one specified as correct was named and was considered reasonably adequate for the task in question, partial credit was given.

RAW SCORE RESULTS:

Mean	24.6
S.D.	5.2

CORRELATION WITH PAY GRADE: .49

RELIABILITY:

.63 (odd-even, corrected), based on 252 cases.

DISTRIBUTION OF STANDARD SCORES BY PAY GRADE

Standard Scores	Strikers	3rd Class	2nd Class	1st Class	Totals
9	1		4	5	10
8	4	4	11	6	25
7	2	12	11	1	26
6	11	18	13	11	53
5	15	17	11	7	50
4	23	31	11	6	71
3	21	15	2	5	43
2	14	5	4	1	24
1	7	3		1	11
0	4	1			5
N	102	106	67	43	318
Median	3.7	4.5	5.9	5.5	4.6

Q_3 Mdn. Q_1

Raw Score _____
Time Started _____
Time Finished _____

RECORD SHEET

TEST RF 109-6

USE OF COMMON HAND TOOLS

Directions: IN THE BLANK APPEARING AFTER EACH OF THE JOB QUESTIONS BELOW, PLACE THE NUMBER OF EACH TOOL ON THE TOOLBOARD THAT YOU WOULD USE IN DOING THE JOB.

IF A JOB CALLS FOR MORE THAN ONE TOOL, LIST THE NUMBER OF EVERY TOOL WHICH YOU WOULD USE IN THAT JOB.

FOR EXAMPLE:

A. What tool or tools would you use in unscrewing a screw with a one-half inch in diameter from a flat open plate? 118 (screwdriver)

B. What tool or tools would you use to thread a blind hole that is one inch deep to fit a 5/16-24 bolt? 143, 144, 145 (taper, plug & bottoming taps)

DO YOU HAVE ANY QUESTIONS?

TIME LIMIT: FIFTEEN MINUTES

---

1. Choose the tool or tools you would need to drive a small taper pin into an armature shaft? _____

2. What tool or tools would you use in smoothing controller contacts? . . . . . _____

3. What tool or tools would you use to measure the exact size wrench to use on a nut? . . . . . _____

4. What tool or tools would you use to cut armored cable? . . . . . _____

5. What tool or tools would you need to remove a roller bearing from an armature shaft? . . . . . _____

6. What tool or tools would you use to enlarge a 3/8" hole by a sixteenth of an inch (diameter) in a piece of 1/8" metal? . . . . . _____

7. Assuming you have a vise, what additional tool or tools would you need to solder a wire to a lug? . . . . . _____

(Turn to next page)

8. What tool or tools would you use to cut off the head of a bolt rusted to a steel plate? . . . . . _____

9. What tool or tools would you use to determine the number of threads to the inch on a screw? . . . . _____

10. What tool or tools would you use to make a perfectly round hook in the end of a piece of heavy wire? . . . . . _____

11. What tool or tools would you use to cut heavy wire? . . . . . _____

12. Choose the tool or tools you would use to tighten a 3/4" nut on a main battery . . . . . _____

13. If you did not have a die, what tool or tools could you use to restore the thread on a 1/2" bolt that had been partly mashed? . . . . . _____

14. A section five inches square is to be cut from a two foot length of 1/8" steel plate. What tool or tools would you have to use? . . . . . _____

15. If you were going to use a hammer in cutting this five inch square section from 1/8" plate, what other tool or tools would you use? . . . . . _____

16. What tool or tools would you use to make a 27/64" hole in 1/8" steel plate? . . . . . _____

17. What tool or tools would you use to square a 3/8" round hole in 1/16" steel plate? . . . . . _____

18. What tool or tools would you use to deepen the keyway in an armature shaft which is one inch in diameter? . . . . . _____

19. What tool or tools would you use to compare the diameters of two lengths of circular wire?. . _____

20. What tool or tools would you use to cut off a section of 1/4" copper tubing? . . . . . _____

SAMPLE ITEM

A cable has been exposed to water and you wish to find if it is safe to operate. You would use:

(1) An ammeter
(2) A hydrometer
(3) A megger
(4) A power factor meter
(5) A potentiometer

VII

JOB KNOWLEDGE

DESCRIPTION

This was a written test consisting of forty multiple-choice questions about the practical and theoretical aspects of the EM's job.

DIRECTIONS:
"In this test booklet you will find incomplete statements followed by five alternative endings. You are to select the alternative ending which correctly, or most nearly correctly, completes each statement."

TIME: 30 minutes.

NO. ITEMS: 40

SCORING:
One point for each correct answer. Maximum possible raw score was 40.

RAW SCORE RESULTS:

Q_3	29.5
Median	27.0
Q_1	22.2

CORRELATION WITH PAY GRADE: .50

RELIABILITY:
.86 (odd-even, corrected), based on 306 cases.

DISTRIBUTION OF STANDARD SCORES BY PAY GRADE

Standard Scores	Strikers	3rd Class	2nd Class	1st Class		Totals
9	2	2	4	7		15
8	2	13	7	11	Q_3	33
7	2	4	9	3		18
6	15	24	17	8	Mdn.	64
5	16	21	15	4	Q_1	56
4	23	22	10	3		58
3	21	11	1	2		35
2	10	3	2	1		16
1	10	4	1	2		17
0	1					1
N	102	104	66	41		313
Median	3.9	5.1	5.7	6.6		4.0

EXAMINATION FOR ELECTRICIAN'S MATE

FORM A

INSTRUCTIONS: This is a test of your knowledge of procedures, functions, and definitions with which submarine electrician's mates should be familiar. In this test booklet you will find incomplete statements followed by five alternatives. You are to select the alternative which makes the best or most nearly correct complete statement. After selecting the correct alternative, make a heavy mark in the answer space provided on the SEPARATE ANSWER SHEET. DO NOT MAKE ANY MARKS IN THIS TEST BOOKLET. Before starting the examination, fill in on the separate answer sheet your name, service number, present rate, and ship or station to which you are attached for duty.

As an example answer the following item using your answer sheet:

1. A cable has been exposed to water and you wish to find if it is safe to operate it. You would use:

(1) An ammeter
(2) A hydrometer
(3) A megger
(4) A power factor meter
(5) A potentiometer

The correct answer to the above is of course (3) "A megger." You should have made a heavy black mark in the third space following the heavy numeral "1." on the separate answer sheet.

Give only one answer to each question. Double answers are graded as being incorrect. If you do not know the answer to any item, you may guess, but avoid wild guessing, because your total score will be the number of right answers minus a small fraction of the number of wrong answers. You will have 30 MINUTES to work on the test. If you finish before time is called, you may go back to check your work.

BE CERTAIN BEFORE STARTING THE TEST THAT YOUR NAME IS ON THE SEPARATE ANSWER SHEET.

DO NOT MAKE ANY MARKS IN THIS TEST BOOKLET.

PRC RK 113-1

2. The main reason a battery charging room must be kept ventilated is to:

(1) Keep the battery temperature down
(2) Keep the man on the battery watch alert
(3) Provide oxygen for the recharging process
(4) Prevent an accumulation of explosive gases
(5) Provide hydrogen for the recharging process

3. In order to hold a motor shaft from turning while the end-nut is being tried for tightness; you would use a:

(1) Stillson wrench
(2) Monkey wrench
(3) Spanner wrench
(4) Strap wrench
(5) Adjustable wrench

4. In tapping a hole that is 1" deep, and does not go through the metal, you would use taps in the following order:

(1) Taper, plug, and bottoming
(2) Plug, taper, and bottoming
(3) Taper, bottoming, and plug
(4) Bottoming, taper, and plug
(5) Taper, and then plug tap is all that is necessary

5. To prevent a twist drill from wandering, when starting to drill, you should use:

(1) A pin punch
(2) A starting punch
(3) A center punch
(4) A prick punch
(5) An alining punch

6. The metal working hammers divide themselves into two classifications: hard-faced and soft-faced. The hard-faced hammers are made of tool steel and the soft-faced are made of such material as brass, copper, etc. To fit a pulley to a shaft, you would use:

(1) Ball peen hammer
(2) Cross-peen hammer
(3) Setting hammer
(4) Soft-faced hammer
(5) Straight peen hammer

7. When using a cold chisel, keep your eye on the:

(1) Cutting edge
(2) Work
(3) Vise
(4) Chisel head
(5) Hammer head

8. A tachometer is used to check the:

(1) Effectiveness of the lubrication in the bearings
(2) Tension on the brush holder springs
(3) Torque exerted on a motor shaft
(4) The number of threads per inch on a screw
(5) Revolutions per minute of a shaft

9. The proper wrench to use on a pipe is:

(1) A monkey wrench
(2) A stillson wrench
(3) An open end wrench
(4) A plier wrench
(5) An adjustable wrench

10. If the jack on a sound-powered telephone headset were short circuited because of a defect:

(1) The set could transmit but not receive
(2) The set could receive but not transmit
(3) The set could either transmit or receive but the rest of the circuit would be inoperative
(4) The whole circuit would be inoperative
(5) The circuit would still function satisfactorily

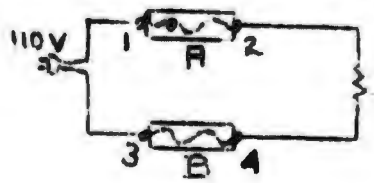
11. Sound-powered head sets should be stowed:

(1) On adjacent jack boxes
(2) Neatly coiled and laid on deck
(3) By returning to the electrical shop
(4) By coiling and stowing in boxes adjacent to the station
(5) In the telephone talkers locker

12. The most common fault with sound-powered telephones is:

(1) Broken leads
(2) Moisture
(3) Loss of power
(4) Cross talk
(5) Jacks shorted out

13. In checking whether Fuse A is good or not, in the circuit below, a voltage tester should be placed across the points:



(1) 1-2
(2) 2-3
(3) 3-4
(4) 1-4
(5) 2-4

14. If in checking a DC compound motor with a megger, a very low resistance reading was obtained at each of the two terminal leads, you could say that:

(1) The Series field has a ground in it
(2) The shunt field has a ground in it
(3) There are no grounds in the circuit and it might therefore be assumed that the motor is in operating order
(4) You could not infer the condition of the motor from the above information alone
(5) At least one ground is present in the motor, and it is therefore not in working order

15. In checking a lighting distribution box for grounds, the first step is to:

(1) Attach the ground lead of the megger to the frame of the ship, and the other lead to the part of the distribution circuit being tested
(2) Turn all switches on the box to the "OFF" position
(3) Remove all fuses in the box
(4) Ground the frame of the distribution box if not already grounded
(5) Replace all bad fuses

16. If you were told to place a DC generator in parallel with one already in operation, the first step to take would be to:

(1) Turn field rheostat on second generator to low
(2) Match engine speeds with engine governors
(3) See that all switches connected with the second generator are open
(4) Set the voltage on the second generator 2-5 volts above that of the first generator
(5) Decrease load on the generator which was already operating

17. Before securing one of two generators operating in parallel, the first step is to:

(1) Reduce load on the machine to be secured
(2) Check the load to see that it does not exceed the capacity of the remaining generator
(3) Make sure the circuit breaker is open and all field resistance is cut in
(4) Make sure the voltage on the generator to be secured is a few volts lower
(5) Match engine speeds with engine governors

18. If the uncorrected specific gravity of a submarine battery is 1.212 and the height of the electrolyte is -2, and the temperature for the electrolyte is 92, the corrected specific gravity is:

(1) 1.212
(2) 1.214
(3) 1.216
(4) 1.210
(5) 1.208

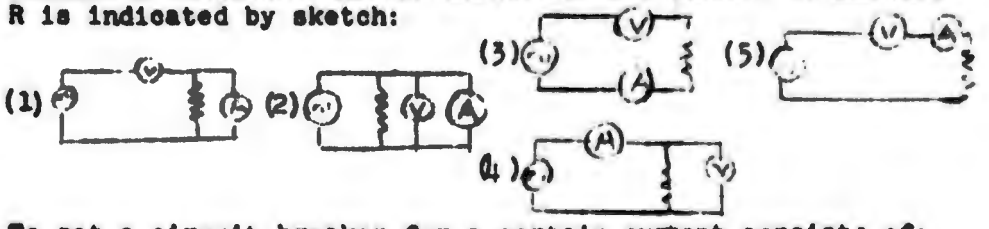
19. The tops of storage batteries should be cleaned with a solution of:

(1) Vinegar
(2) Sulphuric acid
(3) Baking soda
(4) Lead peroxide
(5) Carbon tetrachloride

20. A submarine battery would need charging if the specific gravity was:

(1) 1.205
(2) 1.240
(3) 1.235
(4) 1.180
(5) 1.150

21. The value of a given resistance R could be determined by making certain current and voltage measurements. The correct way to connect a voltmeter and an ammeter in the circuit to measure R is indicated by sketch:



22. To set a circuit breaker for a certain current consists of:

(1) Changing the distance of the armature to the electromagnet
(2) Filing down the carbon contact
(3) Increasing the amount of tension on the latch spring
(4) Increasing the resistance of the electromagnet
(5) Decreasing the amount of tension on the latch spring

23. Improper lubrication of motors is usually a result of:

(1) Using too little oil
(2) Using too much oil
(3) Using the wrong type of oil
(4) Oiling the wrong parts
(5) Dirty lubricating oil

24. In synchronizing alternators the synchroscope indicates differences in:

(1) Voltage
(2) Power factor
(3) Frequency
(4) Phase
(5) Impedance

25. Alternators might be damaged by accidently connecting them in parallel if it were not for:

(1) Equalizers
(2) Interlocks
(3) Synchroscopes
(4) Power limit stops
(5) Power factor meters

26. Which of the following connections would do the most damage?

(1) Voltmeter in series on one side of the line
(2) Voltmeter across the line
(3) Ammeter in series on one side of the line
(4) Ammeter across the line
(5) Voltmeter and ammeter on the line in series

27. If the speed of a rotating shaft is determined to be 52 revolutions in 7 seconds, what is its RPM?

(1) 7.428
(2) 364.0
(3) 445.68
(4) 74.28
(5) 36.40

28. The main reason for removing an accidental ground at once is:

(1) It causes too much voltage drop
(2) It produced electrical interference in the telephone circuits
(3) Another ground elsewhere in the circuit may produce a short circuit
(4) It produces electrolytic action which may corrode the hull of the ship
(5) It will cause switchboard meters to operate incorrectly

29. The switchboard ground detector should be kept in the circuit:

(1) At all times
(2) When starting up a generator
(3) Only when taking ground readings
(4) At least 4 hours a day
(5) At least once a week

30. Carbon tetrachloride is useful to combat electrical fires except when:

(1) The voltage exceeds 400
(2) Gasoline is also involved in the fire
(3) Salt water is present
(4) Ventilation is inadequate
(5) Fresh water is present

31. Ringing through a cable would enable one to detect:

(1) Open circuit
(2) A series circuit
(3) A parallel circuit
(4) A compound circuit
(5) A reactive circuit

32. What is the diameter of a 5625 circular mil wire?

(1) 5.625"
(2) .005625"
(3) .075"
(4) .00375"
(5) .5625"

33. The use of oil on insulated wire:

(1) Impregnates the insulation and raises the dielectric strength
(2) Preserves the insulation by excluding moisture
(3) Prevents insulation breakdown from mechanical abrasion
(4) Causes the insulation to deteriorate
(5) Extends the life of the cable

34. Which type of motor should never be used with a belt drive?

(1) Series wound motor
(2) Shunt wound motor
(3) Cumulative compound
(4) Differential compound
(5) Induction motor with squirrel cage rotor

35. If a voltmeter reading is 12 and the ammeter reading is 48, the ohmeter reading is:

(1) 4
(2) .25
(3) 576
(4) 40
(5) .4

36. The most important requirement for good motor maintenance is:

(1) Keep bearings full of grease
(2) Keep motor windings clean and dry
(3) Keep motor well painted
(4) Check terminals connections daily
(5) Keep it well ventilated

37. A ground on one side of a power line:

(1) Increases the danger of shock on both AC and DC
(2) Decreases the danger of shock on both AC and DC
(3) Has no effect on the danger of shock
(4) Increases the danger with DC but decreases it with AC
(5) Increases the danger with AC but decreases it with DC

38. In order to reverse the directions of rotation of a shunt motor, you would reverse the leads to the:

(1) Starting resistance
(2) Field rheostat
(3) Armature, or field
(4) Armature and field
(5) Starting resistance and field rheostat

39. Most AC voltmeters are calibrated to read:

(1) Instantaneous voltage
(2) Average voltage
(3) Effective voltage
(4) Maximum voltage
(5) Minimum voltage

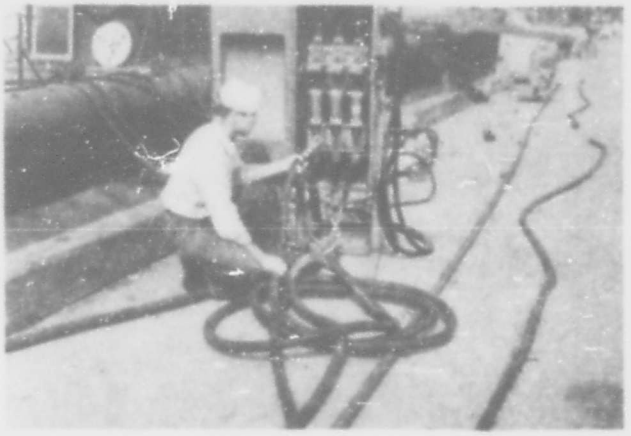
40. When mixing electrolytes:

(1) The acid should be poured into the water
(2) The water should be poured into the acid
(3) No precaution is necessary
(4) The mixing may be performed in the batteries
(5) Use galvanized iron bucket

41. After a generator is shut down, the spaces between commutator bars should be cleaned of carbon dust using:

(1) A wire brush
(2) Dry air
(3) Soapy water
(4) Damp rag
(5) Carbon tetrachloride

SAMPLE PICTURE



VIII

SAFETY

DESCRIPTION

A booklet of photographs taken aboard a submarine was assembled which showed crew members engaged in various routine and non-routine activities. In some of the pictures basic safety precautions were being violated.

DIRECTIONS:

"In this test booklet you will find pictures of men performing tasks aboard submarines. You are to indicate on the answer sheet what safety precautions, if any, are being violated."

TIME: 10 minutes.

NO. ITEMS: 15

SCORING:

One point for each picture correctly analyzed. If more than one violation appeared in a picture, the point was divided by the number of violations and fractional scores were given for each violation indicated. Maximum possible raw score was 15.

RAW SCORE RESULTS:

Mean	8.4
S.D.	2.95

CORRELATION WITH PAY GRADE: .27

RELIABILITY:

.77 (odd-even, corrected), based on 306 cases.

DISTRIBUTION OF STANDARD SCORES BY PAY GRADE

Standard Scores	Strikers	3rd Class	2nd Class	1st Class		Totals
9	5	4	1	3		13
8	6	4	4	5		19
7	6	8	13	6	Q_3	33
6	6	21	9	10	Mdn.	46
5	37	27	18	10		92
4	15	23	7	5	Q_1	50
3	14	8	7	2		31
2	9	3	3	1		16
1	2	3				5
0	2	1				3
N	102	102	62	42		308
Median	4.7	5.0	5.3	5.5		5.0

Name _____ Rate _____ Raw Score ___
Serial # _____ Ship _____ Time Started ___
Time Finished ___

RECORD SHEET

TEST RF 109-7

SAFETY PRECAUTIONS

TIME LIMIT: TEN MINUTES

Enter one or two words in the spaces provided below to describe the violations observed. If there are no safety violations, write the word "NONE."

PICTURE A (Sample)

(a) no goggles

(b) _____

(c) _____

PICTURE #1

(a) _____

(b) _____

(c) _____

PICTURE #2

(a) _____

(b) _____

(c) _____

PICTURE #3

(a) _____

(b) _____

(c) _____

PICTURE #4

(a) _____

(b) _____

(c) _____

PICTURE #5

(a) _____

(b) _____

(c) _____

PICTURE #6

(a) _____

(b) _____

(c) _____

PICTURE #7

(a) _____

(b) _____

(c) _____

PICTURE #8

(a) _____

(b) _____

(c) _____

PICTURE #9

(a) _____

(b) _____

(c) _____

PICTURE #10

(a) _____

(b) _____

(c) _____

PICTURE #11

(a) _____

(b) _____

(c) _____

PICTURE #12

(a) _____

(b) _____

(c) _____

PICTURE #13

(a) _____

(b) _____

(c) _____

PICTURE #14

(a) _____

(b) _____

(c) _____

PICTURE #15

(a) _____

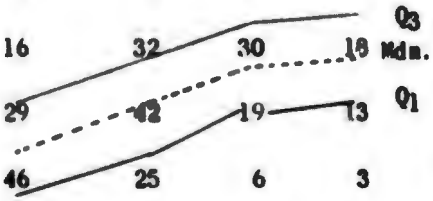
(b) _____

(c) _____

DISTRIBUTION OF AVERAGE PERFORMANCE TEST SCORES BY PAY GRADE

Electrician's Mates

Standard Score	Strikers	3rd Class	2nd Class	1st Class	Totals
9	0	0	0	0	0
8	0	0	0	0	0
7	0	0	0	1	1
6	2	4	11	9	26
5	16	32	30	18	96
4	29	42	19	13	103
3	46	25	6	3	80
2	10	3	0	0	13
1	0	0	1	1	2
0	0	0	0	0	0
N	103	106	67	45	321
Median	3.4	4.1	4.7	4.8	4.1



ENGINEMAN PERFORMANCE TEST BOOKLET

PRC n8 onr 70001

TEST RF 110

Name _____ Rate _____

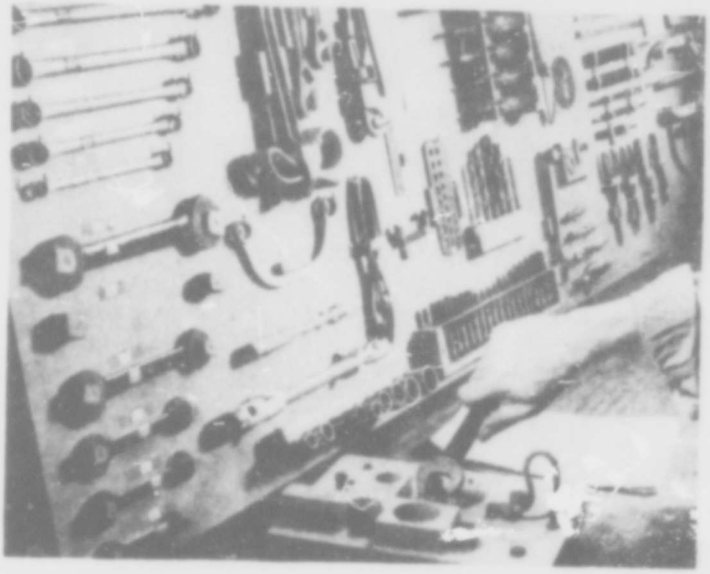
Serial Number _____ Ship _____

Length of time on board _____ months

Length of time in rate _____ months

Length of time in Navy _____ months

Regular _____ Reserve _____ (Check one)



I-A

THE USE AND IDENTIFICATION OF HAND TOOLS: USE OF WRENCHES

DESCRIPTION

Standard Navy tools were mounted on a board. An assortment of bolts, nuts, screws, and small pipe fittings was mounted on a second board. Wrenches were chosen from the tool board to fit the article on the test board.

DIRECTIONS:

"In front of you are two boards: one with tools mounted on it; the other with bolts, nuts, screws, and fittings mounted on it. Choose the tool you would use in loosening or resetting each of the articles on the test board. Record the tool number and size on the answer sheet."

TIME: 15 minutes.

NO. ITEMS: 36

SCORING:

Two points for each tool correctly chosen, and two points for each tool size correctly reported. Maximum possible raw score was 72.

RAW SCORE RESULTS:

Mean	41.1
S.D.	11.0

CORRELATION WITH PAY GRADE: .34

RELIABILITY:

.80 (odd-even, corrected), based on 200 cases.

DISTRIBUTION OF STANDARD SCORES BY PAY GRADE

Standard Scores	Strikers	3rd Class	2nd Class	1st Class		Totals
9	2	3	4	2		11
8	2	3	6	6		17
7	12	18	15	16	Q_3	61
6	22	13	12	15	Mdn.	62
5	31	24	21	15	Q_1	91
4	18	7	6	3		34
3	28	18	16	5		67
2	21	11	5	4		41
1	5	3	2	1		11
0	3	3				6
N	144	103	87	67		401
Median	4.3	4.9	5.2	5.9		5.0

Raw Score _____
Time Started _____
Time Finished _____

RECORD SHEET

TEST RF 110-1A

THE USE AND IDENTIFICATION OF HAND TOOLS

PART A - THE USE OF WRENCHES

SECTION I

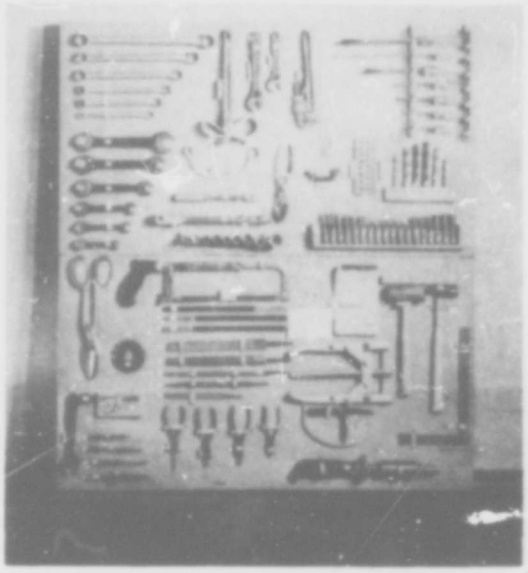
Directions: IN FRONT OF YOU ARE TWO BOARDS; ONE, THE TOOL BOARD, WITH A VARIETY OF TOOLS MOUNTED ON IT, THE OTHER A TEST BOARD WITH BOLTS, SCREWS, AND FITTINGS.

YOUR TASK IS TO CHOOSE THE PROPER TYPE TOOL YOU WOULD USE TO LOOSEN OR RESET EACH OF THE FITTINGS ON THE TEST BOARD. YOU MAY REMOVE THE TOOLS FROM THE TOOL BOARD TO CHECK THEM AGAINST THE FITTINGS ON THE TEST BOARD, BUT DO NOT ACTUALLY LOOSEN OR TIGHTEN ANY OF THE FITTINGS ON THE TEST BOARD.

EACH TOOL HAS BEEN GIVEN A NUMBER AND EACH FITTING ON THE TEST BOARD HAS A LETTER. WHEN YOU HAVE MADE YOUR CHOICE AS TO THE CORRECT TOOL TO USE, WRITE THE NUMBER OF THE TOOL OPPOSITE THE LETTER OF EACH FITTING BELOW. WRITE IN THE SIZE OF EACH TOOL USED IN THE THIRD COLUMN OF THE TABLE BELOW.

TIME LIMIT: FIFTEEN MINUTES

Fitting	Tool No.	Tool Size
A		
B		
C		
D		
E		
F		
G		
H		
I		
J		
K		
L		
M		
N		
O		
P		
Q		
R		



I-B

THE USE AND IDENTIFICATION OF HAND TOOLS: TOOL NAMING

DESCRIPTION

Standard Navy tools were mounted on two boards. Each of the tools was numbered. Most of them could be removed from the board to permit close examination. They were to be identified.

DIRECTIONS:
"In front of you are two tool boards. Listed on your answer sheet are the names of ten tools. You are to match the tool numbers with the tool names which identify them."

TIME: 5 minutes.

NO. ITEMS: 10

SCORING:
One point for each tool correctly identified. Maximum possible raw score was 10.

RAW SCORE RESULTS:

Q_3	8.5
Median	7.4
Q_1	6.2

CORRELATION WITH PAY GRADE: .52

RELIABILITY:
.84 (split half, corrected), based on 241 cases.

DISTRIBUTION OF STANDARD SCORES BY PAY GRADE

Standard Scores	Strikers	3rd Class	2nd Class	1st Class		Totals
9		1				1
8	7	7	3	11		28
7	8	12	23	10	Q_3	53
6	26	18	16	22	Mdn.	82
5	21	21	25	15	Q_1	82
4	33	20	9	8		70
3	22	14	5	1		42
2	15	6	3	1		25
1	9	3	1			13
0	3	1	2			6
N	144	103	87	68		402
Median	4.2	4.9	5.4	5.9		5.0

PART A - CONTINUED

SECTION II

Directions: PRINTED BELOW IS A LIST OF TOOL NAMES. YOU ARE TO FIND THE TOOL ON THE BOARD FOR EACH OF THE TOOL NAMES AND PLACE THE NUMBER OF THIS TOOL BESIDE THE NAME WHICH BEST FITS IT.

TIME LIMIT: FIVE MINUTES

_____ Strap Wrench

_____ Thread Gage

_____ Phillips Head Screwdriver

_____ 25/64" Drill

_____ Socket, 1/2" drive, 9/16"

_____ Bottoming Tap, 5/16" Coarse

_____ Plug Tap, 1/2" Fine

_____ Socket, 8 point, 3/8" drive, 1/2"

_____ 1/2" Socket Wrench Handle

_____ Scribe

(Turn Page)

I-C

THE USE AND IDENTIFICATION OF HAND TOOLS: DRILLING AND THREADING A HOLE TO FIT A BOLT

DESCRIPTION

Mounted on the tool boards (used in Tests IA and IB) was an assortment of taps and tap drills, a thread gauge, a drill card, and other tools needed to drill and thread a hole to fit a bolt.

DIRECTIONS:

"Before you is a bolt, the top of which is painted red. Choose whatever tools and equipment you would need to drill and thread a blind hole one-half inch deep to fit this bolt."

TIME: 10 minutes.

NO. ITEMS: 34

SCORING:

One point each for the number, name, type, and size of each tool or piece of equipment correctly chosen. Maximum possible raw score was 34.

RAW SCORE RESULTS:

Mean	11.8
S.D.	6.0

CORRELATION WITH PAY GRADE: .50

RELIABILITY:

None was computed because the serial order of tool selection was optional. Test-retest would have been the only applicable measure.

DISTRIBUTION OF STANDARD SCORES BY PAY GRADE

Standard Scores	Strikers	3rd Class	2nd Class	1st Class		Totals
9		1	3	6		12
8	1	4	3	4		12
7	12	15	20	18	Q_3	65
6	8	15	11	13	Mdn.	47
5	32	26	22	17	Q_1	97
4	12	11	9	2		34
3	56	21	12	6		95
2	12	3	3	1		19
1	7	4	1			12
0	4	2				
N	144	102	86	67		399
Median	3.4	4.9	5.3	6.1		4.8

Raw Score _____
Time Started _____
Time Finished _____

RECORD SHEET

TEST RF 110-1B

PART B - DRILLING AND THREADING A HOLE TO FIT A BOLT

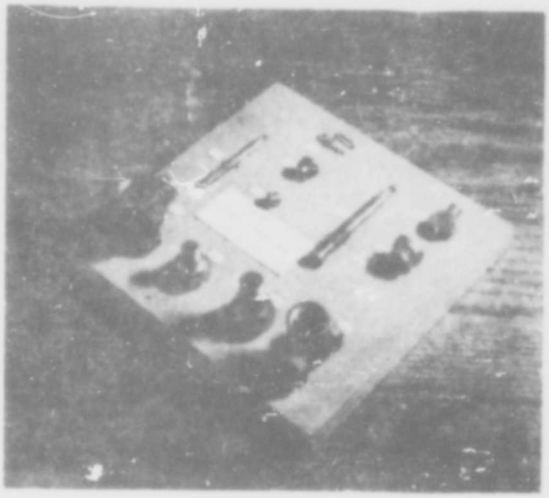
Directions: ON THE UPPER RIGHT HAND CORNER OF THE TEST BOARD USED IN TEST A, YOU WILL FIND A CAPSCREW WHICH IS PAINTED RED.

YOUR TASK IN THIS TEST IS TO CHOOSE WHATEVER TOOLS AND EQUIPMENT YOU WOULD NEED TO DRILL AND THREAD A BLIND HOLE ONE-HALF INCH DEEP TO FIT THE BOLT. YOU MAY REMOVE THE TOOLS AND EQUIPMENT FROM THE TOOLBOARD IF YOU WISH.

PLACE THE NUMBER OF EACH TOOL OR PIECE OF EQUIPMENT THAT YOU WOULD USE IN THE SPACES PROVIDED BELOW. BESIDE EACH NUMBER WRITE IN THE COMPLETE NAME, TYPE, AND SIZE OF EACH TOOL OR PIECE OF EQUIPMENT.

TIME LIMIT: TEN MINUTES

Number	Name	Type	Size



II-A

IDENTIFICATION AND FUNCTION

OF VALVES: GLOBE AND GATE VALVES

DESCRIPTION

The parts of disassembled globe and gate valves were mounted on a board and numbered. They were to be identified by name and function.

DIRECTIONS:

"In front of you are numbered parts of ordinary globe and gate type valves. On your answer sheet is a list of part names. Match the number of the part with the name which describes it.

"Following the list of part names is a list of statements which describe the functions of the different parts. Match the number of the part with the statement which best describes its function."

TIME: 10 minutes.

NO. ITEMS: 22

SCORING:

One point for each part correctly identified, and one point for each function correctly identified. Maximum possible raw score was 22.

RAW SCORE RESULTS:

Mean 13.0
S.D. 4.4

CORRELATION WITH PAY GRADE: .30

RELIABILITY:

.74 (odd-even, corrected), based on 306 cases.

DISTRIBUTION OF STANDARD SCORES BY PAY GRADE

Standard Scores	Strikers	3rd Class	2nd Class	1st Class	Totals
9		1	2	5	8
8	5	7	14	12	38
7	9	10	5	6	30
6	18	19	21	13	71
5	27	21	13	12	73
4	28	19	15	10	72
3	29	13	8	3	53
2	18	9	2	5	34
1	9	4	6		19
0	1	1	1	2	5
N	144	104	87	68	403
Median	4.0	4.8	5.4	5.7	4.7

Raw Score _____
Time Started _____
Time Finished _____

RECORD SHEET

TEST RF 110-2

IDENTIFICATION AND FUNCTION OF VALVE.

THIS IS A TEST OF YOUR KNOWLEDGE OF ORDINARY GLOBE AND GATE TYPE HAND VALVES.

ON THE BOARD IN FRONT OF YOU ARE MOUNTED PARTS OF ORDINARY GLOBE AND GATE TYPE VALVES. ON EACH VALVE PART IS A NUMBER. PRINTED BELOW ON THIS TEST SHEET IS A LIST OF PART NAMES. YOU ARE TO PLACE THE NUMBER OF THE PART IN THE SPACE OPPOSITE ITS NAME. THERE ARE MORE NAMES THAN THERE ARE PARTS, SO THE QUICKEST METHOD WILL BE TO LOOK AT THE PART AND THEN FIND ITS NAME IN THE LIST. WRITE THE WORD "NONE" IN THE SPACE OPPOSITE THE NAME IF THERE IS NO PART ON THE BOARD CORRESPONDING TO THE NAME.

TIME LIMIT: FIVE MINUTES

Disc	____	Globe Valve Bonnet	____
Disc Nut	____	Graphite Packing	____
Gate (or Wedge)	____	Non-rising Stem	____
Gate Valve Body	____	Packing Gland	____
Gate Valve Bonnet	____	Ring	____
Globe Valve Body	____	Rising Stem	____

NOW YOU ARE TO PLACE THE NUMBER OF EACH PART BESIDE THE STATEMENT LISTED BELOW ON THIS SHEET WHICH BEST TELLS WHAT THE PART DOES.

TIME LIMIT: FIVE MINUTES

1. Transmits motion from hand wheel to gate (wedge) ____
2. Holds packing between bonnet and stem ____
3. Provides a stuffing box and covers gate valve body ____
4. Provides a means for full flow or full stop rather than throttling ____
5. Provides a liquid tight seal when properly scraped into wedge face ring ____
6. Provides a seal on globe or gate type valves ____
7. Regulates flow when moved up or down ____
8. Fastens valve disc to stem ____
9. Positions disc by rising at same rate as disc ____
10. Provides a stuffing box for stem and covers globe valve body ____

II-B

IDENTIFICATION AND FUNCTION OF VALVES: AIR COMPRESSOR VALVES

DESCRIPTION

Four air compressor valves, three suction and one discharge, were to be identified and their stages named.*

DIRECTIONS:

"In front of you are four air compressor valves. You are to identify each valve, giving the number of its stage, and marking whether it is suction or discharge."

TIME: 10 minutes.

NO. ITEMS: 8

SCORING:

One point for each stage correctly named, and one point for each suction or discharge identification correctly made. Maximum possible raw score was 8.

RAW SCORE RESULTS:

Q_3	6.45
Median	5.4
Q_1	3.8

CORRELATION WITH PAY GRADE: .30

RELIABILITY:

.81 (split half, corrected), based on 202 cases.

DISTRIBUTION OF STANDARD SCORES BY PAY GRADE

Standard Scores	Strikers	3rd Class	2nd Class	1st Class	Total
9					
8					
7	42	27	29	11	109
6					
5	29	26	27	8	90
4	18	19	15	9	61
3	30	26	13	8	77
2	11	6	2	1	20
1	14	6	1		21
0					
N	144	104	87	38	393
Median	4.4	4.5	5.0	6.7	4.8

*Originally, the valves were also to be disassembled to see if their discs needed lapping. The resulting "needs lapping" score, however, proved to be an unreliable measure. Unless the need for lapping was obvious, neither the test administrators nor the men taking the test could agree consistently as to whether a particular disc needed it or not.

Raw Score _____
Time Started _____
Time Finished _____

RECORD SHEET

TEST RF 110-3

AIR COMPRESSOR VALVES

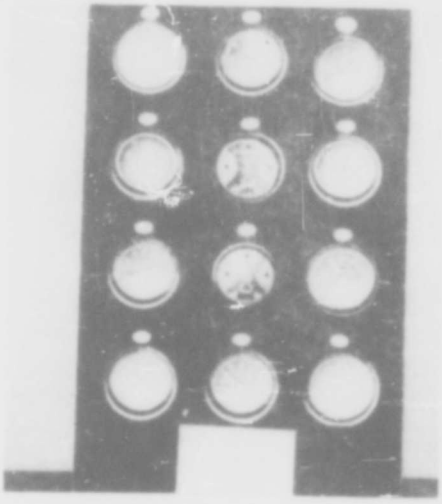
Directions: IN FRONT OF YOU ON THE BENCH ARE FOUR AIR COMPRESSOR VALVES. YOU ARE TO IDENTIFY EACH VALVE AS TO STAGE AND SUCTION OR DISCHARGE. THEN YOU ARE TO DISASSEMBLE EACH VALVE AND FIND OUT IF THE DISC NEEDS LAPPING AND FINALLY YOU ARE TO REASSEMBLE THE VALVES SO THAT THEY WORK PROPERLY.

EACH VALVE IS LETTERED A, B, C, OR D. IN THE BOXES ON THIS PAGE, PUT IN THE STAGE NUMBER UNDER THE COLUMN MARKED STAGE. THEN CHECK WHETHER THE VALVE IS SUCTION OR DISCHARGE AND PUT A MARK IN THE APPROPRIATE COLUMN. THEN DISASSEMBLE THE VALVE AND FIND OUT IF THE DISC NEEDS LAPPING. IF IT DOES WRITE "YES" IN THE COLUMN, IF NOT WRITE "NO."

FINALLY, REASSEMBLE EACH VALVE SO THAT IT WORKS PROPERLY.

TIME LIMIT: TEN MINUTES

	Stage	Suction	Discharge	Disc Needs Lapping
Valve A				
Valve B				
Valve C				
Valve D				



DIRECTIONS:

"In front of you are photographs of instruments ordinarily found on main engine panels. For each instrument, record: (1) the reading; (2) whether or not the reading is within normal operating range; and (3) the maximum and minimum readings for safe operation of the engine."

TIME: 10 minutes.

NO ITEMS: 56 (two instruments required one set of four answers each; five instruments required two sets of four answers each; four instruments required one set of two answers each; one instrument was not read).

SCORING:

One point for each correct answer. Maximum raw score was 56.

RAW SCORE RESULTS:

Q_3	32.8
Median	29.0
Q_1	24.5

CORRELATION WITH PAY GRADE: .23

RELIABILITY:

.67 (odd-even, corrected), based on 386 cases.

III

INSTRUMENT PANEL ANALYSIS

DESCRIPTION

Photographs were made of the dial faces of some of the instruments normally found on a main engine instrument panel. Instrument readings simulated normal and abnormal operating conditions. The readings were to be recorded and interpreted.

DISTRIBUTION OF STANDARD SCORES BY PAY GRADE

Standard Scores	Strikers	3rd Class	2nd Class	1st Class		Totals
9	6	2	4	4		16
8	6	6	7	9		28
7	12	9	9	7	Q_3	37
6	13	15	15	9		52
5	48	43	30	24	Mdn.	145
4	8	6	10	9	Q_1	33
3	15	6	5	5		31
2	23	9	4			36
1	9	6	1	1		17
0	4	2	2			8
N	144	104	87	82		403
Median	4.8	5.0	5.2	5.3		5.0

RECORD SHEET

TEST RF 110-4

Raw Score _____
Time Started _____
Time Finished _____

INSTRUMENT PANEL ANALYSIS

INDICATE THE TYPE OF MAIN ENGINE ON THE SUBMARINE TO WHICH YOU ARE ATTACHED:

FAIRBANKS MORSE _____
GENERAL MOTORS _____

Directions: IN FRONT OF YOU ARE PHOTOGRAPHS OF INSTRUMENTS ORDINARILY FOUND ON MAIN ENGINE PANELS. FOR EACH INSTRUMENT YOU ARE TO RECORD THE INFORMATION CALLED FOR IN THE SPACES PROVIDED IN THE TABLE BELOW.

IN COLUMN I PLACE THE NUMERICAL READING FOUND ON THE INSTRUMENT.

IN COLUMN II INDICATE WITH A "Yes" OR "No" WHETHER OR NOT THE READING IS WITHIN THE NORMAL OPERATING RANGE.

IN COLUMNS III AND IV GIVE THE MAXIMUM AND MINIMUM READINGS AT WHICH IT WOULD STILL BE SAFE TO OPERATE THE ENGINE.

TIME LIMIT: TEN MINUTES

Instrument Number	I Reading	II Within Norm. Range (Yes or No)	III Maximum Safe	IV Minimum Safe
1.				
2.				
3.				
4.a				
4.b				
5.				
6. White				
6. Dark				
7.a				
7.b				
8.				
9. White				
9. Dark				
10. White				
10. Dark				
11.				

SAMPLE ITEM

In order to hold a motor shaft from turning while the end-nut is being tried for tightness, you would use a:

(1) Stillson wrench
(2) Monkey wrench
(3) Spanner wrench
(4) Strap wrench
(5) Adjustable wrench

IV

JOB KNOWLEDGE

DESCRIPTION

This was a written test consisting of thirty-nine multiple-choice questions about the theoretical and practical aspects of the EN's job.

DIRECTIONS:

"In this test booklet you will find incomplete statements followed by five alternative endings. You are to select the alternative ending which correctly, or most nearly correctly, completes each statement."

TIME: 30 minutes.

NO. ITEMS: 39

SCORING:

One point for each correct answer. Maximum possible raw score was 39.

RAW SCORE RESULTS:

Q_3	35.1
Median	32.0
Q_1	29.5

CORRELATION WITH PAY GRADE: .50

RELIABILITY:

.68 (odd-even, corrected), based on 399 cases.

DISTRIBUTION OF STANDARD SCORES BY PAY GRADE

Standard Scores	Strikers	3rd Class	2nd Class	1st Class	Total
9	1	7	8	10	26
8	1	1	7	8	17
7	6	3	13	7	29
6	18	26	21	18	83
5	28	33	19	13	93
4	29	20	11	9	69
3	26	10	1	3	40
2	22	3	7		32
1	8				8
0	4	1			5
N	143	104	87	68	402
Median	3.9	5.1	5.8	6.6	5.0

EXAMINATION FOR ENGINEMEN

FORM A

INSTRUCTIONS: This is a test of your knowledge of procedures, functions, and definitions with which submarine enginemen should be familiar. In this test booklet you will find incomplete statements followed by five alternatives. You are to select the alternative which makes the best or most nearly correct complete statement. After selecting the correct alternative, make a heavy mark in the answer space provided on the SEPARATE ANSWER SHEET. DO NOT MAKE ANY MARKS IN THIS TEST BOOKLET. Before starting the examination, fill in on the separate answer sheet your name, service number, present rate, and ship or station to which you are attached for duty.

As an example answer the following item using your answer sheet:

1. In order to hold a motor shaft from turning while the end-nut is being tried for tightness, you would use a:

(1) Stillson wrench
(2) Monkey wrench
(3) Spanner wrench
(4) Strap wrench
(5) Adjustable wrench

The correct answer to the above is of course (4) "Strap wrench." You should have made a heavy black mark in the fourth space following the heavy numeral "1." on the separate answer sheet.

Give only one answer to each question. Double answers are graded as being incorrect. If you do not know the answer to any item, you may guess, but avoid wild guessing, because your total score will be the number of right answers minus a small fraction of the number of wrong answers. You will have 30 MINUTES to work on the test. If you finish before time is called, you may go back to check your work.

BE CERTAIN BEFORE STARTING THE TEST THAT YOUR NAME IS ON THE SEPARATE ANSWER SHEET.

DO NOT MAKE ANY MARKS IN THIS TEST BOOKLET.

EXAMINATION FOR ENGINEMEN

FORM A

2. Which of the following tools would be used to remove brass fittings (nut and sleeve) from small, low pressure copper tubing, which takes a 1/2" nut?

   (1) Gas (combination) pliers
   (2) Crescent wrench
   (3) 1/2" socket wrench
   (4) 1/2" open end wrench
   (5) 1/2" box wrench

3. Three parts common to both gate and globe type valves are:

   (1) Non-rising stem, bonnet, and disk
   (2) Non-rising stem, gate and yoke
   (3) Packing gland, bonnet and body
   (4) Packing gland, yoke and gate
   (5) Non-rising stem, yoke, and bonnet

4. After a Diesel engine is started, the gauge which should be checked first is the:

   (1) Lube oil pressure
   (2) Inboard water temperature
   (3) Tachometer
   (4) Exhaust water temperature
   (5) Salt water pressure

5. When starting a main engine, the governor control knob should be set to:

   (1) 100 RPM
   (2) 350 RPM
   (3) 500 RPM
   (4) 720 RPM
   (5) 1000 RPM

6. When starting a main engine, the outboard exhaust valve should be:

   (1) Closed tightly
   (2) Opened when the engine is jacked by hand
   (3) Closed just as the engine starts to fire
   (4) Opened just as the engine starts to fire
   (5) Opened for a few seconds and then closed

7. One of the following is <u>not</u> a step in preparing to start a main engine:

(1) Test high temperature and low pressure alarms
(2) Set governor control for idling
(3) Start lube oil purifier
(4) Prime fuel oil system
(5) Disengage generators

8. One of the following instrument readings is outside the normal operating:

(1) Lube oil from engine temp. - 150 degrees
(2) Lube oil to engine pressure - 12 lbs. @ 700 RPM
(3) F.W. pressure at 720 RPM - 20 lbs.
(4) Generator bearing temperature - 140 degrees
(5) Tachometer reading - 450 RPM

9. Air compressor valve seats are checked for smoothness after lapping by:

(1) A depth gauge and a micrometer
(2) A valve known to be smooth
(3) Replacing them on the air compressor
(4) Using Prussian blue and a surface plate
(5) An outside caliper

10. When replacing rings of packing in a pump or valve, the packing joints should be:

(1) Soaked in water
(2) Lined up evenly
(3) Soaked in oil
(4) Staggered
(5) Cleaned with carbon tetrachloride

11. The order in which taps would be used to thread a blind hole would be:

(1) Bottoming, plug, and taper
(2) Plug, bottoming, and taper
(3) Taper, plug, and bottoming
(4) Taper, bottoming and plug
(5) Plug and bottoming taps only

12. In tightening down the main bearings a _____ should be used.

(1) An open end wrench
(2) A heavy strap wrench
(3) A torque wrench
(4) A box end wrench
(5) A monkey wrench

13. It is usually safe to smoke:

(1) In the lower flats of the engine room
(2) In the battery well
(3) When the batteries are being charged providing the hydrogen detector reads at least 3 per cent
(4) In the motor room
(5) Topside when "Baker" is flying

14. While using a grinder, one should always:

(1) Wear gloves
(2) Wear an apron
(3) See that water is at hand
(4) See that the tool rest is in place
(5) Wear goggles

15. To clean the screen of the air silencer, one should use:

(1) Steel wool
(2) Carbon tetrachloride
(3) Waste
(4) A stiff brush
(5) Gasoline

16. Condensate of too high salinity is:

(1) Redistilled
(2) Drained to the bilge
(3) Used for boiler feed
(4) Treated with water softening chemicals
(5) Used for cooking

17. Frequent tests are made of the F.W. in the condenser to detect the presence of:

(1) Oil
(2) Air
(3) Salt water
(4) Acids
(5) Carbon dioxide

18. If fuel leaks from the tip of the unit injector when a slight pressure is applied to the plunger, the trouble is probably that:

(1) The tappet valve is set too loose
(2) The spring loaded check valve is not seating properly
(3) The plunger is too loose in the band
(4) The injector holes are too large
(5) No trouble is indicated since the injector unit should operate this way

19. In the 4 stroke cycle engine, one cycle is completed by:

(1) One stroke
(2) Two strokes
(3) Three strokes
(4) Four strokes
(5) Eight strokes

20. The most frequent reason for adding oil to hydraulic systems is because the oil:

(1) Becomes dirty
(2) Is used up in the system
(3) Leaks out
(4) Becomes worn out
(5) Mixes with water

21. Casualties and their causes should be logged in the:

(1) Engineers bell book
(2) Ships log
(3) Engineering night order book
(4) Special occurrences book
(5) Engineering log

22. A sudden increase in pressure at the oil pumps may be caused by:

(1) A clogged strainer
(2) The grade of oil being too thin
(3) Oil temperature too high
(4) Oil temperature too low
(5) Water in the system

23. Before removing the piston from a liner, one must be sure:

(1) The piston is worn enough to be removed
(2) To remove the piston
(3) To measure the ring gap clearance
(4) To clean the top of the piston with CCl_4
(5) To remove all carbon from the liner

24. The cause of an engine not firing on one cylinder might be:

(1) A faulty injector
(2) The compression being too high
(3) The camshaft being out of time
(4) The governor not functioning properly
(5) Too great a tolerance between piston and lindr

25. If an engine has been operating for a long time at high speed. it should be:

(1) Shut off immediately when not needed
(2) Checked for alignment
(3) Allowed to idle for a few minutes before shutting off
(4) Left with the overboard water discharge valve open until the engine cools
(5) Left with the overboard water discharge valve closed until the engine cools

26. While an engine is in operation, lube oil must be tested for the presence of water:

(1) Every eight hours
(2) Once every week
(3) Every 24 hours
(4) Once a month
(5) Once each watch

27. The purpose of jacking over an engine is to:

(1) Check water pumps
(2) Free pistons
(3) Check compression
(4) Check for freeness
(5) Start fuel oil curculating

28. An engine should <u>never</u> be run for a long time at:

(1) Top RPM without a load
(2) Top RPM with a load
(3) Half speed with a load
(4) 3/4 speed with a load
(5) Half speed with a heavy load

29. Because of the large quantities of oil contained in the system of large Diesel engines, they have:

(1) Extra large crankcases
(2) A sump tank
(3) Provision to drain the extra oil into the bilges
(4) An oil pan to carry the extra oil
(5) Large openings in the injector valves

30. In order to have a balanced engine, each cylinder must:

(1) Have a high compression
(2) Have a clean exhaust
(3) Produce its share of the work
(4) Have a blue smoky exhaust
(5) Have no exhaust

31. Compression in the Diesel engine cylinder must cause a temperature high enough to insure:

(1) Seating of the valves
(2) Vaporizing of the fuel
(3) Warming of the lube oil
(4) Warming of the fuel oil
(5) Ignition of the fuel oil

32. In receiving or discharging fuel aboard ship, the hose should always be:

(1) Grounded
(2) Rubber
(3) Thirty feet longer than needed
(4) Metal
(5) Not less than four inches in diameter

33. Pressure relief valves are placed in hydraulic systems to:

(1) Release fluid from actuating cylinders when movement is completed
(2) Decrease the RPM of a pump when the systems operating pressure is obtained
(3) Protect the system from damage by too high a pressure
(4) Reduce the pressure to the amount needed for the operation of the more delicate appliances
(5) Provide for adding fluid to the system as is necessary

34. The main function of the reduction gear is to:

(1) Steady the power flow
(2) Increase the motor power
(3) Operate the engine more smoothly
(4) Reduce the shaft RPM
(5) Add oil to the system

35. Fuel oil pump flanges and lines should be kept tight to prevent:

(1) Corrosion of threads and flanges
(2) The engine from losing power
(3) Costly leaks of oil and danger of fire
(4) Salt water from entering the system
(5) Fresh water from entering the system

36. One of the best ways to protect a fuel injector is to:

(1) Oil it regularly
(2) Keep fuel filters clean
(3) Keep nozzles clean
(4) Keep the day tank at low level
(5) Keep the day tank at a high level

37. The lubricating oil level gauge is used to determine:

(1) The oil temperature
(2) The amount of oil in the filter
(3) If the engine has enough oil to operate safely
(4) The oil pressure
(5) The level of oil in the bearings of the lube oil pump

38. For lubrication, the unit injector depends upon:

(1) Lubrication oil from the pressure system
(2) Oil from the camshaft bearings
(3) The fuel oil itself
(4) Oil from the scavenger oil pump
(5) Timing of regulator valves

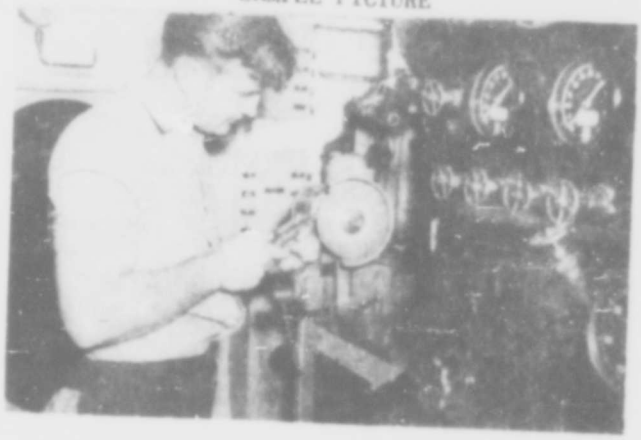
39. To maintain the proper temperature for operation, the flow of water through the engine is controlled by a:

(1) Pressure relief valve
(2) Manually operated valve
(3) Thermostat and bypass
(4) Butterfly valve
(5) Gate type valve

40. The fuel manifold assembly in the General Motors engine fuel oil system:

(1) Supplies fuel oil to galleries through lower line and returns it to pump sump through upper line
(2) Supplies lube oil to galleries through upper line and returns it to sump through lower line
(3) Supplies fuel oil to sump through lower line and to injectors through upper line
(4) Supplies fuel oil to injectors through lower line and returns fuel oil to tank through upper line
(5) Supplies fuel oil to injectors through upper line and returns fuel to tank through lower line

SAMPLE PICTURE



V

SAFETY

DESCRIPTION

A booklet of photographs taken aboard a submarine was assembled which showed crew members engaged in various routine and non-routine activities. In some of the pictures basic safety precautions were being violated.

DIRECTIONS:

"In this test booklet you will find pictures of men performing tasks aboard submarines. You are to indicate on the answer sheet what safety precautions, if any, are being violated."

TIME: 10 minutes.

NO. ITEMS: 15

SCORING:

One point for each picture correctly analyzed. If more than one violation appeared in a picture, the point was divided by the number of violations; fractional scores were then given for each violation indicated. Maximum raw score was 15.

RAW SCORE RESULTS:

Mean 8.7
S.D. 2.4

CORRELATION WITH PAY GRADE: .36

RELIABILITY:

.75 (odd-even, corrected), based on 393 cases.

DISTRIBUTION OF STANDARD SCORES BY PAY GRADE

Standard Scores	Strikers	3rd Class	2nd Class	1st Class	Totals
9	4	5	2	6	17
8	7	7	5	6	25
7	16	12	9	14	51
6	28	15	22	18	83
5	16	19	21	11	67
4	32	20	11	7	70
3	18	13	7	3	41
2	13	8	6	2	29
1	3	1	2		6
0	4	1			5
N	141	101	85	67	394
Median	4.5	4.9	5.3	6.1	5.2

Q_3 Mdn. Q_1

Name _____ Rate _____ Raw Score __
Serial # _____ Ship _____ Time Started __
Time Finished __

RECORD SHEET

TEST RF 110-6

SAFETY PRECAUTIONS

TIME LIMIT: TEN MINUTES

Enter one or two words in the spaces provided below to describe the violations observed. If there are no safety violations, write the word "NONE."

PICTURE A (Sample)

(a) No goggles

(b) _____

(c) _____

PICTURE #1

(a) _____

(b) _____

(c) _____

PICTURE #2

(a) _____

(b) _____

(c) _____

PICTURE #3

(a) _____

(b) _____

(c) _____

PICTURE #4

(a) _____

(b) _____

(c) _____

PICTURE #5

(a) _____

(b) _____

(c) _____

PICTURE #6

(a) _____

(b) _____

(c) _____

PICTURE #7

(a) _____

(b) _____

(c) _____

PICTURE #8

(a) _____

(b) _____

(c) _____

PICTURE #9

(a) _____

(b) _____

(c) _____

PICTURE #10

(a) _____

(b) _____

(c) _____

PICTURE #11

(a) _____

(b) _____

(c) _____

PICTURE #12

(a) _____

(b) _____

(c) _____

PICTURE #13

(a) _____

(b) _____

(c) _____

PICTURE #14

(a) _____

(b) _____

(c) _____

PICTURE #15

(a) _____

(b) _____

(c) _____

DISTRIBUTIONS OF AVERAGE PERFORMANCE TEST SCORES BY PAY GRADE

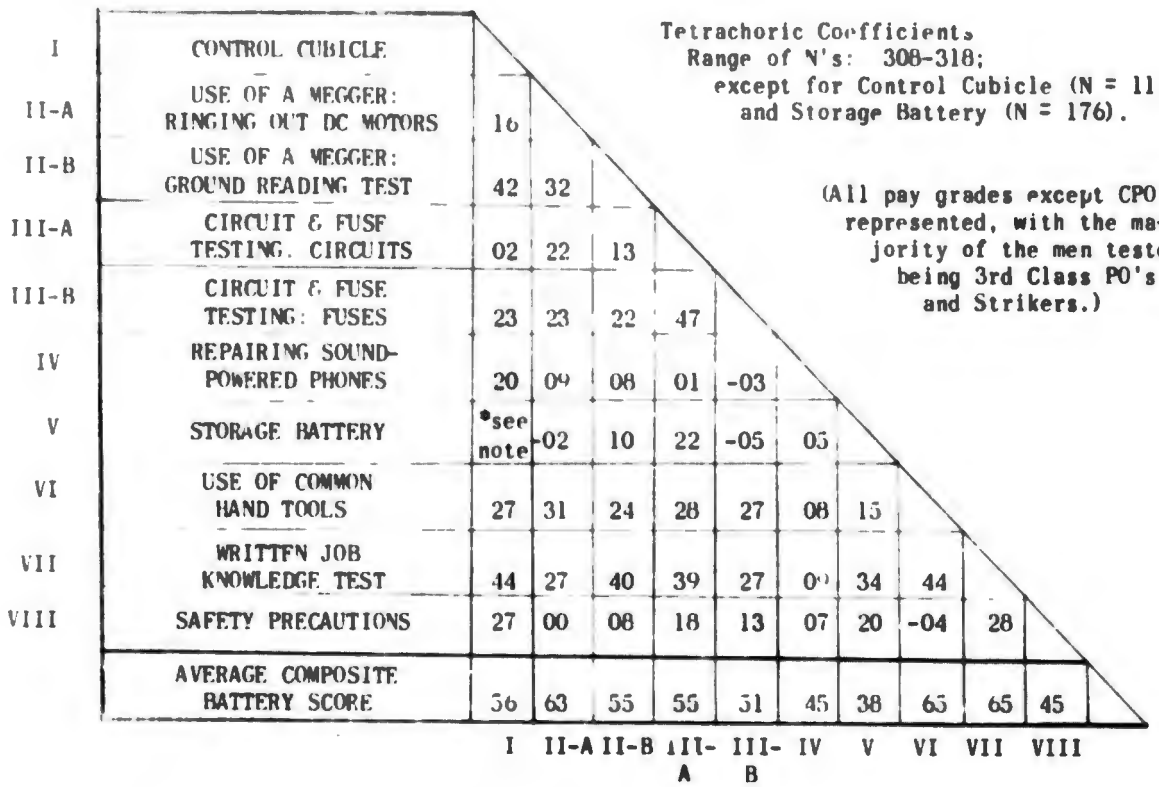
Enginemen

N = 403

Standard Score	Strikers	3rd Class	2nd Class	1st Class		Total
9	0	0	0	0		0
8	0	0	0	0		0
7	0	2	2	5		9
6	7	6	19	27	Q_3 Mdn.	59
5	26	42	38	26	Q_1	132
4	55	32	19	8		114
3	43	18	9	2		72
2	10	4	0	0		14
1	3	0	0	0		3
0	0	0	0	0		0
N	144	104	87	68		403
Median	3.8	4.4	4.9	5.4		4.5

INTERCORRELATIONS OF PERFORMANCE TESTS

ELECTRICIAN'S MATES

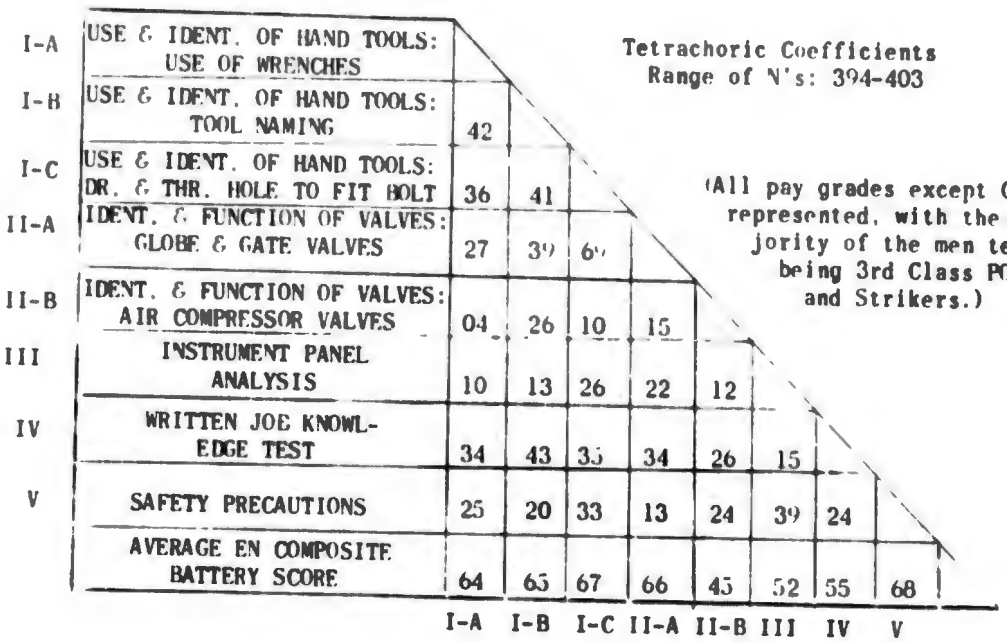


		I	II-A	II-B	III-A	III-B	IV	V	VI	VII	VIII
I	CONTROL CUBICLE										
II-A	USE OF A MEGGER: RINGING OUT DC MOTORS	16									
II-B	USE OF A MEGGER: GROUND READING TEST	42	32								
III-A	CIRCUIT & FUSE TESTING: CIRCUITS	02	22	13							
III-B	CIRCUIT & FUSE TESTING: FUSES	23	23	22	47						
IV	REPAIRING SOUND-POWERED PHONES	20	09	08	01	-03					
V	STORAGE BATTERY	*see note	-02	10	22	-05	05				
VI	USE OF COMMON HAND TOOLS	27	31	24	28	27	08	15			
VII	WRITTEN JOB KNOWLEDGE TEST	44	27	40	39	27	09	34	44		
VIII	SAFETY PRECAUTIONS	27	00	08	18	13	07	20	-04	28	
	AVERAGE COMPOSITE BATTERY SCORE	56	63	55	55	51	45	38	65	65	45

*Insufficient number of cases (cf. the N's above).

INTERCORRELATIONS OF PERFORMANCE TESTS

ENGINEMEN



		I-A	I-B	I-C	II-A	II-B	III	IV	V
I-A	USE & IDENT. OF HAND TOOLS: USE OF WRENCHES								
I-B	USE & IDENT. OF HAND TOOLS: TOOL NAMING	42							
I-C	USE & IDENT. OF HAND TOOLS: DR. & THR. HOLE TO FIT BOLT	36	41						
II-A	IDENT. & FUNCTION OF VALVES: GLOBE & GATE VALVES	27	39	60					
II-B	IDENT. & FUNCTION OF VALVES: AIR COMPRESSOR VALVES	04	26	10	15				
III	INSTRUMENT PANEL ANALYSIS	10	13	26	22	12			
IV	WRITTEN JOB KNOWLEDGE TEST	34	43	35	34	26	15		
V	SAFETY PRECAUTIONS	25	20	33	13	24	39	24	
	AVERAGE EN COMPOSITE BATTERY SCORE	64	65	67	66	45	52	55	68

Chapter IV

DISCUSSION OF TEST RESULTS AND INTER-TEST RELATIONSHIPS

Reliability of the Performance Tests

The reliability of a test is an indication of how consistently it measures what it is intended to measure. A fairly long test, for example, is usually more reliable than a short test, because there is less chance for persons taking the test to score well or poorly just as a matter of luck; chance errors are more likely to average out over a large number of cases.

It was especially important, therefore, to determine if the job-sample tests in the EM and EN performance batteries were reliable enough to be considered stable measuring devices, since the tests had been held to short time limits for ease of administration.

It was found that the reliabilities of the individual tests and of each performance battery as a whole were adequate for practical measuring purposes.[1] It could be expected that the same group of EM's and EN's would get approximately the same scores on the tests if they took them again after a suitable lapse of time. Chance factors were not playing an important part in scores made on the tests.

The Practical Performance Tests compare favorably in consistency of measurement with other types of achievement tests.

---

[1]Reliability coefficients ranged from .50 to .93 for the individual tests. Reliabilities of the EM and EN composite batteries (job-sample plus written tests) were estimated to be .88 and .90, respectively.

The reliabilities of the composite batteries were estimated using a method suggested by C. I. Mosier, "On the Reliability of a Weighted Composite," Psychometrika, 1943, 8:161-168. The generalized statement of the reliability of a composite is a function of the reliabilities, the dispersions, and the intercorrelations of the components.

Correlation of Pay Grade with Performance Test Scores

On the average, 1st and 2nd Class PO's scored higher on the performance tests than did 3rd Class PO's and Strikers.[2] There was, however, a good deal of overlapping in scores, with men in the lower pay grades frequently out-performing men in the higher pay grades.

This pay grade overlap may have been caused, in part, by the usually more recent school experience of Strikers and 3rd Class PO's, and by their more active day to day contact with the various tasks selected for the performance test batteries. Men in higher pay grades devote much of their time to administrative and supervisory duties, and their technical duties tend to be more specialized.

It will come as a surprise to many, however, that 1st and 2nd Class PO's were not markedly superior in performing tasks which were selected as representative of the 3rd Class level of job performance. This would seem to indicate that if practical factor performance tests had been included in advancement in rate examinations, the men in the higher pay grades would have been better equipped to "handle their rates."

The Qualifications for Advancement in Rate, NAVPERS 18068, requires that men demonstrate their abilities to perform the practical factors of their prospective pay grades, but no adequate means of measuring those abilities objectively is in use. It is considered that job-sample performance tests can provide this means.

Relationships between Individual Tests in the Performance Batteries

It was found that men who scored high on one test in the performance

---

[2]Coefficients of correlation (tetrachoric) between scores and pay grade ranged from .13 to .52, with the median at .36. Scores were split at the median to compute the tetrachoric r's

batteries did not necessarily score high on another. The relationships between scores made on the individual tests proved to be moderate to low (see pages 73 and 76) [3] If these findings are substantiated in future research, it is an indication that a man's ability to do one task aboard ship does not imply very much about his ability to perform other tasks of his job

The generally low inter-test relationships suggest that the men tested tended to specialize in certain tasks of their jobs. The men may either have forgotten how to do the other tasks, or, not having had sufficient practical application of training lessons, they may never have really learned how to do them. The performance tests may, therefore, have indicated practical factor training deficiencies in addition to having indicated the differences among men's abilities to perform.

Correlation between Written Tests and Performance Tests

The kind of achievement test most often administered in school and on the job is the written objective examination, usually of the multiple-choice or true-false type. To determine if written tests give a complete account of school or job performance, two such tests, the job-knowledge and safety tests (see pages 33, 43, 61, and 70), were included in both the EM and EN performance batteries. Scores made on these tests were then correlated both with scores

---

[3] All coefficients of correlation computed between scores made on pairs of tests within batteries were below .50, with the single exception of a .69 between two tests in the EN battery. The scores of all pay grades except CPO were included in these computations. Considering the moderate correlation of test scores with pay grade mentioned above, it might be expected that these inter-test relationships would be higher, since the reliabilities permit. To determine how much effect pay grade was having on the inter-test relationships, the effect of pay grade was partialled out. It was found that the correlations dropped, on the average, about fifteen points. In view of the substantial reliability coefficients, these resulting relationships must be considered to be low.

made on the individual job sample tests (see pages 75 and 76) and with average job-sample test scores [4]

As can be seen, the written tests correlated with the performance tests to only a moderate extent. The differences in performance ability brought out by the average performance test scores, therefore, could be only partly accounted for by the measures provided by the written tests.

It is concluded from these results that job-sample performance tests should be used in conjunction with written job-knowledge tests to obtain a full measure of a given man's ability to master the requirements of his rate.

Verbal Intelligence as Related to the Performance Tests

To give the most realistic picture of actual ability to perform the practical factors of shipboard jobs, job-sample performance tests should not require the degree of vocabulary ability which is usually such an important factor in the taking of written achievement exams. No adequate attempt was made to study fully the importance of facility with words in taking the performance tests, but use was made of available data to get a suggestion of the relationships involved

---

[4]Pearson product-moment coefficients of correlation between the written job-knowledge tests and the average job-sample test scores (written test scores were not included in these averages) were .46 for the EM's and .49 for the EN's. These coefficients compare with tetrachoric r's .65 and .68 computed between job-knowledge scores and composite battery average scores, these latter averages including the written test scores.

It is considered that the Pearson r's of .46 and .49 give a better indication of the relationship holding between written tests and performance tests. The reliabilities of the written tests were .86 and .68, and the reliabilities of the job-sample tests (computed as equally weighted composites) were .84 and .88 for the EM and EN tests, respectively. The Pearson r's of .46 and .49 obtained between the written tests and performance tests, therefore, were not limited to those values by their respective reliabilities.

Since the Navy General Classification (GCT) and Arithmetical Reasoning (ARI) tests are considered to be largely measures of verbal intelligence,[5] scores made on the GCT and ARI were correlated with scores made on the written tests and performance tests in the EM and EN composite batteries. The resulting relationships, which are listed in Table I, give a rough indication of the part played by verbal intelligence in determining scores made on the composite batteries.

TABLE I

Correlations Between GCT and ARI Scores
and Selected Performance Measures

	EM's N 225		EN's N 265	
	GCT	ARI	GCT	ARI
Safety Tests	.23	.07	.08	.14
Job-Knowledge Tests	.34	.21	.26	.21
Job-Sample Tests (Avg.)	.23	.27	.20	.22
Composite Batteries (Avg.)	.28	.27	.21	.24

It will be noted that the correlations were generally low. Further, there was no significant difference between the relationship of verbal ability to scores on the job-knowledge and safety tests and verbal ability to scores on the job-sample tests.

It was concluded that, for the groups studied, differential verbal ability was not a critical factor in the performance test scores.[6]

---

[5]Both the GCT and ARI have been shown to have factor loadings of at least .86 on verbal intelligence (Stuit, Dewey B., Editor, Personnel Research and Test Development in the Bureau of Naval Personnel, Princeton University Press, Princeton, N. J., 1947, p. 74.).

[6]It should be pointed out here that submarine personnel are selected on the basis of GCT and ARI combined scores, a combined score of 100 or more being required for entrance to submarine school. The range of scores on these variables, therefore, has been restricted, thus reducing the relationships between them and any other measures with which they might be correlated such as the performance batteries.

Chapter V

THE RELATIONSHIPS BETWEEN THE PERFORMANCE TESTS AND OTHER MEASURES

This research on job-sample tests was started because it was felt that these practical factor tests measured aspects of performance that could not be measured in any other way. These tests were intended to duplicate the actual job as closely as possible

It has already been pointed out (see page 80) that performance tests need to be used in conjunction with written achievement tests to obtain a more complete picture of a person's ability. In addition to the written tests commonly used in job and school situations, various methods of rating performance are widely utilized. The Quarterly Marks are one such method. It was thought that performance tests would also prove to be necessary supplements to these performance ratings.

To study the relationship between performance as rated and performance as measured (by the job-sample tests) two experimental measures of shipboard performance were developed along with the Practical Performance Tests: the Performance Check Lists and the Performance Rating Scale.[1] Scores on the performance tests were correlated with estimates of the men's abilities obtained on these rating devices to determine the extent to which ratings could be accepted as substitutes for actual tests of ability to perform.

A series of experimental aptitude tests was also administered to the incoming candidates at the Enlisted Submarine School, New London, as a part of this over-all study of shipboard performance measures and their relation to selection and training procedures.[2] Scores made on the aptitude tests were

---

[1]The rating scale and check list studies are described in Parts II and III of this Final Report.

[2]The aptitude testing program is described in Part V.

correlated with scores subsequently made on the performance tests. The measure of correlation indicated the extent to which the aptitude test scores predicted what men's subsequent shipboard performance was likely to be.

Correlation of Performance Test Scores with Rating Scale and Check List Scores

The Performance Rating Scale was made up of eleven generalized item-statements which described personal work characteristics pertinent to shipboard job performance (see the next two pages for sample pages from the rating scale booklet). Ratings assigned for these work characteristics gave indications of general job knowledge and ability and gave indications of attitudes towards work and towards shipboard duties in general.

The Performance Check Lists (see page 86 for sample page from the EM check list; the same general form was followed in the EN check list) were made up of 53 and 50 task-items selected from the jobs of submarine EM's and EN's, respectively. The Officers and Petty Officers using the check lists were asked to indicate whether or not the men serving under them could perform the listed tasks "unsupervised," with "occasional supervision," or if they needed "constant supervision." The items were scored according to the degree of supervision the man was reported to require in order to do each task. The checkers also indicated whether or not they had recently seen each man do the task in question.

In the studies of the relationships of the rating devices and the performance tests, it was found that what Officers and Petty Officers said men under them could do was not closely related to the scores these men attained on the performance tests.[3] The low correlations between rating scores and test scores indicate that, in the instances considered, performance ratings were not

[3]Complete discussions and analyses of these studies are reported in Parts II, III, and IV of this Final Report.

PERFORMANCE RATING SCALE

FOR ENLISTED NAVAL PERSONNEL

(OFFICE OF NAVAL RESEARCH PROJECT N8 onr 70001)

U.S.S. _____

DIVISION: _____

NAME OF RATER: _____

RANK OR RATE: _____

DATE: _____

Form RF 108

Psychological Research Center

Los Angeles, California

INSTRUCTIONS TO RATERS

You will find the names of the men in your gang or division listed in this booklet. They are to be rated by you on several qualities which you will recognize as important for success in the Navy.

The qualities are described at the top of each page. Along the side of each page various degrees of the quality in question are indicated. Some men in your group will be pretty well described by one particular group of statements, while others may seem to fall between two groups of statements (that is, two groups of statements partially describe them.) Your task is to indicate with a check mark the position of each man in your group with respect to the trait in question.

On the following page a sample rating sheet is shown to indicate how a completed rating might look. Here each man has been compared with the others and rated on the trait of **Job Knowledge.** Notice that the check marks have been well spread out and that no two people received the same rating. These are two characteristics of well-performed ratings.

Observing the following procedures will help make your ratings most valuable:

1) Consider each man in comparison to the others in his group as you rate each trait. There will be a few outstanding men in each gang, and a few who are not so good, while most will fall somewhere in between.

2) Rate the best and the poorest man in each trait first. With these limits established, rate the remainder of the men in relation to them.

3) If possible, avoid giving tie ratings. Before you rate two men exactly equal, consider carefully whether there is not some small difference between them.

4) Remember that most men's ratings vary from trait to trait. Because a man is high (or low) in one trait does not necessarily mean he will be high (or low) on the others. Each trait should be considered separately. For example, it is improbable that the same man or men will be highest (or lowest) in **every** trait in the scale.

5) **This is important.** Do not rate one man higher than another simply because he is in a higher pay grade. Experience and ability generally run together, but they are not always perfectly related. These ratings are to be used for research purposes only and will not be a factor in anyone's advancement. We sincerely request your frank and honest impressions.

KNOWLEDGE OF THE JOB

How well does each man know the technical duties of his rate? Does he know all the fine points or does he just know enough to get by? How often does someone have to help him get the job done? Does he know more or less than most men of the same rate?

	E.J.Brownell EM 2/c	J.A.Carson EM 3/c	L.L.Furgeson EM 1/c	T.J.Harrison EM 1/c	F.G.Moore EMFA	F.L.Parker EM 2/c	W.N.Thompson EM 3/c	S.E.Turner EMFA
Has as much or more job knowledge as the very best of his rate. Knows all the fine points of his job. Never needs help on the job.			✓	✓				
Practically never needs help on the job. Has very little to learn about his job except for a few of the most technical aspects.	✓					✓	✓	
Has adequate knowledge to turn in a satisfactory job. Sometimes needs help on the job, since he still has a few things to learn.					✓			
Has much to learn about his job. Needs supervision very frequently since he lacks much of the fundamental knowledge necessary to do the job alone.		✓						✓

(The following material was taken from the Performance Check-List for Electrician's Mates, Office of Naval Research Project N8 onr 70001)

INSTRUCTIONS FOR ELECTRICIAN'S MATE CHECK-LIST

In this booklet you will find described a number of tasks which men in the Electrician Gang are often called upon to perform. You are asked to indicate which of your men can do these various tasks.

It is expected that the more experienced men, with higher rates, will be able to do more of these tasks than the men with lower rates or Strikers. However, you should not automatically check a man one way or the other just because of his rate. You may occasionally find, for example, a 3rd class who can do some things that a 2nd class cannot do.

In this check-list you will be able to answer in one of three ways for each man you check. For each task you can indicate whether the man can do the job:

Unsupervised--Without supervision or any technical help whatever. Can do the whole job by himself.
Occasionally Supervised--Needs only an occasional check to see that everything is going O.K.
Continuously Supervised--Needs to be told what to do and helped practically throughout the job. Men who cannot do the job at all should also be checked in this row.

In addition to checking each man in one of the above categories, we would also like to know whether or not you have personally observed each man doing the task in question recently enough so that you can be absolutely sure that you have checked him correctly. If you have recently seen him do it, place a check in the space provided.

A sample item is shown below, indicating how your men should be rated.

		Harris EM2	Hank EM3	Quinn EMFN	Kent EM2	Parker EM1	Wallace EMFN
Can parallel D.C. generators, using correct procedure.	Unsupervised	✓	✓			✓	
	Occasionally Supervised				✓		✓
	Continuously Supervised			✓			
	Recently saw him do it	✓	✓		✓		✓

an adequate substitute for performance tests.

It is concluded, therefore, that rating methods, by themselves, do not sufficiently reflect the differences in men's abilities to perform the practical factors of their jobs.[4] Performance ratings need to be supplemented with performance tests

Correlation of Performance Test Scores with Selected Aptitude Test Scores

Since the fall of 1948, several especially chosen aptitude tests[5] have been administered to the incoming candidates at the Enlisted Submarine School, New London. Scores made on these tests were tabulated and analyzed along with scores made on the Navy General Classification (GCT) and Arithmetical Reasoning (ARI) tests.

Of the more than 2,000 men tested at New London, Practical Performance Tests were administered to 107, 56 of whom had become shipboard EN's and 51 of whom had become shipboard EM's. Selected aptitude test scores of these men were correlated with the scores they made on the performance tests. These relationships, along with the intercorrelations of the aptitude tests themselves, are shown in Tables II and III.[6]

Especially noteworthy were the relationships between tests of mechanical aptitude (Navy Mechanical and Guilford-Zimmerman Survey of Mechanical Knowledge)

---

[4]The possibility that the ratings may reflect important aspects of shipboard performance other than practical and technical skills is considered in Part II of this Final Report.

[5]The experimental aptitude battery included such standard tests as the Thurstone Primary Abilities Series and the Guilford-Zimmerman Aptitude Surveys, Parts IV and VII (Perceptual Speed and Mechanical Knowledge), plus several other tests developed or adapted for the project. See Final Report, Part V.

[6]All tests not shown yielded coefficients below those reported.

TABLE II

INTERCORRELATIONS OF SELECTED APTITUDE TESTS AND AVERAGE COMPOSITE BATTERY SCORES

ELECTRICIAN'S MATES
(Third Class PO'S & Strikers)

Pearson Product-Moment Coefficients
N = 51

1	NAVY GENERAL CLASSIFICATION TEST										
2	NAVY MECHANICAL	32									
3	THURSTONE VERBAL MEANING	49	-03								
4	THURSTONE REASONING	41	11	59							
5	THURSTONE WORD FLUENCY	48	03	51	35						
6	GUILFORD-ZIMMERMAN PERCEPTUAL SPEED	16	-18	13	22	11					
7	GUILFORD-ZIMMERMAN MECHANICAL KNOWLEDGE	36	62	11	18	11	-11				
8	SPATIAL ORIENTATION	26	31	20	35	18	21	17			
9	DIRECTION MARKING	29	12	25	28	14	12	25	46		
10	SOCIAL SCIENCE	56	28	74	49	56	13	47	32	18	
11	AVERAGE COMPOSITE BATTERY SCORE	34	45	18	14	36	-20	49	25	31	48
		1	2	3	4	5	6	7	8	9	10	11

TABLE III

INTERCORRELATIONS OF SELECTED APTITUDE TESTS AND AVERAGE COMPOSITE BATTERY SCORES

ENGINEMEN
(Third Class PO's & Strikers)

Pearson Product-Moment Coefficients
N 56

		1	2	3	4	5	6	7	8	9	10	11
1	NAVY GENERAL CLASSIFICATION TEST											
2	NAVY MECHANICAL APTITUDE TEST	35										
3	THURSTONE VERBAL MEANING	37	-10									
4	THURSTONE REASONING	16	12	10								
5	THURSTONE WORD FLUENCY	30	01	38	08							
6	GUILFORD-ZIMMERMAN PERCEPTUAL SPEED	14	03	00	36	-07						
7	GUILFORD-ZIMMERMAN MECHANICAL KNOWLEDGE	20	40	08	-03	14	-06					
8	SPATIAL ORIENTATION	05	42	-09	25	17	15	-01				
9	DIRECTION MARKING	01	33	13	05	-33	25	07	34			
10	SOCIAL SCIENCE	42	23	62	12	04	18	09	20	34		
11	AVERAGE COMPOSITE BATTERY SCORE	07	37	06	-03	-15	20	29	15	43	38	

and the performance tests.[7] These relationships indicate that mechanical aptitude test scores give a good prediction of how well prospective EM's and EN's will perform their shipboard jobs.

When scores from the Navy Mechanical Aptitude, Guilford-Zimmerman Mechanical Knowledge, Direction Marking, and Thurstone Word Fluency tests were combined, it was found that they predicted scores on the EM performance battery better than did a combination of the Navy Mechanical, GCT, and ARI. Similarly, a combination of the Navy Mechanical, Guilford-Zimmerman Mechanical Knowledge, Direction Marking, and Social Sciences tests predicted EN performance test scores better than did the Navy Mechanical, GCT, and ARI. These data are summarized in Table IV.

Having the two parallel groups of EM's and EN's who had taken both the aptitude tests and performance tests with which to work made up in part for their lack in size. The correlations proved to be similar in the two groups, and this tended to lend as much or more credence to the findings as would similar results from a larger single group.

The results of these correlational studies indicate that a higher average level of shipboard performance could be realized if submarine school candidates were screened with measures that place more emphasis on mechanical, visualizing, and spatial skills than do the GCT and ARI now used for screening purposes.

---

[7] A further correlation was made between Navy Mechanical scores and performance test scores using a larger sample (performance tests were administered aboard ship, and so Basic Battery scores were available in the men's service records). Pearson r's of .36 for 163 EN's and .46 for 180 EM's were obtained (scores of all pay grades being used). These coefficients compare with the Pearson r's of .37 and .45, respectively, obtained from the scores of those men tested at New London and followed into the fleet (cf. Tables II and III).

TABLE IV

PREDICTIVE VALIDITIES OF COMBINATIONS OF APTITUDE TEST SCORES FOR THE FM AND EN PERFORMANCE TEST BATTERIES[9]

Combinations of Experimental Aptitude Tests	Combinations of Navy Basic Battery Tests
FM's N = 51 R = .62 Tests: Navy Mechanical Aptitude Guilford-Zimmerman Mechanical Knowledge Direction Marking Thurstone Word Fluency	FM's R = .51 Tests: Navy Mechanical (N = 180) Navy General Classification (N = 225) Navy Arithmetical Reasoning (N = 225)
EN's N = 56 R = .56 Tests: Navy Mechanical Aptitude Guilford-Zimmerman Mechanical Knowledge Direction Marking Social Science	EN's R = .40 Tests: Navy Mechanical (N = 163) Navy General Classification (N = 250) Navy Arithmetical Reasoning (N = 249)

[9]Multiple coefficients of correlation were approximated by the Gengerelli Method (J. A. Gengerelli, "A Simplified Method for Approximate Multiple Regression Coefficients," Psychometrika, Vol. 13, #3, 1948). All of these coefficients are considered to be subject to correction upward in view of the selection at the submarine school on the basis of GCT - ARI combined scores, which restricted the range of scores used in these correlations.

Correlation of Submarine School Grades with Performance Test Scores

To determine how well submarine school grades indicate what a man's subsequent shipboard performance is likely to be, the final standings in submarine school of 155 EM's and 188 EN's who were tested with the performance tests were correlated with the scores the men made on the shipboard job samples.

Final standing in submarine school is determined from an unweighted average of individual and composite ratings given by instructors and written examination averages. In the case of both EM's and EN's, submarine school final standing correlated .40 with scores made on the composite performance test batteries.

Submarine school grades do indicate to a reasonable extent, therefore, how well a man will perform the technical aspects of his prospective rate. It appears, however, that selected aptitude test scores, as noted in the previous section, are somewhat better predictors of men's abilities to perform the practical factors of shipboard jobs.

Chapter VI

CONCLUSIONS OF THE PERFORMANCE TEST STUDY

The principal conclusions from this study of Practical Performance Tests are:

1. The tests are reliable and objective measures of ability to perform shipboard duties.

2. They measure aspects of shipboard performance not being measured by written tests and rating methods.

3. They can be administered easily aboard ship.

The development, administration, and analysis of the job-sample performance tests resulted in the following conclusions regarding the construction and use of such tests:

Serialization of items. There are many tests, especially tests of operational procedures, in which the man being tested is required to proceed in a step-by-step manner. In other words, he is required to make Step A, Step B, Step C, etc., in that order. Sometimes, in this kind of test, a correct response at Step B is dependent upon a previous correct response at Step A; any chance error at A, therefore, may generate a further error at Step B or any other subsequent step.

An example of this is found in a megger test in which a man is expected to get resistance readings. Prior to taking the readings, he must either turn off the switch (Step A) or remove the fuse (Step A'), hook up his megger (Step B) and take the reading (Step C). An error at A, A', or B will produce an error at C even though the subject does know how to read the megger.

There are many instances where serialization of items is difficult to avoid. If it cannot be avoided, its effect on performance should be taken into account in the scoring.

Multiple Manned Equipment. There are pieces of equipment that require two or more persons for proper operation. Examples are large engines and electrical distribution boards. When tests are to be conducted in such cases, the man being tested should work with a second person who is highly experienced in the operation of the equipment. Otherwise, the errors of the second person will detract from the score of the person being tested.

If the second person is experienced, however, the added difficulty arises that he may give cues to the man being tested, through questioning of verbal commands, hesitancies, and so forth. This element must be taken into consideration in scoring.

Use of Idle Equipment. In this research project, an attempt was made to test the ability of 3rd Class EN's to start and stop main engines. The test called

for the man to go through the motions but not actually to start the engine. It was found that even 1st Class EN s and CPO's had difficulty in performing the test because gauge hands did not move, warning bells did not ring, no engine sounds were heard, oil pressure lights did not light, and so on.

In general, without the visual and auditory cues to which they were accustomed, the men's behavior patterns were broken and they sometimes became flustered over a task that was familiar and ordinarily routine.

Casualties as Test Items. In a system as relatively simple as a set of sound powered phones, casualties have worked out satisfactorily as test items. In more complex systems, however, or where diagnostic procedures are not necessarily prescribed in detail, casualty tests may upset the scoring procedures. For example, a person may hit upon a casualty by chance right at the start, or he may follow other equally acceptable diagnostic procedures and spend an uneconomically long time at the test. His score in either case is overly dependent upon chance.

Face Validity. In this research it was found that testing was far easier if the tests looked like the real shipboard job. The fuse test panel in the tentative EM test battery had all the elements of a good test (reliability, etc.), but a change to the standard Navy fuse panel in the final EM battery brought better cooperation from men taking the test and more ready acceptance from Officers and CPO's.

Further, when performance tests are used for training, it is, of course, desirable to have them resemble as much as possible the real thing.

Objective Scoring. In all tests the man being tested was asked to mark or copy his answers on paper. The safety test was the only one in which he had to spell any words. All others were answered with an 'X,' with an identification number, or with a reading from an instrument. In this manner, a minimum of "paper work" demands were put on the man. This is considered an important factor, especially since one of the assumptions underlying the development of performance tests is that men may be proficient in their jobs and still not be able to express themselves, either verbally or on paper.

It is also felt that a man being tested should record his own responses rather than have the test administrator record them. An administrator might influence test results, either through some bias, through inattention, or through inability to observe some of the minor or more subtle moves made by the man being tested.

Other Practical Considerations. It was found that by making test items homogeneous, tests could be short, five to fifteen minutes, and still be adequately reliable. Short tests are necessary if a representative selection of the tasks of a job are to be included in a test battery.

Homogeneity requires the use of repetitive items in a test. For example, in the fuse test all the fuses were tested in the same way; one fuse could be misjudged without misjudging another, thus avoiding the serialization of items.

If items are not homogeneous, however, they should be at least discrete, as in the sound-powered phone test where the casualties were independent of one another.

The mobility of the tests is also important. All of the Practical Performance Tests could be stowed in the trunk of a car or under the seat

of a motor launch and carried aboard ship by hand. This meant that the tests could be taken to the men to be tested with a minimum of difficulty.

Many performance tests, of course, can be built around actual operational equipment aboard ship. The possible use of such equipment should always be kept in mind.

The use of practical factor performance tests in the Navy need not be confined to any specialized training or testing program, nor to any other necessarily limited field of application. Performance tests can be used to standardize practical factor requirements for advancement in rate. They can be used to point out practical factor training deficiencies. The tests themselves, being representative tasks or mock-ups of shipboard jobs, can be used as training devices. The practical applications of performance tests may thus be related to many phases of Navy life. Performance tests are, in every sense of the word, "practical."

BIBLIOGRAPHY

Ash, Philip, "Analysis of the Navy's Method of Position Evaluation," Public Personnel Review, July 1950, 130-138.

Bennett, G K. and Cruikshank, R. M., A Summary of Manual and Mechanical Ability Tests, Psychological Corporation New York, 1942.

Brandt, Hyman, "Development and Construction of an Armed Forces Qualifications Test," American Psychologist, 1949, 4:239 (Abstract); see also 239 and 240.

Brümmer F., "A Mechanical Ingenuity Test," Journal of General Psychology, 1929, 2:522-526

Buros, O. K., Mental Measurements Yearbook, 1949. Highland Park, N. J.

Chapman, J C., Trade Tests, Henry Holt and Co., New York, 1921.

Cronbach, L. J., and Neff, W. D. "Selection and Training," Chapter 23 in Human Factors in Undersea Warfare, Committee on Undersea Warfare, National Research Council, Washington D. C., 1949, pp. 491-513.

Deal and Esman, "Developing and Using Performance Standards," Personnel, May 1949, 418-422

Earle, F. M., and MacRae, A., "Tests of Mechanical Ability," National Institute of Psychology, 1929, Report No. 3.

Feder, D. D., "The Use of Objective Achievement Examinations in a Naval Training Program," Education Psychological Measurement, 1946, 6:213-221.

Gengerelli, J. A., "A Simplified Method for Approximate Multiple Regression Coefficients," Psychometrika, Vol. 13, No. 3, 1948.

Guilford, J P., Fundamental Statistics in Psychology and Education, McGraw-Hill Book Co., Inc., New York, 1950.

Hausman, Howard J., and Mitchell, Phillip H., "Techniques for Measuring the Proficiency of Military Aircraft Mechanics," Headquarters Strategic Air Command, Andrews Air Force Base, Washington, D. C., Pamphlet No. 3, and Study No. 1, both unpublished.

Hausman, H. J., Begley, J. T., and Paris, H. L., "Selected Measures of Proficiency for B-29 Mechanics, Study No. 1," Human Resources Research Laboratory, Bolling Air Force Base, Washington, D. C., 1949. (HRRL Report No. 7)

Hildreth, G H., A Bibliography of Mental Tests and Rating Scales, Psychological Corporation, New York, 1939.

Levine and Gorham, "Validation of Proficiency Tests for Infantryman," American Psychologist, July 1950, p. 360 (Abstract).

Mosier, C. I., "On the Reliability of a Weighted Composite," Psychometrika, 1943, 8:161 168

Link, H. C., "Psychological Tests in Industry," Annals of the American Academy of Politics and Social Science, 1923, 110:32-34.

Newman, W I , "Practical Trade Tests," Factory and Industrial Management, February, 1932, pp. 75-76.

Paterson, D. G., Elliot, R. M., Anderson, L., Toops, H., and Heidbreider, Minnesota Mechanical Ability Tests, University of Minnesota Press, Minneapolis, Minn., 1930.

Philip, B. R., "A Comparison of an Electrical Circuit Tracing Test with the O'Connor Wiggly Block Test," Journal of Applied Psychology, 1935, 19:148-165.

Robinson, E. S., "The Analysis of Trade Ability," Journal of Applied Psychology, 1919, 3:352-357.

Rosenberger, Homer T., "Testing Occupational Training and Experience," Education and Psychological Measurement, 1948, 8.101-115

Rossett, N. E., Arakelian, P., "A Test Battery for the Selection of Dial Switchmen," Journal of Applied Psychology, June, 1939, pp. 358-366.

Shartle, Carroll L., "A Selection Test for Electrical Troublemen," Personnel Journal, October, 1932, pp. 177-183.

Short, O. C., "Suggested Tests for General Machinists," Public Personnel Studies, 1936, 4:211-223.

Stead, W. A., and Shartle, C. L., Occupational Counseling Techniques, American Book Co., New York, 1940.

Stuit, Dewey B., (Editor) Personnel Research in Test Development in the Bureau of Naval Personnel, University of Princeton Press, Princeton, N. J., 1947

Super, Donald E., Appraising Vocational Fitness by Means of Psychological Tests, Harper and Bros , New York, 1949.

Sweezy, E. E., "Job Performance Standards in Government," Public Personnel Review, January, 1949, pp. 28-34.

Thompson, L. A., et al, Interview Aids and Trade Test Questions for Employment Offices, Harper and Bros., New York, 1936.

Tiffin, J., Purdue Vocational Achievement Tests: Manual of Directions, Keys, and Tentative Norms, Purdue University Press, Lafayette, Indiana, 1940.

Tiffin, J., and Greenly, R. J., "Employee Selection Tests for Electrical Fixture Assemblers and Radio Assemblers," Journal of Applied Psychology, April, 1939, pp. 240-263.

Tiffin, J., and Greenly, R. J., "Experiences in the Operation of a Punch Press," Journal of Applied Psychology, 1939, 23:450-460.

Uhlaner, J. E., and Brundage, E. G., "Comparison of Army and Navy Classification Tests," Pamphlet. Bureau of Naval Personnel and Army Ground Forces, (unpublished).

Uphoff, "Objective Tests for the Promotion of Marines," American Psychologist, 1949, p. 306 (Abstract)

Viteles, M. S., The Human Factor in Substation Operation; Specifications and Tests for Substation Operators," Personnel Journal, August, 1929, pp. 81-113.

Wicks, E. C., Poliacik, John Jr., and Ellberg, John, Shopwork, American Book Co., San Francisco 1943.

Constructing and Using Achievement Tests, NAVPERS 16808-A.

Curriculum for Naval Reserve Submarine Rate Training--Electrician's Mate P. 3/c, and 2/c Naval Reserve Training Coordinator, Commander of Submarines in the Atlantic, 1948.

Curriculum for Naval Reserve Submarine Rate Training--Electrician's Mate, P. 1/c, and Chief, Naval Reserve Training Coordinator, Commander of Submarines in the Atlantic, 1948

Curriculum for Naval Reserve Submarine Rate Training--Engineman, D. 1/c, and Chief, Naval Reserve Training Coordinator, 1948.

Curriculum for Naval Reserve Submarine Rate Training--Engineman, D. 3/c, and 2/c, Naval Reserve Training Coordinator, Commander of Submarines in the Atlantic, 1948.

Curriculum for Naval Reserve Training--Submarine Qualification, The Submarine School, U. S. Naval Submarine Base, New London, Connecticut, 1946.

Development of Achievement Tests for Class "A" Naval Training School (Torpedoman), OSRD 5520 (RESTRICTED).

Development of Achievement Tests for Gunner's Mates Schools, OSRD 5259 (RESTRICTED).

Development of Achievement Tests for Landing Craft School, Coronado, Calif., OSRD 5670 (RESTRICTED).

Development and Use of Performance Tests as Criteria in Evaluating 20 mm. Gunnery Classification Procedures, NAVPERS 18070.

Development of Performance Tests for Use in Class "A" Electrical Schools, OSRD 5666 (RESTRICTED).

Evaluation of Prediction of Submarine Officer's Evaluation of Enlisted Men, OSRD 5557.

Final Performance Test Class "A" Naval Training School, Torpedomen, NAVPERS 16970 (RESTRICTED).

Fleet Type Submarine, The. NAVPERS 16160 (RESTRICTED)

Gauges and Rating Scales for Grading Shop Work. NAVPERS 16694.

Human Factors in Military Efficiency. Aptitude and Classification. Summary Technical Report, Vol. I, Applied Psychology Panel, NDRC, Washington, D. C., OSRD, 1946. pp. 491-513 (RESTRICTED).

Human Factors in Military Efficiency: Training and Equipment. Summary Technical Report, Vol. II, Applied Psychology Panel, NDRC, Washington, D. C., OSRD, 1946 (RESTRICTED).

Identification Test. 5 inch/38. NAVPERS 16620 (RESTRICTED)

Identification Test. 40 mm.. NAVPERS 16621 (RESTRICTED).

Identification Test. 20 mm . NAVPERS 16622 (RESTRICTED).

Identification Test. Caliber .50 Browning Machine Gun. NAVPERS 16623 (RESTRICTED).

Identification Test. Small Arms. NAVPERS 16624 (RESTRICTED).

Instructions for Use in Preparation for the Rating of Electrician's Mate 3/c and 2/c. Navy Training Courses, Bureau of Navigation, 1941

Instructions for Use in Preparation for the Rating of Electrician's Mate, 1/c and Chief. Navy Training Courses, Bureau of Navigation, 1940.

Identification and Performance Tests on Distilling Plants. NAVPERS 16645 (RESTRICTED).

Identification and Performance Tests on Internal Combustion Engines. NAVPERS 16643 (RESTRICTED).

Identification and Performance Tests on Pumps. NAVPERS 16644 (RESTRICTED).

Identification and Performance Tests on Shipfitting. NAVPERS 16693 (RESTRICTED).

Manual of Enlisted Navy Job Classification. NAVPERS 15105.

Manual of Instructions for Naval Occupational Analysis. NAVPERS 15083.

Memorandum on Constructing Work Readiness Tests. OSRD 5521.

Memorandum on Micromotion Analysis of the Service of the 3 inch/50 Gun. OSRD 6176 (RESTRICTED).

Memorandum on the Construction and Validation of a Work Readiness Test for Distilling Plant Operators. OSRD 5507.

Performance Test. 5 inch/38. NAVPERS 16625 (RESTRICTED).

Performance Test. Caliber .50 Browning Machine Gun. NAVPERS 16626 (RESTRICTED).

Performance Test on AC Equipment and Interior Communication. NAVPERS [illegible] 18 (RESTRICTED).

Performance Test on DC Equipment, NAVPERS 16716 (RESTRICTED).

Performance Test on Wiring, NAVPERS 16717 (RESTRICTED).

Qualifications for Advancement in Rating, NAVPERS 18068 (RESTRICTED).

Qualifications Notebook, Organized Submarine Division 11, San Diego, 1943.

Radio Code Receiving Examinations, NAVPERS 16798 (RESTRICTED).

Selection and Training of Gun Crews, OSRD 1209 (RESTRICTED).

Special Devices, NAVEXOS P-530, Special Devices Center, ONR, Port Washington, L. I., N. Y., 1949 (RESTRICTED).

Submarines, Enlisted Billet Descriptions, NAVPERS 15646 (RESTRICTED).

"Suggested Tests for Various Trades," Public Personnel Studies, No. 4, 1926.

Validity Data for the U. S. Navy Basic Test Battery, Form 1 and Form 2, NAVPERS 16719.

"Testing the New Operators Knowledge of his Machine," Factory Management and Maintenance, December, 1942, pp. 84-85.

U. S. War Department Army Trade Screening Tests, U. S. War Department, Pamphlet, No. 12-13, 1945.

Valve Identification Tests, NAVPERS 16642 (RESTRICTED).

UNCLASSIFIED