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Guided Missile Personnel Research: Report No. 2

Part One

COLLECTING AND COMPILING TASK INFORMATION FOR NEWLY DEVELOPED GUIDED MISSILES

Prepared under the Sponsorship of the
BUREAU OF NAVAL PERSONNEL

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* RESEARCH REPORT *

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by

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PREFACE

The human factors involved in the operation and maintenance of guided missiles are variables which must be considered in determining the reliability of the weapon. The over-all reliability is a resultant of the reliabilities of the individual components of the weapon system. The reliabilities of the components of the system are, in turn, a function of the following variables:

1. The basic principles of the operation of the weapon.
2. The design of the weapon.
3. Engineering testing and evaluation.
4. Fabrication and production.
5. Production inspection and quality control.
6. Transportation (handling), assembly and stowage.
7. Preflight check-out.
8. Trouble-shooting.
9. Servicing and repair.
10. The tactical use of the weapon.

Variables 1 through 5 are usually considered to be the responsibility of the missile designer and manufacturer and Navy engineering, human engineering, and inspection agencies. It is, however, variables 6 through 9 in the above list which largely reflects the adequacy of personnel selection, training, and job structure. The proficiency of Naval personnel in performing the tasks associated with variables 6 through 9 significantly contribute to the reliability of a particular guided missile.

Toward this objective and in order to base personnel plans and policy on sound objective data, the Personnel Analysis Division of the Bureau of Naval Personnel has planned a program of systematic guided missile personnel research. The procedures developed and the data obtained in this program can contribute to the following:

1. The specification of the knowledges and skills required by personnel to perform the job behaviors associated with the tasks required by the new weapon.
2. A comparison of the knowledges and skills required by the new weapon with the knowledges and skills available in existing manpower.

3. Recommendations for an efficient job structure for personnel concerned with the new weapon.

4. The development of on-the-job criteria of job effectiveness.

5. Recommendations for the selection and training of personnel to operate and maintain the new weapon.

6. The development and construction of tests of job proficiency.

7. Recommendations for the most efficient organization and use of operations and maintenance manpower.

In the guided missile personnel research program during the period from July 1952 to July 1953, the project undertaken by the American Institute for Research has been concerned primarily with the following objectives:

1. The compilation of task information for Terrier missile activities.

2. The development of testing procedures and methodology for measuring the proficiency of personnel who perform duties associated with the operation and maintenance of Terrier.

The work accomplished toward these objectives are reported in the following two reports:

A. Guided Missile Personnel Research: Report No. 2
   Part One: Collecting and Compiling Task Information for Newly Developed Guided Missiles.
   Part Two: A Compilation of Task Information for Terrier Missile Activities.

B. Guided Missile Personnel Research: Report No. 3: A Proficiency Test Battery for Guided Missile Technicians.

Report No. 2 is presented here.

ABSTRACT

The primary purpose of this report is to present a compilation of task information for Terrier missile activities which will facilitate the work of Navy agencies concerned with personnel and training. Task information and technical engineering information were obtained from all phases of the Terrier program. In the course of obtaining this information, many possible sources were investigated and various procedures for obtaining task information were employed. Terrier was in the test and evaluation stage of a newly developed weapon, and it was necessary to investigate the contributions of all possible sources in order to produce a relatively stable analysis of the tasks required for the operation and maintenance of the Terrier missile.

This experience led to the formulation of Part One of this report. Part One is entitled, Collecting and Compiling Task Information for Newly Developed Guided Missiles. The essential aim of this portion of the report is to present recommendations and considerations for the collection and processing of task data in a widely-applicable fashion so that they are useful for future work with new guided missiles and for newly developed weapons in general. Part One should be of assistance to Navy Department job analysts for the modification of their information-collecting procedures when these procedures are applied to newly developed weapons in the test and evaluation stage.

Part Two of this report entitled, A Compilation of Task Information for Terrier Missile Activities, presents the compilation of task information for Terrier. This compilation contains the following:

1. Detailed analyses of the tasks involved in the following Terrier missile activities:
   a) Handling, stowage and assembly.
   b) Missile servicing.
   c) Missile testing and check-out.
   d) Adjustment, replacement and repair for the missile and associated equipment.
   e) Trouble-shooting and casualty analysis for the missile and its associated equipment.
2. An index of the technical materials concerning the Terrier Missile and associated equipment which were collected during the test and evaluation stage of the weapon.

3. An overview and technical summary of the operation and functioning of Terrier.

4. A comparison of Terrier subject matter with standard curriculum material similar to the Navy common core electronics curriculum.

Part One of this report is presented under separate cover. Part Two is divided into two volumes, Volume I and Volume II, each under separate cover.

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Very special appreciation is due to the officers and men of the Terrier guided missile training and service units. The enthusiastic and intelligent cooperation of these individuals contributed significantly to the research efforts upon which this report is based.

Appreciation is due to the Personnel Analysis Division of the Bureau of Naval Personnel for the encouragement of objective research and evaluation procedures in the guided missile personnel research program. Mr. Edward J. Fallon, who served as scientific liaison officer, deserves mention for his efforts in this capacity.

The Personnel and Training Branch, Psychological Sciences Division of the Office of Naval Research should also be mentioned for the encouragement of objective research procedures. Mr. Louis J. Sparvero, Resident Representative of the Office of Naval Research in Pittsburgh should be thanked for his cooperation in liaison matters.

Acknowledgment should be made to Dr. John C. Flanagan, Director of Research and Dr. Elmer D. West, Deputy Director for Administration and Research, both of the American Institute for Research, for their suggestions and assistance in the course of the research project.

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Dr. J. Frank Pierce
Prof. Wesley M. Rohrer, Jr.
Prof. George E. Jones, Jr.
Dr. John H. Neiler

all of the University of Pittsburgh.

C O N T E N T S

PART ONE--COLLECTING AND COMPILING TASK INFORMATION FOR NEWLY DEVELOPED GUIDED MISSILES

PART TWO—A COMPILATION OF TASK INFORMATION FOR TERRIER MISSILE ACTIVITIES

Volume 1

Volume 2

INTRODUCTION TO PART ONE

In the course of preparing a compilation of task information for Terrier missile activities, the American Institute for Research investigated many sources of possible information and employed various procedures for obtaining this information. Terrier was in the test and evaluation stage of a newly developed weapon, and no definitive operation and maintenance manuals and no highly experienced group of Terrier operating personnel were available. Under these circumstances, it was necessary to investigate the contributions of all possible sources of information; different sources produced information on different aspects of Terrier missile activities, and information from one source could corroborate the tentative information obtained from another source. In this way it was possible to build up an over-all picture of the tasks required for the operation and maintenance of the Terrier missile.

This experience led to the formulation of Part One of this report. This portion of the report presents considerations and recommendations for the collection and compilation of task information for newly developed guided missiles. This part of the report should be of assistance to Navy Department job analysts for the modification of their information-collecting procedures when these procedures are applied to newly developed missiles during their test and evaluation stages. Future work with new guided missiles should test the generality of these considerations and offer modifications and improvements applicable to newly developed weapons in general.

The data and materials upon which this report is based were obtained through field work at Terrier missile installations and by visits to agencies and organizations concerned with Terrier. Interview data, observational data, and technical materials were obtained from the following sources:

Applied Physics Laboratory, Johns Hopkins University.
Bureau of Naval Personnel, Personnel Analysis Division.
Bureau of Naval Personnel, Training Division, Curricula and Instructor Training Branch.
Bureau of Naval Personnel, Training Division, Functional Training.
Bureau of Ordnance, Guided Missile Branch.
Bureau of Ordnance, Launching Devices.
Bureau of Ships, Ship Installations.
Bureau of Yards and Docks, Handling and Packaging Section.

Consolidated Vultee Aircraft Corporation, Guided Missile Division.
Guided Missile Unit No. 21, U.S.S. Mississippi.
Guided Missile Service Unit No. 211, U.S. Naval Mine Depot, Yorktown.
Guided Missile Training Unit No. 23, U.S.S. Norton Sound.
Naval Inspector of Ordnance, Consolidated Vultee Aircraft Corporation, Pomona, California.
U.S. Naval Air Missile Test Center, Pt. Mugu.
U.S. Naval Guided Missile School, Pomona, California.
U.S. Naval Ordnance Test Station, Inyokern.

CHAPTER I

COLLECTING TASK DATA FOR NEWLY DEVELOPED WEAPONS

The collection of task* data for pre-production weapons undergoing engineering testing and evaluation presents some special problems when compared with the accomplishment of a job or billet analysis for the tasks associated with a weapon that has been in use in the fleet for some time. The sources of data differ in the two situations and appropriate procedures for obtaining job and task information in each situation must be devised. This chapter discusses the kinds of data available for a newly developed weapon and general procedures for obtaining task information.

In general, it should be pointed out that the data obtained at this time are usually in preliminary form, e.g., certain components may, in the future, be redesigned and circuitry modified. However, for personnel research at this stage it is not necessary that data be completely technically perfected or in the exact form that it will be when the weapon is in mass production. This is so because the essential skills and knowledges underlying the operation and maintenance of complex electronic-mechanical equipment do not change significantly, as far as the basic behavior of the technician is concerned, from pre-production model to production model. This has been empirically shown in studies where the job behaviors required by prototype and the job behaviors required by a production model have been analyzed and compared. The circuitry and engineering details of an equipment may be changed in the course of engineering testing and evaluation, but the essential skills and knowledges for which a man must be selected and trained, e.g., testing and checking, aligning and adjusting, and troubleshooting the equipment involved will remain relatively constant unless the basic principles of operation and the basic design of

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* The word "task" as used in this report refers to a work mission that is accomplished in the operation and maintenance of a guided missile, such as, checking out the missile with a particular test equipment, charging the missile hydraulic system, assembling missile sections, etc. A task may be performed by one or more men; the part each man plays and the behaviors he performs are part of his guided missile duties.

the weapon are radically changed. In such a case a different type of weapon is being dealt with. It appears, however, that if the underlying design continues and the changes resulting from engineering testing and evaluation are variations of this design, then job behaviors and their underlying basic skills and knowledges can be specified for the purposes of personnel agencies. (The term "personnel agencies", as used in this report, is broadly defined and refers to agencies concerned with the development of training curricula, training aids, rate qualifications, aptitude test batteries, etc.)

General Considerations

An important consideration in obtaining task data for newly developed weapons it to eliminate as much as possible those aspects of task performance that are unique to the test and evaluation phase of a new weapon and which will not become part of the operating situation in the fleet. Such aspects involve, for example, instrumentation specific to the collection of test and evaluation data, such as, elaborate telemetering equipment, improvised equipment adapted for temporary conditions; and procedures that are specific to temporary installations. On the basis of future plans and specifications by Navy bureaus and the weapon manufacturers, such temporary aspects can be identified approximately. Identification and investigation of these factors during the test and evaluation phase can decrease the amount of necessary future revision of job information data. However, the status of the weapon and plans for its operation and maintenance may be such that it is difficult to distinguish some of the more temporary from the more permanent aspects of the situation. In this case, it is best to analyse and report all job activities which are judged by engineering and operating personnel as likely to be included in the future operational situation and revise when further information is obtained. In relation to the total job, the amount of necessary revision will be small and advance job information will still be available.

For a weapon in the test and evaluation phase, one-shot data collection is not enough; arrangements should be made for the continuous flow of job information to personnel research agencies. This flow keeps the end products of personnel research, e.g., training curricula, proficiency measures, job codes, etc., in realistic contact with eventual fleet requirements.

It should be re-emphasized that the technical data available during the test and evaluation phase of a new weapon are, from the engineers' point of view, often in preliminary and tentative form and personnel agencies may be requested to await the formal

distribution of such materials when they are in more polished form. This can delay personnel research and planning. Personnel agencies require access to data even though it is considered to be in preliminary form. It has been previously pointed out that while in most instances engineering details of equipment may be changed in final form, personnel research and planning can begin with these preliminary materials.

The Data Available and Data Collecting Procedures

During the test and evaluation phase of a newly developed weapon, four primary sources of data may be available:

A. Cognizant Navy technical bureaus

B. The activities of design and production engineering contractors

C. The activities of field units testing and evaluating the weapon

D. The tasks and duties performed by personnel in jobs which are closely related to the job performances required by the new weapon

These data sources offer more or less information depending upon the stage of the development of the weapon and its associated equipment:

A. Cognizant Navy Bureaus

Initial preliminary and orientation information is best obtained from the technical files and libraries of the Navy bureau cognizant for the particular weapon concerned. This material may exist in the separate sections responsible for various aspects of the weapon. This material should be obtained and studied by job analysts so that they have some familiarity with the weapon and can proceed realistically with subsequent data-collecting steps. It is desirable that copies of the pertinent materials in these technical libraries be obtained so that they can be used for the particular purposes of personnel agencies. Arrangements should be made for the technical bureau concerned to keep the personnel activity responsible for the collection of data notified and aware of new material that is received. Also at this time a list can be obtained of the equipment manufacturers and contractors who are concerned with building the equipment involved in a particular weapon program.

B. Engineering Contractors' Activities

The activities of the engineering contractors in designing, evaluating, and planning production of the new weapon offer

excellent sources from which data can be abstracted which are useful for personnel research and planning. Investigation and analysis by the American Institute for Research of the activities of the weapon manufacturer and associated equipment manufacturers has indicated the sources of information listed below. This list describes departments or working groups in the manufacturers' organizations. After the title of each group the following is given: (a) a brief description of the function of the group, (b) the kind of data available from the working group which may be useful for personnel purposes, and (c) the importance of these data for personnel purposes.

1. Design Engineering Department

   Function: The development of plans for the design and construction of the new weapon; the redesign of unreliable components.

   Available data: Basic blueprints, redesign changes, equipment specifications. A manual may be available which has been written for use within this department for such a purpose as the orientation of newly hired engineers. Such a manual may precede more official publications by as much as a year or more.

   Importance of data: These data involve the basic mechanisms and circuitry with which personnel will have to work and in which they will have to be trained. Such data can be used primarily for advanced work in curriculum and proficiency test development.

2. Service Publications Department

   Function: The preparation of service manuals which will be used in operations and maintenance.

   Available data: Preliminary field manuals.

   Importance of data: These are the manuals with which personnel will work in the field. These manuals can be employed for job and task analysis and for the development of training manuals. They also offer material for the construction of proficiency tests and assistance in the specification of rate qualifications. Their clarity, unambiguity, and ease of using are important for the efficient performance of job duties, and training agencies should review them with this in mind early in the development of a training program.

3. Test and Servicing Equipment Department

Function: The development and selection of special check-out, maintenance and service equipment.

Available data: Test equipment blueprints, philosphy of maintenance.

Importance of data: These are the special equipments associated with the new weapon which must be operated and maintained; involved here are usually some decisions about the various divisions of maintenance and the level of personnel required for maintenance and repair duties. Test and servicing equipment and the over-all policy on maintenance procedures when using this equipment, in many respects, defines the tasks involved in the maintenance of the weapon. If the weapon is largely checked out by go-no-go equipment, the cues which a man interprets and to which he responds are a function of the test equipment. It may be that trouble-shooting and repairing the weapon involve, for the most part, relatively simple package replacement while detailed technical trouble-shooting and repair is required for the test and servicing equipment. Data on the over-all maintenance structure are especially useful for policy planning concerning the personnel and organizational requirements for the maintenance and servicing of the weapon and for preliminary establishment of the aptitude and rate qualification levels of maintenance personnel. This over-all information and data on specific test and servicing gear are also useful for job and task analysis, and for curriculum and proficiency test development.

4. Technical Procedures Department

Function: The preparation of production test procedures.

Available data: Standard test procedures, check lists.

Importance of data: Many of these procedures and check lists employed on the production line are applicable to the performance of job duties in the field. The materials can be employed for job and task analysis, for early training and for proficiency testing programs.

5. Reliability Study Department

Function: The investigation of sources of component unreliability.

Available data: Lists of component malfunctions and

associated unit failures or personnel malpractices.

Importance of data: These lists can give important emphases for training purposes; it is useful to distinguish, in so far as possible, between those malfunctions which will be designed out and those which most likely will persist as part of field operations. It is likely that any equipments and components which are very unreliable will be redesigned or modified in some way. Job and task analysts and training agencies can be watchful for new developments in these equipments and components.

6. Field Operations Department

Function: The specification of field operating and maintenance procedures; and the preparation of reports on operating problems in the field.

Available data: Operating and maintenance procedures and check-lists in use in the field, compilations of operation and maintenance problems.

Importance of data: These field procedures contain the essentials of the procedures which military personnel must use and be trained in. Operating problems may suggest appropriate training emphases so that these problems can be minimized. The extent to which available Navy personnel perform these operations satisfactorily can indicate the need for better trained or higher aptitude personnel or the possibility of less technical training and the use of lower aptitude personnel.

7. Factory and Customer Training Department

Function: The training of military personnel assigned to the manufacturer for training, and the training of employees for work on the production line.

Available data: Training curricula, training materials.

Importance of data: These materials present the kind of training program advocated by the manufacturer, the compilation of training materials, and the development of a curriculum. It may be possible to find here a core of material which has been abstracted from the mass of engineering detail available at the manufacturer's installation and which is especially useful for development of curricula, procedures, and proficiency examinations for an in-service training program.

8. Quality Control Department

Function: The compilation and investigation of component production failures and the reasons for them.

Available data: Analyses of production failures.

Importance of data: Many production failures are similar to those that will occur in field operation and maintenance; important training emphases can be determined from these and material can be obtained for the improvement of training and the development of trouble-shooting and repair training exercises.

9. Production Supervision Department

Function: The observation and analysis of personnel malpractices on the production line; and the supervision of tasks which are similar to the tasks performed by Navy personnel.

Available data: A list of frequent personnel malpractices in production testing and checkout procedures and information about how these tasks are performed.

Importance of data: Many of these production procedures are similar to military job duties and many individuals on the production line have a training background similar to Navy enlisted personnel. Hence, the job performance and malpractices of these individuals offer preliminary job and task analysis information and leads for the development of training procedures in testing, adjustment, trouble-shooting, and repair.

The departments listed above may vary in terms of organization and function with different engineering manufacturers and the kind of data described may be available in more or less usable and readily accessible form. Arrangements can be made with the local Naval Inspector of Ordnance for the forwarding of new information which is produced in the various departments of the manufacturer subsequent to the first visit by a data-collecting team.

C. Field Unit Activities

The activities of military testing and evaluation field units provide important sources of job data. These units include technical bureau and OPDEVFOR evaluation units; these units consist of Navy personnel and a manufacturer's representative. At these units information can be obtained about the tasks that must be performed by Navy personnel in handling, testing, aligning, trouble-shooting, and

repairing the new weapon and its associated equipment. Data from these field units can be obtained by primarily two techniques: 1.) Planned observation and interview, and 2.) Systematic collection and analysis of maintenance records.

Planned Observation and Interview

This technique can be called an "activity interview" and combines an interview procedure with observation of task performance. The procedure consists of the following steps:

a) On arrival at a weapon test and evaluation center, a general conference is held with the personnel in charge of the various working groups. Usually certain groups are established to accomplish particular functions, e.g., fire control group, handling and launching group, missile test group, etc. At this general conference the purpose of the data-collecting team is explained and separate meetings are arranged with the officers in charge of each working group. For these separate meetings each officer is requested to bring two well qualified men for each of the separate functions performed by his group.

b) At the separate group meetings, the organization of duties within each group is discussed and separate task categories are decided upon. One or several men working together are requested to fill out a Task Analysis Form which includes their particular weapon duties. This form is distributed and explained at this time. An illustrative Task Analysis Form is shown in Exhibit A at the end of this chapter. A separate meeting is arranged with each person or persons filling out a form.

c) When the forms are completed, they are employed as a basis for an activity interview; the men are requested to simulate with the actual equipment the operations they described in the form. As this is done the operations and behaviors involved are discussed and additions, changes and revisions are made on the Task Analysis Form. The kind of information included in each of the categories on this form is as follows:

Task: The title of the task is contained here. A task is considered as a group of work activities which accomplish a particular work mission during the process of operating and maintaining the weapon or piece of associated equipment, for example, assembling the missile sections, charging the missile hydraulic system, or checking out the missile with a particular piece of test equipment. A task can be performed by one or more men. Different tasks are usually, but not always, performed within separate time units; they are likely to utilize different tools and equipments; they usually are performed at

different points along the line of flow, and they are often performed by different personnel. The title of the task describes the nature of the mission as well as can be done in a few words.

Operations Involved: This is a list of the work activities performed to accomplish the task. It is exactly the same breakdown of work as occurs in check-lists and operating instructions, for example, connecting circuit-tester cables to power supply, connecting circuit-tester cables to the missile, turning on circuit tester, setting "A" dial on first position to check if circuit input is between 1.0 v and 2.5 v, etc. When check-lists or operating instructions are copied directly on the form, they are checked first for accuracy and completeness. Operations which are only occasionally or rarely a part of the task (operations which only occur under special conditions) are included as well as operations which are a normal part of the task. Appropriate qualifying remarks accompany these occasional operations. Each operation is designated with a number.

Behaviors: These are explanations of how each operation is performed. The behaviors describe (1) the personnel actions which take place, e.g., lifting a container, unscrewing a bolt, drilling a hole, turning a switch, reading a voltage dial, etc.; and (2) how personnel perform the actions, e.g., unscrewing bolts with a pneumatic wrench, twisting on a hose connection by hand, lifting a container with two hands, visually noting if indicator light is red or green, listening for repetitive clicks which indicate a test panel switch should be thrown off, etc. If, for example, a number of operations all involve the use of a monorail hoist, the behaviors required for operating the hoist need only be described once. It is the purpose of Behaviors to give complete descriptions of just what the men working on the task do. For an operation such as "turning on circuit-tester", there might be listed such behaviors as:

(a) Visually checking that voltage indicator on face of circuit-tester panel reads 60 v.

(b) Pressing "ON" button with finger.

(c) Visually checking that "POWER ON" light goes on.

Each of the operations involved in a task can be numbered and the group of Behaviors which apply to each operation is designated with the number of the operation.

Cues Available for Task Performance: These are the indications available to task personnel to tell them how something has been done or what should be done next, for example, indicator lights; operating sounds; voltage dial readings; pressure gauge readings; oscilloscope waveforms; tightnesses of bolts, latches, and valves; positions of switches; positions of mating surfaces; etc. In each case it should be specified how the cues are perceived, that is, visually, tactually, by ear, etc. The cues are identified with the operations to which they refer.

Time Required: This is the time required to perform the entire task and the major parts of it. The task may be broken down into such major parts as setting up the equipment, conducting the test, analysing the test results, and shutting down the equipment. If the time requirements are likely to vary according to the conditions under which the task is performed, those conditions and their consequences are specified.

Tools and Equipment: This list identifies the equipment worked upon, auxiliary equipment, tools, check-lists, and technical materials, such as schematic diagrams, which are used in the performance of the task.

Precautions: This is a list of the actions taken or measures observed to prevent injury to personnel, damage to equipment, or task inefficiency. The standard precautions required for work with all electronic equipment and propulsive or explosive ordnance materials can be specified by stating the publications which describe these precautions. The precautions which are unique to the particular task are described in detail with reference to the operations for which they are required.

Personnel Malpractices: This is a list of the incidents of incorrect performances of operations, omissions of operations, or violations of precautions which are reported as having occurred on the task.

Team Structure: This specifies the number of men involved in the performance of the task and the operations which are performed by each man. The person who supervises the task is identified and his duties listed.

Sources of Information: This is a list of all the training manuals, operating manuals, maintenance manuals, and technical materials pertinent to the task.

Comments: Information which is pertinent to the task but which cannot be included under any of the other categories is mentioned here. A statement can be included here concerning the adequacy, completeness and long range stability of the data included on the Task Analysis Form.

Record of Personal Data: It may be desirable to obtain personal data on the men who fill out the task analysis form and who participate in the activity interview. This can serve the following purposes: (1) The men are required to attach their names and their supervisors names to their work; this, in many cases, motivates men to do a more careful job than when they are asked to report anonomously. (2) The experience and background of the men may offer some basis for evaluating the data obtained if conflicting data are reported by different personnel. (3) The man or men completing the form are identified in case any follow-up field work is required for supplementation or clarification of the report.

Maintenance Records

Systematic collection of equipment casualties and trouble-shooting and repair procedures is an important function of a data-collecting program. Trouble-shooting and repair duties are obviously an important function of a maintenance technician. Procedures for performing these duties, however, are usually not given in maintenance manuals as standardized techniques. Trouble-shooting especially is left up to the ingenuity and insight of the technician. For this reason intensive training in trouble-shooting representative casualties which occur in the new weapon or its associated equipment should be heavily emphasized in a training program. Maintenance records, systematically collected and carefully analyzed, can provide a realistic basis for establishing the kinds of casualties and the kind of trouble-shooting procedures that should be taught in training and tested on proficiency examinations.

In order to obtain these data on a continued-flow basis, the Maintenance Data Form has been developed. Information on this form should be obtained for missile test equipment and associated equipment as well as for the missile itself. An illustrative Maintenance Data Form is presented in Exhibit B at the end of this chapter. The categories in this form can be explained by a job analyst to the personnel at a guided missile field unit. The forms then can be incorporated as a regular part of maintenance report procedures and forwarded to the appropriate personnel research agency. The categories on the form can be explained as follows:

1. Equipment: The name, Mark and Mod of the equipment, e.g., missile or test and servicing gear.

2. Casualty: This is a statement of what major component of the equipment went bad or malfunctioned.

3. Symptom: This is the particular symptom that led to the knowledge that the equipment was malfunctioning. This may be the result obtained from a particular check or testing procedure, e.g., a pattern on an oscilloscope, a voltmeter reading or some other testing device indication; it may be the recognition of the fact that launching was faulty or target hits were ineffective, etc.

4. How detected: This states the particular way in which the symptom was noticed. The "Symptom" category describes just what the symptom was, e.g., whether it was an out-of-tolerance reading, a faulty or incorrect wave form, that the missile did not launch properly or some such indication. The "How Detected" category describes just how or when this symptom was noticed, e.g., during a particular operation, when using a particular piece of test equipment or in the course of a visual check of the missile or test equipment.

5. Specific defective part: This states exactly what particular component was causing the difficulty or malfunctioning. This may be a defective tube, a broken lead, a solder joint that has come apart, a bad receiver package, etc.

6. Trouble-shooting and repairing procedures: This states in detail the exact procedure which the maintenance man went through from the time he noticed the symptom to the time he positively identified and corrected the specific defective part. The particular categories under trouble-shooting and repairing procedures are the following:

Sequence of checks performed: This is a listing of all the checks performed in the order that they were performed in locating and identifying the defective part. These checks may be a visual inspection, checks with a voltmeter, checks with an oscilloscope, checks with a special testing console, measures of the amount of wing movement, etc.

Reasons for each check: This column is used to obtain a record of the particular reasoning processes that went on in the course of trouble-shooting. When a proficient man performs a check, he usually performs it for some

reason. He might check a certain component because he has deduced, on the basis of his understanding of how the system functions, that this component could have caused the symptom; or he might check a component because in his experience he has found that a defect in this component usually results in the kind of symptom he is trouble-shooting.

Instruments, tools, diagrams, check-lists used: This states what particular instruments, tools, diagrams, and check-lists were used in the performance of a particular check.

What does this check indicate? As a result of performing a particular check, the maintenance man decides that this check indicates that a particular component is faulty or not faulty, or in-tolerance or out-of-tolerance, or it may indicate that another component which feeds into this one is faulty.

Action taken as a result of this check: On obtaining the results of a particular check, the maintenance man makes a decision. He may decide to make one or more additional checks; he may decide to replace a particular component; or he may decide to make an adjustment. These actions are included in this column of the Maintenance Data Form.

Some descriptions of the trouble-shooting process might be quite lengthy and may not be amenable to this columnar form; however, most are. If such is the case, however, the maintenance man or person filling out the form can use the back of the sheet to write whatever additional material is necessary.

The job analyst can leave a set of Maintenance Data Forms at a particular Navy installation, and set up a procedure whereby the forms, as they are filled out, are forwarded in groups of ten or so to a personnel research agency. Such a continuous feedback process from the field to personnel agencies can help to insure a realistic program of maintenance training and proficiency measurement.

Equipment Logs: An additional source of information about casualties and also about preventative maintenance and servicing activities are the logs kept by field units for specific equipments. The job analyst should read these logs and from them abstract data about which he would want to request more detailed information.

D. Related Tasks and Ratings: Overlapping Activities

Once an over-all view has been obtained of the tasks involved in the activities necessary for the operation and maintenance of a newly developed weapon, important sources of task information are the duties performed in related tasks by existing Navy ratings. An important outcome of personnel research concerned with a new weapon is the identification of those skills and knowledges required by the new weapon that overlap with the skills and knowledges possessed by existing manpower. Personnel with certain kinds of training may be capable of performing duties on the new weapon without additional training; others may require brief on-the-job training or some brief additional formal training, i.e., transition training from equipment they know to similar, new, or modified equipment. Consideration of overlap yields information which is especially significant for the determination of (a) sources of manpower which are available for the operation and maintenance of the new weapon, (b) the degree to which training is necessary for this available manpower to perform duties associated with the new weapon and (c) the possible necessity for the establishment of a new rating or job code.

It has been found most feasible to identify overlapping activities in terms of the tasks and duties required for the operation and maintenance of the major pieces of equipment that are used with the new weapon which are similar to equipment operated and maintained by existing Navy ratings. For example, for Terrier missile activities task information indicated that external guidance and control activities employ the Mark 25 Mod 6 radar which is a modification of the Mark 25 Mod 2, the latter being in wide use in the Navy. These Terrier activities also employ components such as the Mark 37 director, the Mark 6 stable element and the Mark 84 and 85 which are very similar to the equipment used in existing fire control systems. The Terrier missile launchers are modifications of existing types of gun mounts and the tasks and duties involved in the two are similar.

The identification of overlapping activities can be accomplished by comparison of preliminary task data obtained for the new weapon with information about the duties performed by existing Navy ratings. Materials of special interest in this connection are training curricula, training and field manuals, the qualifications for advancement in rate, and the organization of duties for a particular rating. Also of interest here are the differences between the standard equipment in use in related activities and the modifications of this equipment developed for use with the new weapon. This latter information

can be obtained from the manuals describing the modified equipment and by interviewing personnel operating and maintaining this new gear. The manner in which overlap can be reported is presented in Chapter II which discusses the processing and compiling of task data.

Summary

On the basis of extensive field work involved in collecting task information for the Terrier missile, this chapter discusses the collection of task data for newly developed weapons. During the test and evaluation stage of a newly developed weapon the following sources of data may be available:

A. Cognizant Navy technical bureaus

B. The activities of design and production engineering contractors

C. The activities of field units testing and evaluating the weapon

D. The tasks and duties performed by personnel in jobs which are closely related to the job performances required by the new weapon

These sources of information are discussed and procedures are recommended for obtaining data from them.

EXHIBIT A

TASK ANALYSIS FORM

TASK ANALYSIS FORM

A. Task _____

B. Operations Involved	C. Behaviors
(Over)	(Over)

B. Operations Involved (cont'd)	C. Behaviors (cont'd)

D. Cues Available for Task Performance	F. Tools and Equipment
E. Time Required	

G. Precautions	H. Personnel Malpractices

I. Team Structure	J. Sources of Information
	K. Comments

RECORD OF PERSONAL DATA

Interviewer _____ Date _____

Place of Interview: _____

1. NAME _____ SERIAL NUMBER _____

   RATE _____ RATING _____ NEC _____

2. LENGTH OF TIME IN NAVY ACTIVE DUTY _____ RESERVE _____

3. TITLE OF PRESENT BILLET _____

4. GUIDED MISSILE DUTIES _____

5. OTHER DUTIES _____

6. NAME, GRADE & TITLE OF IMMEDIATE SUPERVISOR _____

   _____

7. HIGHEST LEVEL OF EDUCATION AS A CIVILIAN _____

8. ARMED FORCES SERVICE SCHOOLS ATTENDED

Name	Where	When
_____	_____	From _____ To _____
_____	_____	From _____ To _____
_____	_____	From _____ To _____

9. WORK EXPERIENCE IN NAVY (List in order all billets, except schools, held six months or more. Begin with the most recent.)

   a. _____ d. _____

   b. _____ e. _____

   c. _____ f. _____

10. MAJOR CIVILIAN WORK EXPERIENCE (Include job title, and months of experience)

    _____

    _____

    _____

EXHIBIT B

MAINTENANCE DATA FORM

DATE _____

MAINTENANCE DATA FORM

A. Equipment: _____

B. Casualty: _____

C. Symptom: _____

D. How Detected: _____

E. Specific Defective Part: _____

F. Trouble-shooting and Repairing Procedures:

Sequence of checks performed	Reasons for each check	Instruments, tools, diagrams, check lists used	What does this check indicate	Action taken as a result of this check, e.g., repair, replacement, adjustment, additional check

(Use other side of page if necessary)

CHAPTER II

PROCESSING AND COMPILING TASK DATA FOR NEWLY DEVELOPED WEAPONS

As task* information of the kind described in Chapter I is collected, these data must be processed, organized, and presented in a form that is readily useful to personnel agencies. This information affords a basis for the development of such end-products as rating structures and rate qualifications, selection requirements, manpower planning, training curricula, and proficiency examinations. The using agencies who produce these end-products will be required to perform more or less final processing of the task information depending upon their particular jobs. The essential function of the initial processing and compiling of task information described in this chapter is to make this information available to these agencies in a comprehensive, organized, and usable manner. The compilation of task information should serve to present material that can be used immediately by personnel agencies and also to refer these agencies to additional source materials. The processing of task data can produce three kinds of information: (1) Description and analysis of the tasks involved in the operation and maintenance of the new weapon. This information is generally useful to personnel agencies. (2) Specific analyses usable by particular personnel agencies, e.g., a comparison of Terrier circuitry with basic electronic circuitry for use by a curriculum development agency. (3) General engineering information about the weapon system for personnel agencies interested in a subject matter description of the newly developed weapon. This is especially useful for training and proficiency measurement agencies.

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* The word "task" as used in this report refers to a work mission that is accomplished in the operation and maintenance of a guided missile, such as, checking out the missile with a particular test equipment, charging the missile hydraulic system, assembling missile sections, etc. A task may be performed by one or more men; the part each man plays and the behaviors he performs are part of his guided missile duties.

The processing and organization of the task data collected for the Terrier missile by the American Institute for Research proceeded through the following steps:

Step 1. An over-all categorization and description of the activities involved in the operation and maintenance of the new weapon.

Step 2a. Specification of the overlap between the activities of existing Navy ratings and activities required by the new weapon.

Step 2b. Identification of the non-overlapping activities of the new weapon that require detailed personnel research and analysis.

Step 3. Organization and presentation of task analyses and task information for the non-overlapping activities.

This chapter describes each of these steps.

Step 1. Over-all categorization and description of the activities involved in the operation and maintenance of the new weapon.

In this step the tasks involved in the operation and maintenance of the new weapon are categorized and each task is briefly described. For guided missile activities, two major categories are applicable:

A. External Guidance and Control Activities: This includes tasks associated with fire control and external missile guidance, e.g., operation and maintenance of the director, radar and computer equipment, and synchronization of this equipment with hoist and launcher.

B. Missile Activities: This includes tasks associated with the "bird", its component parts, and its associated test, servicing and handling equipment, e.g., assembling, stowing, testing, trouble-shooting and repairing missile components and missile test equipment.

These two major categories of activities are subdivided into the following kinds of sub-categories:

Operations: This refers to the performance of handling and manipulatory procedures such as the handling and assembly of a missile, its installation on the launcher,

and prefiring and firing guidance and control activities. Testing and checking activities are not included in this category.

Operational Maintenance: This refers to the routine performances of testing, checking, alignment, and adjustment procedures, the use of go-no-go test equipment, the use of servicing equipment and the replacement of plug-in components. These activities are not considered as complex trouble-shooting performances.

Technical Maintenance (casualty analysis and repair): This refers to the complex trouble-shooting of the missile and associated test equipment and the repair of complex circuitry.

In this step, it is also desirable that an integrated picture of the work involved in the new weapon be presented. This can be accomplished by means of an overview description of work flow which shows the tasks performed in the operation and maintenance of the new weapon from the time it leaves the production line until it is fired at a target.

The accomplishment of Step 1. for the Terrier missile is presented in Chapter II of Guided Missile Personnel Research: Report No. 1.

Step 2a. Specification of the overlap between the activities of existing Navy ratings and activities required by the new weapon.

As defined in Chapter I of this report, overlapping activities are major activities being performed by existing Navy ratings that require tasks and duties similar to those required for the operation and maintenance of the newly developed weapon. In this step, the tasks described in the previous step are compared with the tasks accomplished by related Navy ratings; this is discussed in Chapter I. The resulting comparisons can be presented in a series of tables; one table for each related rating. Each table includes the following columns of information (numbering the columns from left to right).

Column 1. Duties Performed by the Rating That are Related to New Weapon Activities: This column states the overlapping duties currently being performed by personnel in the rating concerned.

Column 2. New Weapon Duties: This column states the new weapon duties related to the duties listed in Column 1.

Column 3. Differences and Similarities: This column presents the major differences and similarities between the duties in the previous two columns.

Column 4. Additional Training Required: This column presents estimates of the kind of training (none, on-the-job training, or transition training) required for a man in the rating to learn to perform new weapon duties related to his present duties.

Examples of overlay tables for two ratings with respect to the Terrier missile are given in Exhibit C at the end of this chapter. Tables for other ratings with respect to Terrier are given in a previous report, Guided Missile Personnel Research: Report No. 1.

The comparison of the duties of existing ratings with the duties required for the performance of Terrier duties indicates the following:

a) External guidance and control activities with the exception of operational and technical maintenance of the launcher and hoist system, may be delegated to the Fire Control Technician. Equipment modified for missile operations (such as the Mark 25/6 radar which is a modification of the Mark 25/2 radar) will require some additional training. Other components (such as the Mark 37 director, the Mark 6 stable element, and the Mark 84 and 85 computers) are very similar to those used in present fire control systems and should require little or no further training.

b) Launcher and hoist system operational and technical maintenance activities may be delegated to the existing rating of Gunner's Mate. The present Terrier missile launchers are modifications of existing types of gun mounts (40 and 90 mm). Another activity which may be assigned, with little or no additional training, to the Gunner's Mate is the handling and stowage of missile ordnance.

Step 2b. Identification of the non-overlapping activities of the new weapon that require detailed personnel research and analysis.

Non-overlapping activities involve tasks which are not included in the duties of existing Navy ratings. For Terrier, special missile test equipment and the missile itself are relatively unique and the operation and maintenance of these equipments

involve tasks which are not performed by personnel in existing ratings. Obviously, there is some overlap with any Navy rating that works with electronic and hydraulic equipment, but the overlap for the tasks involved in the missile and its special test equipment is minimal for practical purposes as compared with other Terrier activities such as fire control and launcher (gun mount) maintenance.

For Terrier, analysis has shown that the duties that remain, after overlap has been specified as in Step 2a, are duties that are primarily concerned with preparing the missile for firing; these activities include missile operations, missile operational maintenance and missile technical maintenance. These activities form a family or constellation of tasks and duties which are not readily incorporated as a group into the activities of present Navy ratings.

The activities identified in this step form a group of tasks somewhat unique to the new weapon and hence require detailed analysis for the development of an adequate personnel program.

Step 3. Organization and presentation of task analyses and task information for the non-overlapping activities.

The end-product of this step is a reference source which personnel agencies can consult in order to obtain information about the tasks involved in the operation and maintenance of the new weapon. This compilation should either contain the information required or should refer to specific sources of additional detailed information. Insofar as possible, the information should be presented in order to serve as many as possible of the various aims of personnel agencies, e.g., from over-all manpower planning to the development of specific training aids.

For maximum utility, a compilation of job information should include the following:

1. Specification of scope and content.
2. Analyses of the tasks involved.
3. An index of technical material.
4. A technical summary.
5. Comparison of the subject matter of the new weapon with standard curriculum material.

Each of these will now be described.

1. Specification of Scope and Content

This is an introductory statement and over-all picture of the activities involved in the new weapon. Stated here also is a delineation of those non-overlapping activities and tasks particularly covered in the compilation.

2. Analyses of the Tasks Involved

In this section, the operations involved in each of the tasks and their associated behaviors are described and analyzed. These descriptions and analyses are the resultant of the data obtained from the various sources described in Chapter I. The categories recommended for analyses of each task are listed and defined below. To some extent these categories are similar to the categories contained in the Task Analysis Form used for the data-collecting activity interview (see Chapter I).

Task Summary: This category is a synopsis of the task; it explains the nature of the task in terms of what is accomplished, the type of equipment involved, and the type of work performed. It is written to permit the investigator to go into the more thorough analysis which follows with some understanding and with a picture of the over-all task. It may also serve as a source of information for those who are not concerned with the details of the task. The summary can include discussions of such things as the difficulty level of the task behaviors, the long-range stability of the task, etc.

Subtasks and Behaviors: Subtasks are the major divisions within a task, which are formed by dividing the task operations into meaningful groups. These subtasks or groups of operations are meaningful in that they each represent an independent mission within the over-all task mission, such as, setting up the equipment, conducting the test, analysing the test results, and shutting down the equipment.

Behaviors involve descriptions of the operations included in each subtask. The behaviors describe (1) the operations which occur, e.g., lifting a container, unscrewing a bolt, drilling a hole, turning a switch, reading a voltage dial, etc., and (2) how personnel perform the operations, e.g., unscrewing bolts with a pneumatic wrench, twisting on a hose connection by hand, lifting a container with two hands, visually noting if an indicator light is red or green, listening for repetitive clicks which indicate that a test panel switch should be thrown, etc. If, for example, a series of operations all involve using a monorail hoist, the behaviors required for operating the hoist need be described only once. It is the purpose of Behaviors to give complete descriptions of just what the men working on the task do.

Cues Available for Task Performance: These are the indications available to personnel to tell them how something has been done or what should be done next, for example, indicator lights; operating sounds; voltage dial readings; pressure gauge readings; oscilloscope waveforms; tightnesses of bolts, latches, and valves; positions of switches; positions of mating surfaces, etc. In each case it is specified how the cues are perceived, that is visually, tactually, by ear, etc. For optimally effective training procedures, training aids and proficiency measures, it is necessary that the kinds of stimuli or cues used during the actual task be available during these off-the-job training situations. Identification of these cues is the function of this category.

Major Decisions: These are the critical decisions a man must make that determine the successful accomplishment of a task. Behaviors having the following characteristics are included in this category:

1. At the completion of a task, cues are available on the basis of which a decision is made which determines the next task that must be performed, for example, the missile does not check out and must be rejected, or the missile does check out and requires routing to the launcher.

2. In the course of performance of the task, cues are at times available which require making decisions to alter the sequence of operations or to perform operations not usually required for the task, for example, stopping a test when the missile smokes or makes an unusual noise, starting a test over again when an operation is omitted or performed incorrectly, reporting a malfunction that was discovered by chance, etc.

Both the decisions and the cues to which they are made are described.

Special Precautions: This is a list of the actions taken or measures observed to prevent injury to personnel, damage to equipment, or task inefficiency. The precautions which are unique to the particular task are described in detail. Standard Navy precautions, such as those required for all electronic equipment, high pressure air-hydraulic equipment, and propulsive or explosive ordnance materials can be listed in a separate subcategory.

Personnel Malpractices: This is a compilation of the incidents of incorrect performances of required behaviors, omissions of required behaviors, or violations of precautions which are

reported on the Task Analysis Forms as having occurred in the accomplishment of the task. Identification of these malpractices is important for training and proficiency measurement. In training, instructors must be taught to watch for these and prevent their occurrence. In proficiency testing it is important to emphasize the situations in which these malpractices occur; doing this helps yield test items which discriminate between proficient and non-proficient personnel.

Tools and Equipment: This list identifies the equipment worked upon, auxiliary equipment, tools, check-lists, and technical materials, such as schematic diagrams, which are used in the performance of the task.

Time Required: This category specifies the time required to perform the entire task and each subtask. Qualifying remarks are included when times vary under different conditions, i.e., when team size, the material to be worked on, or working equipment vary. The reported times are estimates made on the basis of job observation and interrogation of personnel. Such estimates may be helpful for allotting training time, determining personnel complements, and planning operating systems.

Team Structure: This category specifies the number of men involved in the performance of the task and the duties of each man. The member of the team who supervises the task is identified with a description of his supervisory duties. This category may offer useful information for preliminary allotment and assignment of personnel to guided missile units.

Skills and Knowledges: This is a summary listing of the kinds of skills and knowledges required for adequate performance of the task. The skills and knowledges are inferred on the basis of analysis of task behaviors presented in the previous categories. This list offers information for inferring aptitude and for identifying ability level and specifications necessary for developing selection procedures, training procedures and rate structures.

Sources of Task Information: This is a list of the training manuals, operating manuals, maintenance manuals, and technical materials pertinent to the task.

Task analyses for Terrier missile activities are presented in Part Two of this report.

3. An Index of Technical Material

This is an index of the material on the new weapon collected by the data-collecting agency. An index for the Terrier missile is presented in Part Two of this report. Analysis of Terrier missile activities showed the following index categories to be most applicable:

Missile Engineering Data

(a) General operation and maintenance manuals
(b) Specific missile systems and components

Missile Testing and Servicing Engineering Data

(a) General testing and servicing information
(b) Specific test and servicing equipment and procedures

Missile Handling and Assembly

Data Pertinent to Casulaty Analysis

Information Pertinent to Specific Missile Installations

Training and Curricula

4. A Technical Summary

If the technical data on the new weapon is not yet organized into an over-all set of manuals and exists in a series of technical orders and separate publications, it is desirable that engineering personnel be asked to outline the over-all system of the weapon. These notes can be included in the compilation of task information and are especially useful for the development of training curricula and proficiency examinations. A format for this technical summary as employed for Terrier is presented in Part Two of this report.

This technical summary consists of two parts, a brief overview of missile functioning and more detailed technical notes. The first part describes the characteristics of the missile system in terms that are understandable to individuals with a minimum of technical background. The second part consists of a set of notes which present an engineering analysis of the missile. In this second part the missile is divided into sections or subsystems. Each section is divided into a stage; a stage is defined as a functional unit, usually a group of components, which operates upon or in some manner modifies a signal in a prescribed manner. Information for each stage is described in terms of the following categories:

Function: A description of the operation, or modification which the section or stage performs upon the signal fed into it.

Input: A brief description of the signal that is fed into the section or stage as well as the immediate source of the signal.

Operation: The method by which the signal is operated upon or modified.

Output: A brief description of the signal coming out of the section or stage, and the name of the missile section or stage to which the signal is sent.

Tests: A listing, primarily, of the tests that are performed by special missile equipment.

Location: Information about the relative location of the section or stage in the missile.

References: A listing of the sources of information employed in the writing of a particular part of the notes.

Principles: A listing of the basic principles (electronic, mechanical, or hydraulic-pneumatic) used in the stage.

5. Comparison of the Subject Matter of the New Weapon With Standard Curriculum Material

In the case of a primarily electronic weapon, this comparison involves a specification of whether the circuitry involved is special or is covered in the general Navy electronic core curriculum. Again this sort of analysis is especially useful for curriculum development. This is done for the Terrier missile in Part Two of this report.

For this comparison, the missile is analyzed into stages and significant smaller functional units. Each stage or unit is classified as either basic or special. Since Terrier is primarily an electronic device, the classification of "basic" is used for general material similar to that covered by the Navy common core electronics curriculum up through receivers and transmitters. The classification of "special" is used for stages and units that should be emphasized, i.e., reviewed or introduced in a course designed specifically for Terrier technicians assuming a background of the "basic" subject matter. Some units are classified as basic but have unique uses in the missile system; these units are labled "basic with special uses."

Concluding Remarks: Describing Actual Operating Conditions

When task data that has been collected during the testing and evaluation phase of a new weapon is compiled as a source of task information, it is necessary to take account of the existing and possible differences between the present situation and the actual future operational situation. As has been pointed out in Chapter 1, the general skills, knowledges and aptitudes required by the tasks involved in a new weapon can be specified reliably from test and evaluation stage data. In the course of collecting and compiling task information, estimates can be made as to which tasks will continue in the future operational situation and which tasks will be discontinued after the test and evaluation period. These estimates can be made on the basis of (a) the knowledge the data collector has obtained about the weapon system and the activities required to operate and maintain it and (b) the judgments of engineering, operating, and planning personnel. A compilation of task information should include those tasks which appear likely to be a part of future actual operations. More specifically, with reference to particular guided missile activities, the following comments can be made:

a) Handling and assembly procedures: Loading and transportation involve primarily standard Navy procedures. Special equipment for assembly and handling will usually be introduced early in the test and evaluation stage. In general, it can be stated that moveable articles, i.e., not part of a ship's structure, will be employed early in a missile test and evaluation and task analysis data for them can be obtained. On the other hand, shipboard structures like an operational CAG hoist installation and specific features of the CAG outfitting will not be amenable for task analysis until late in the test and evaluation stage.

b) The use of testing equipment and go-no-go consoles: Usually in the test and evaluation phase non-ruggedised factory-type equipment is in use. It appears from analysis of Terrier task data that the changes which occur in ruggedising test equipment for field use will not involve major changes in the skills and knowledges required to operate and maintain them; the changes are likely to occur in minor details of circuit construction and in specific dials, switches and indicators.

c) Trouble-shooting and repair: Prediction of the kind of casualties with which the maintenance man will have to deal can be obtained from a compilation of the troubles that occur during

EXHIBIT C

EXAMPLES OF OVERLAP TABLES

FOR TWO RATINGS

WITH RESPECT TO THE TERRIER MISSILE

FIRE CONTROL TECHNICIAN (FT)

Duties Related to Guided Missile Activities	Guided Missile Duties	Differences & Similarities	Additional Training Required
A. Operation & maintenance of the 25/2 radar system.	Operation & maintenance of the 25/6 radar system.	Circuits have been added to the 25/2 radar system to become the 25/6 system. Essentially these circuits enable the radar to transmit guidance intelligence to the missile in addition to positioning the launcher for firing. A detailed listing of modifications from the 25/2 to the 25/6 are listed in OP 1831.	A formal transition course emphasizing the differences between the Mod 2 and the Mod 6.
B. Operation & maintenance of the Mk 37 director.	Operation & maintenance of the Mk 37 director.	Identical.	None.
C. Operation & maintenance of the Mk 1A computer.	Operation & maintenance of the GM 2, Mk 84 & 85 computers.	Operation of GM 2 computer does not require personnel for monitoring the prediction section and the star-shell computer found on the Mk 1A. These sections have been removed. Aside from these sections, the GM 2, the Mk 84 & 85 are similar to standard computers.	On-the-job training emphasizing the differences between the Mk 1A and the GM 2 and the Mk 84 & 85 computers.
D. Operation & maintenance of the Mk 6 stable element.	Operation & maintenance of the Mk 6 stable element.	Identical.	None.

FIRE CONTROL TECHNICIAN (FT) (continued)

Duties Related to Guided Missile Activities	Guided Missile Duties	Differences & Similarities	Additional Training Required
E. Director/Radar alignment procedures.	Director/Radar alignment procedures.	Identical.	None.
F. Operation & maintenance of electronic equipment.	Maintenance of missile components and associated test equipment.	Familiar basic electronic circuits and new specialized circuits are incorporated in the missile electronic system. (Reference to these circuits can be found in OP 1956 and related publications.	Transition training concerned with the specialized missile and missile test equipment circuitry.

GUNNER'S MATE (GM)

Duties Related to Guided Missile Activities	Guided Missile Duties	Differences & Similarities	Additional Training Required
A. Handling, transfer and stowage of ordnance material.	Handling transfer and stowage of boosters, sustainers and warheads.	There are no essential job differences between the procedures generally employed with explosives and propulsives and the procedures required by the Terrier missile.	Adequate experience from on-the-job training should make personnel proficient in missile component stowage and handling.
B. Operation and maintenance of 40 mm and 90 mm gun mounts and drives.	Operation and maintenance of X-5 and X-7 launchers and drives.	X-5 launchers use 40 mm gun mounts and drive mechanisms; X-7 launchers use 90 mm gun mounts and drive mechanisms. Train and elevation drives used on the gun mounts are reversed on the launcher to give the launcher more power in elevation. In place of gun barrels launcher arms are installed.	On-the-job training is adequate for both operation and maintenance procedures. Some familiarization oriented toward problems peculiar to missiles could be appended to the present gunner's mates' training courses.
C. Operation and maintenance of ammunition hoists.	Operation and maintenance of missile CAG ready-service ring and hoist.	The CAG ready-service ring and hoist is a complex conveyor and hoist. Complex timing circuits are involved in the operation of the ready-service ring.	Transition training or intensive on-the-job training is involved here.
D. Battery alignment.	Launcher alignment.	Launcher "boresighting" is done with equipment similar to that which is used for boresighting guns. This equipment is modified for installation on a launcher.	Brief on-the-job training should suffice here.
E. Use of standard electrical and hydraulic test equipment.	Check-out, alignment and servicing of missile components.	Specialized testing equipment and procedures are employed in addition to standard equipment and procedures.	Transition training in the use of missile check-out, alignment & servicing procedures and familiarization with the operation of missile components.