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AN ANALYSIS OF AEGIS CASREP AND 2-KILO MAINTENANCE FAILURE DATA

by

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March, 1993

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This thesis attempts to determine if the maintenance technicians who graduate from the AEGIS Training Center (ATC) receive a sufficient amount of training. Using the AEGIS CASREP and 2-KILO maintenance history files from the NAVSEALOGCEN located in Mechanicsburg, Pennsylvania, an analysis is conducted to determine: (1) if the percentage of curriculum hours devoted to the components of a specific equipment identification code (EIC) match with the percentage of total maintenance hours spent repairing those components in the fleet, and (2) if an analysis of the CASREP and 2-KILO Direct-Indicator element codes will identify any areas where formal training has been insufficient. Based on the findings of this thesis, recommendations were made: (1) to reduce the amount of training for eleven EIC's, and (2) to increase the amount of training for nine EIC's. Additionally, the Direct-Indicator element codes were found to be poor indicators for identifying areas of insufficient training. The results obtained during this study are expected to provide the AEGIS Training Center with more information on how to better determine the training requirements of its students.

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An Analysis of AEGIS CASREP and 2-KILO Maintenance Failure Data

by

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Lieutenant, United States Navy
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of the requirements for the degree of

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ABSTRACT

This thesis attempts to determine if the maintenance technicians who graduate from the AEGIS Training Center (ATC) receive a sufficient amount of training. Using the AEGIS CASREP and 2-KILO maintenance history files from the NAVSEALOGCEN located in Mechanicsburg, Pennsylvania, an analysis is conducted to determine: (1) if the percentage of curriculum training hours devoted to the components of a specific equipment identification code (EIC) match with the percentage of total maintenance hours spent repairing those components in the fleet, and (2) if an analysis of the CASREP and 2-KILO Direct-Indicator element codes will identify any areas where formal training has been insufficient. Based on the findings of this thesis, recommendations were made: (1) to reduce the amount of training for eleven EIC's, and (2) to increase the amount of training for nine EIC's. Additionally, the Direct-Indicator element codes were found to be poor indicators for identifying areas of insufficient training. The results of this thesis are expected to provide the AEGIS Training Center with more information on how to better determine the training requirements of its students.

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I. INTRODUCTION

A. PROBLEM STATEMENT

One of the jobs of the maintenance curriculum-planning officer at the AEGIS training center (ATC) is to ensure that the maintenance technician receives a sufficient amount of maintenance training for each piece of equipment in the technician's curriculum. Although this job is extremely difficult, it can be facilitated if the curriculum-planning officer understands the type and frequency of the maintenance actions required of the maintenance technician after he reports to the fleet. In particular, once the curriculum-planning officer is knowledgeable of the frequency and types of unscheduled maintenance repairs required of the technician in the fleet, he can then use this information as a training guide to help him determine the number of training hours that should be devoted to each piece of equipment.

The curriculum-planning officer has several methods at his disposal by which to determine the frequency and types of tasks that are being performed by the fleet technicians. One method consists of conducting an analytical job analysis of the maintenance-material-management (3-M) and casualty reporting (CASREP) data files. This analysis would be used to determine the frequency and types of unscheduled maintenance tasks performed on each piece of equipment in the technician's training curriculum. This information could then be used to assist the curriculum-planning officer in determining situations where the amount of repair training is sufficient or insufficient. Maintenance training that proves to be more than sufficient may be reduced with little risk when the equipment failure rate is discovered to be low.

B. BACKGROUND

The Department of Defense (DoD) is a unique internal labor force because it "trains technicians, it does not hire them" (Murray, 1986, p.142). However, the cost to train these technicians in terms of dollars and manpower resources is very high. For example, the DoD active duty forces training budget for fiscal year 1992 approached $20 billion and consumed over 178,000 training loads[1]. Additionally, 64% of the training loads were devoted to preparing new personnel to perform their first duty assignments. The Navy alone spent over $5 billion in fiscal year 1992 and consumed over 66,000 student/trainee

[1] "Training Loads" are the average number of students and trainees participating in formal individual training and education courses during the fiscal year. For a full fiscal year, training loads are the equivalent of student/trainee manyears of the participants, including both those in temporary and permanent change of station status. (Military Manpower Training Report, 1992, p.2)

manyears in training its active duty personnel. (Military Manpower Training Report, 1992, pp.6-20) Within the Navy, the AEGIS Training Center spent approximately $14 million in fiscal year 1992 preparing its technicians to maintain and operate the AEGIS combat systems suite (Sine, 1992). What do these figures mean?

In an era of unlimited budgets and manpower resources, they do not mean very much. However, in an era of limited budgets and manpower resources, these figures represent the requirement that the maximum effectiveness of every training dollar be achieved.

The purpose of this study is not to debate the military's hiring practices, but rather to determine if the cost of training the AEGIS maintenance technicians can be reduced by analyzing the unscheduled maintenance data files for the AEGIS combat system.

Because the military is in an era of restricted budgets and reduced manpower resources, the curriculum-planning officer at the ATC must ensure that the technicians who graduate from the ATC receive a sufficient amount of training at minimum cost. The following are examples of some of the questions that need to be asked by the curriculum-planning officer before this objective, sufficient training at minimum cost, can be achieved.

Are the students who graduate from the ATC's maintenance training curriculum adequately prepared to meet the equipment maintenance needs of the AEGIS combat systems suite? Do the customers, the commanding officers of AEGIS ships, believe that the newly reported maintenance technicians receive a sufficient amount of maintenance training prior to reporting onboard? Would a change in the number of hours devoted to teaching maintenance repair on a specific item of equipment improve the quality of the graduate technician?

One way to determine if the technicians are receiving a sufficient amount of classroom training is to compare the ratio of curriculum training hours devoted to a specific piece of equipment to the ratio of unscheduled maintenance hours required to repair that specific piece of equipment in the fleet. If the ratio of maintenance training hours for a piece of equipment does not correlate positively and substantially with the ratio of unscheduled maintenance hours required to repair the equipment, then the officer in charge of curriculum planning needs to determine if a change in the training curriculum is appropriate. The primary goal of this study is to identify any equipment within the maintenance technician's curriculum for which the ratio of training hours does not correlate positively and substantially with the ratio of unscheduled maintenance hours.

C. OBJECTIVE

The objective of this study is to determine if the amount of maintenance training in the AEGIS training curriculum is appropriate by analyzing the historical failure rates of the AEGIS combat systems equipment.

D. RESEARCH QUESTIONS

1. Primary research question

Are the maintenance repair technicians who graduate from the ATC receiving an appropriate amount of training for each item of equipment in their curriculum when compared to the number of unscheduled maintenance hours required to maintain that item of equipment in the fleet?

2. Subsidiary research questions

a. Will an analysis of the AEGIS 2-KILO maintenance data indicate any areas where formal maintenance training has been insufficient?

b. Will an analysis of the AEGIS CASREP technical assistance request data uncover any areas where formal AEGIS repair training is insufficient?

E. SCOPE, LIMITATIONS AND ASSUMPTIONS

1. Scope

Appendix A is a listing of the equipment identification codes (EIC)[2], by curriculum, for the

[2] The EIC is a seven-character code: The first position identifies the system; the second identifies the subsystem; and the third and fourth identify the equipment category in that system. The remaining three digits provide greater definition of the part of the equipment being worked on and should be used when known.

components for which operation and maintenance training is being taught at the ATC. This maintenance training is conducted in four separate curricula. These curricula are: Display, SPY-1A, Fire Control and Operational Readiness Test System (FCS/ORTS), and Computer. These curricula will be analyzed in the following order:

- Display
- SPY-1A
- FCS/ORTS
- Computer

2. Limitations

For the purpose of this study, the following limitations were imposed:

- This study focuses only on the Ticonderoga class AEGIS cruisers, CG-47 to CG-69. Appendix B is a listing of the ships by hull number, name, fiscal year (FY) of commissioning, and unit identification code (UIC)[3].

3. Assumptions

For the purpose of this study, it was assumed that:

- Unscheduled/corrective maintenance was only performed by the technician when needed.
- That the time between equipment failures is independent of its repair history.
- The percentage of instructional training hours provided should approximately match the percentage of maintenance hours spent repairing that equipment. And that when this difference is small, a positive indication exists that

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[3] The unit identification code is a five-character alphanumeric code used to identify organizational entities within the Department of the Navy.

sufficient training is being provided.

- This study will identify those EIC's for which the percentage of maintenance hours performed does not approximately match the percentage of training provided.
- Maintenance training may be decreased with minimum risk when the percentage of training is larger than the percentage of maintenance performed.
- Maintenance training may need to be increased when the percentage of maintenance performed is larger than the percentage of training provided.
- Information obtained from this study will be of assistance to the AEGIS Training Center when determining the percentage of training time that should be devoted to specific EIC's within a curriculum.

F. ORGANIZATION OF STUDY

Succeeding chapters of this study will focus on the following areas:

Chapter II discusses the background issues for this study by providing a brief description of the 3-M maintenance data system and the AEGIS Training Center.

Chapter III discusses previous research that applies to this study.

Chapter IV is a description of the data and provides a discussion of the methodology used during this study.

Chapter V Describes and analyzes the results of the research effort.

Chapter VI provides (1) a summary of the study; (2) recommendations; and (3) conclusions.

II. BACKGROUND

To accomplish the Navy's assigned missions, Naval warships must be able to conduct sustained operations at sea. The ability to maintain a warship at sea as an effective fighting unit for extended periods of time depends primarily on the abilities of her crew and on the material readiness of the ship prior to getting underway. The capabilities of the crew depend primarily upon how well they are trained prior to arriving onboard. The ship's material condition of readiness depends primarily on how well the crew maintains the ship. Successful warships are those that are able to combine these two elements into an effective weapons system.

To assist the crew in maintaining a high state of material readiness, the ship's 3-M maintenance system was developed. Within the AEGIS community, the AEGIS Training Center was developed to ensure that all combat systems personnel were properly trained prior to arriving onboard an AEGIS class ship. The remaining sections of this chapter will describe the ship's 3-M system and the AEGIS Training Center, respectively.

A. 3-M Maintenance Systems

1. Objectives

The following is a list of the objectives for the 3-M maintenance systems:

- Achievement of uniform maintenance standards and criteria.
- Effective use of available manpower and material resources in maintenance and support efforts.
- Documenting information relating to maintenance and maintenance support actions.
- Improvement of maintainability and reliability of systems and equipment by provision of documented maintenance information for analysis.
- Provision of the means for reporting ship configuration changes.
- Identification and reduction of the cost of maintenance and maintenance support in terms of manpower and material resources.
- Reduction of the costs of accidental material damage by means of accurate identification and analysis of cost.
- Provide the means to schedule, plan, manage, and track maintenance.
- Provision of data on which to base improvements in equipment design and spare parts support.

(OPNAVINST 4790.4B CH-1, 1987, p.1-1)

2. 3-M SYSTEMS SCOPE

3-M systems are fully applicable to all ships, service craft, small boats and non-aviation fleet test and support equipment. Also included are the Navy's Meteorological Equipment, Naval Air Traffic Control, Air Navigation and Landing Systems (NAALS), and equipment of the Commander Naval

Reserve Force and Chief of Naval Education and Training Activities (OPNAVINST 4790.4B CH-1, 1987, p. 1-1).

3. 3-M SYSTEMS

The ship's 3-M system is divided into two major subsystems: the Planned Maintenance System (PMS) and the Maintenance Data System (MDS). The PMS provides the maintenance technician with a schedule of the minimum maintenance actions necessary to maintain the equipment in a fully operational condition and within specifications. If performed as scheduled, these maintenance actions are designed to prevent equipment failures that might otherwise require numerous corrective actions and severely affect equipment reliability (OPNAVINST 4790.4B CH-1, 1987, p. 1-3). Because PMS is a planned system, the ability to predict the expected number of maintenance hours devoted to PMS work is not difficult. Since the focus of this study is to determine the number of maintenance hours devoted to corrective maintenance, the remaining parts of this study will focus on corrective maintenance actions.

The MDS provides an automated system by which maintenance personnel report corrective maintenance actions on all categories of equipment. This information is then made available to authorized users by the Type Commander (TYCOM) and the Navy Maintenance Support Office Department within the Naval Sea Logistics Center. The user may then utilize this information to analyze maintenance and logistic support problems, to develop the current ship's maintenance project (CSMP), and to generate automated work requests for maintenance actions deferred for outside assistance (OPNAVINST 4790.4B CH-1, 1987, p. 1-6).

The usefulness of MDS is dependent upon the accuracy, adequacy, and timeliness of the information reported into the system. MDS is a system in which potential benefits are directly proportional to the efforts applied. The MDS system is divided into two categories:

1. Organizational Maintenance Management System (OMMS)
2. Intermediate Maintenance Management System (IMMS)

(OPNAVINST 4790.4B CH-1, 1987, p. 1-2).

OMMS is an automated system used aboard ships to manage and report organizational level maintenance and related equipment configuration changes and logistic support actions (OPNAVINST 4790.4B CH-1, 1987, p. 1-7).

IMMS is a Shipboard Non-Tactical ADP Program (SNAP) system of computerized procedures used aboard tenders, aircraft carriers, repair ships, and repair bases/activities. These automated procedures are used to manage the planning, scheduling, reporting, production, and monitoring of the maintenance workloads of tended ships, the parent tender, and other large combatants. The Maintenance Resource Management System (MRMS) performs the same function at Shore Intermediate Maintenance Activities (OPNAVINST 4790.4B CH-1, 1987, p. 1-2).

4. 3-M SYSTEMS DESCRIPTION

The 3-M systems are the nucleus for managing maintenance aboard all ships and shore stations of the Navy. They provide all maintenance and material managers throughout the Navy with the means to plan, organize, direct, control, and evaluate manpower and material resources expended or planned for expenditure in support of maintenance (OPNAVINST 4790.4B CH-1, 1987, p. 1-2).

5. MDS FORMS

The following forms are used to describe the type of maintenance action being conducted:

a. OPNAV 4790/2K: Ship's Maintenance Action Form

This form is used by maintenance personnel to report:

- Deferred maintenance actions[4].
- Completed maintenance actions[5] which do not result in configuration changes (including those previously deferred).

[4] Maintenance actions that require some type of assistance from an activity external to the ship or cannot be completed within 30 days.

[5] Used to identify the completion of maintenance actions previously deferred and to document the completion of those non-deferred maintenance actions described in (OPNAVINST 4790.4B CH-1, 1978, p. 9-3).

b. OPNAV/2L: Supplemental Form

This form is used by maintenance personnel to provide amplifying information relating to the maintenance action reported on an OPNAV 4790/2K (e.g., drawings, listings and special instructions needed by the repair activity) (OPNAVINST 4790.4B CH-1, 1987, p. 9-24). The information on this form is not entered into the MDS, therefore, this information will be of no importance during this study.

This study will focus on the maintenance information that is reported into the MDS via the OPNAV 4790/2K by the AEGIS maintenance technicians.

6. DESCRIPTION of the OPNAV 4790/2K FORM

Appendix C is an example of a blank OPNAV 4790/2K form. This form is divided into six sections:

- **Section I-Identification**. This section is used to identify the equipment or systems on which the maintenance actions are being performed.
- **Section II-Deferral Action**. This section is always filled in when reporting the deferral of a maintenance action.
- **Section III-Completed Action**. This section is always filled in when reporting the completion of a maintenance action.
- **Section IV-Remarks/Description**. This section must be filled in when reporting the deferral of a maintenance action. It is filled in when reporting the completion of a maintenance action only when such remarks are considered important to the maintenance action.
- **Section V-Supplementary Information**. This section is filled in by the maintenance person when technical

documentation is required for a maintenance action. (e. g., technical publications, blueprint numbers, etc.)

- **<u>Section VI-Repair Activity Planning/Action</u>**. This section is used by the repair activity for planning and estimating purposes.

(OPNAVINST 4790.4B CH-1, 1987, p. 9-25)

B. AEGIS TRAINING CENTER

The AEGIS system is the U.S. Navy's state-of-the-art combat weapon system.

> It can defeat an extremely wide range of targets from wave top to directly overhead. AEGIS is extremely capable against anti-ship cruise missiles and manned aircraft flying in all speed ranges from subsonic to supersonic. The AEGIS system is effective in all environmental conditions having both all-weather capability and demonstrated outstanding abilities in chaff and jamming environments. The computer-based command and decision element is the core of the AEGIS combat system. It is this interface that makes the system capable of simultaneous operations against a multi-mission threat: anti-air, anti-surface, and anti-subsurface warfare. The combat system also has the capability for overall force coordination. AEGIS brings a revolutionary...combat capability to the U.S. Navy (Bowen, 1992).

As an evolving technology, the integration of the AEGIS combat system with ship acquisition required unique management and planning.

> In 1977, The AEGIS shipbuilding project (PMS-400) was established at Naval Sea Systems Command. The special management treatment combines and structures hull, mechanical, and electrical systems, combat systems, computer systems, repair parts, personnel maintenance documentation, and tactical operation documentation into one unified organization...For the first time in the history of surface combatants, PMS-400 introduced an organization that has both responsibility and authority to simultaneously manage development, acquisition, combat systems integration and life-time support (Bowen, 1992).

Under the PMS-400 charter, the AEGIS Training Center was formally commissioned in October of 1985 and is headquartered at the Naval Surface Warfare Center (NSWC), Dahlgren, Virginia.

The mission of the AEGIS Training Center is to train combat systems officers and enlisted personnel in the knowledge and skills required to maintain competency and proficiency in operating and maintaining the AEGIS combat system, combat systems management, decision making, and communications, and to perform such other functions as may be directed by the AEGIS Program Manager (PMS-400) (ATC Instruction 5400.1B, 1991 and Bowen, 1992).

The ATC is a composite command with 12 subordinate AEGIS Training Units and Training Support Groups in the United States and overseas. Primary instructional and administrative facilities are located at the AEGIS Education Center (AEC) in Dahlgren. Additional instruction is conducted by the AEGIS Training Support Units (ATU) located at the Combat Systems Engineering Development Site, Moorestown, New Jersey and at the AEGIS Combat Systems Center, Wallops Island, Virginia. AEGIS Training Support Groups (ATSG) provide training and lifetime engineering support to AEGIS class ships and shore facilities. These ATSG's are located in Norfolk, Virginia; San Diego, California; Mayport, Florida; Philadelphia, Pennsylvania; Long Beach, California; St. Inigoes, Maryland;

Pascagoula, Mississippi; Bath, Maine; Pearl Harbor, Hawaii; and Yokosuka, Japan (Bowen, 1992).

The Commanding Officer of the ATC, Dahlgren, Virginia has cognizance over 32 courses of instruction, which range in length from 1 to 26 weeks (ATC Course Description Catalog, 1992). Currently, over 7000 students per year receive training at one or more of the AEGIS training sites (Sine 1992). For officers, the AEGIS training pipeline provides training for prospective Commanding Officers/Executive Officers (PCO/PXO), Combat Systems Officers (CSO), and AEGIS Officer Console Operators (AOCO). Senior enlisted personnel and certain officers are trained to operate and maintain the AEGIS Weapons System (AWS) and/or the AEGIS Combat System (ACS). After completion of Navy Technical schooling, junior enlisted personnel in the AEGIS pipeline receive training on the operation and maintenance of specific equipment within their rating. Team training to simulate Combat Information Center (CIC) operations is provided to all precommissioning crews (ATC Course Description Catalog, 1992 and Bowen, 1992).

1. AEGIS Education Center

The AEGIS Education Center (AEC), Dahlgren, Virginia, is composed of the Cruiser and Destroyer Education Facilities. The 61,500 square foot Cruiser Education building contains 23 classrooms, 21 equipment laboratories, two technical libraries, offices, and support areas. The adjoining Destroyer

Education building has 78,000 square feet with 24 classrooms, seven equipment laboratories, one technical library, and related support areas. Laboratories include radar, computer, display, console, and shipboard support equipment, all installed similarly to the actual equipment on board ship. Classrooms are in the traditional style with erasable-marker boards, tables, and overflow storage for curriculum related materials. Class size ranges from two to two dozen personnel depending on the course. There are 300 instructors at AEC, of which 42 are contracted civilians and the remainder, military. The instructor staff is organized into three eight-hour shifts which conduct classes 24 hours a day from Sunday midnight to Saturday noon (Bowen, 1992).

The classes taught at the AEC are:

- AEGIS Prospective Commanding Officer/Prospective Executive Officer, CG-47 to 64, 5 weeks.
- AEGIS Prospective Commanding Officer/Prospective Executive Officer, CG-65 to DDG, 5 weeks.
- AEGIS Combat Systems Officer, CG-47 to 64, 5 weeks.
- AEGIS Combat Systems Officer, CG-65 to DDG, 5 weeks.
- AEGIS Weapons System Operation and Maintenance, CG-47 to 64, 17 weeks.
- AEGIS Weapons System Operation and Maintenance, CG-65 to DDG, 17 weeks.
- AEGIS Fundamentals, CG-47 to DDG, 2 weeks.
- Radar System AN/SPY-1A Operation and Maintenance, CG-47 to 58, 24 weeks.
- Radar Systems AN/SPY-1B/1D Operation and Maintenance, CG-59 to DDG, 24 weeks.

- AEGIS Fire Control System/Operational Readiness Test System Operation and Maintenance, CG-47 to 64, 25 weeks.
- AEGIS Fire Control System/Operational Readiness Test System Operation and Maintenance, CG-65 to DDG, 18 weeks.
- AEGIS Display System Operation and Maintenance, CG-47 to 59, 25 weeks.
- AEGIS Display System Operation and Maintenance, CG-60 to DDG, 23 weeks.
- AEGIS Computer System Operation and Maintenance, CG 47 to 64, 24 weeks.
- AEGIS Computer System Operation and Maintenance, CG-65 to DDG, 20 weeks.

(ATC Course Description Catalog, 1992)

2. AEGIS Training Units

The AEGIS Training Units (ATU) provide specific training at remote locations where operational equipment is required (ATC Instruction 5400.1B, 1991). The combat Systems Engineering Development Site, Moorestown, New Jersey, conducts training on new AEGIS equipment in conjunction with engineering development (Bowen, 1992). A full scale arrangement of the AEGIS Combat System within a duplication of a ship's superstructure allows realistic team training. The following officer and enlisted training is conducted at Moorestown:

- AEGIS Combat Systems Maintenance Manager, CG-65 [illegible] 7 weeks.
- AEGIS Combat Information Center Team (Precommissi[illegible] [illegible]G-47 to DDG, 2 weeks.
- AEGIS Training Supervisor, CG-47 to DDG, 1 week.

(ATC Course Description Catalog, 1992)

The Combat Systems Center, Wallops Island, Virginia, conducts officer and enlisted operator training for AEGIS fleet units and support commands (ATC Instruction 5400.1B, 1991). This training includes:

- AEGIS Officer Console Operator (AOCO), CG-47 to 64, 4 weeks.
- AEGIS Officer Console Operator (AOCO), CG-65 to DDG, 4 weeks.
- AEGIS Combat Information Center Supervisor, CG-47 to DDG, 4 weeks.
- AEGIS Combat Systems Maintenance Manager, CG-47 to 64, 7 weeks.
- AEGIS Combat Systems Maintenance Manager, CG-65 to DDG, 7 weeks.

(ATC Course Description Catalog, 1992)

3. AEGIS Training Support Groups

The ATSG's in Norfolk, Virginia; San Diego, California; Mayport, Florida; Bath, Maine; Pascagoula, Mississippi; Long Beach, California; Pearl Harbor, Hawaii; and Yokosuka, Japan provide logistic support for training, implementation, integration and engineering development of:

- Fleet introduction of AEGIS ships.
- Battle Readiness (excludes ATSG Bath and Pascagoula).
- AEGIS Systems Maintenance.
- Training Appraisals for Type Commanders (excludes ATSG Bath and Pascagoula).
- Pre-commissioning Training (ATSG Bath and Pascagoula only).

(ATC Instruction 5400.1B, 1991, ATC Course Description Catalog, 1992)

To accomplish their missions, the ATSG's conduct the following training:

- AEGIS Combat System Maintenance Team , CG-47 to 64, 1 week (ATSG Norfolk, San Diego, Mayport, Pearl Harbor, Bath, Pascagoula, and Yokosuka).
- AEGIS Combat System Maintenance Team, CG-65 to DDG, 1 week (ATSG Norfolk, San Diego, Mayport, Pearl Harbor, Bath, Pascagoula, and Yokosuka).
- AEGIS embarked Staff, CG-47 to 64, 1 week (ATSG Norfolk, San Diego, Mayport, Pearl Harbor, Bath, Pascagoula, and Yokosuka).
- AEGIS Embarked Staff, CG-65 to DDG, 1 week (ATSG Norfolk, San Diego, Mayport, Pearl Harbor, Bath, Pascagoula, and Yokosuka).
- AEGIS Training Supervisor, CG-47 to DDG, 1 week (ATSG Norfolk, San Diego, Mayport, Pearl Harbor, Bath, Pascagoula, and Yokosuka).
- AEGIS AN/SPS-49(V) Air Search Radar System Operator, CG-47 to 73, 2 days (ATSG Norfolk, San Diego, Mayport, Pearl Harbor, Bath, Pascagoula, and Yokosuka).
- AEGIS Combat Information Center Team (Shipboard), CG-47 to DDG, 1 week, (ATSG Norfolk, San Diego, Mayport, Pearl Harbor, Bath, Pascagoula, and Yokosuka).

(ATC Course Description Catalog, 1992)

Training, implementation, integration, and engineering development of radio communications is conducted by ATSG, Naval Electronics Systems Engineering Activity (NESEA), St. Inigoes, Maryland. The courses taught are:

- AEGIS Radio Communications System Team, CG-47 to DDG, 3 weeks.
- Interrogator System AN/UPX-29(V) Maintenance, CG-47 to DDG, 4 weeks.

AEGIS Training Support Group Long Beach provides additional logistic support and training in Engineering Development Models (EDM), Underway Replenishment (UNREP), and testing weapons systems. ATSG Philadelphia provides logistic support and training in Waste Heat Recovery Systems (WHRS), Low Pressure Air Compressor (LPAC), Rankine Cycle Energy Recovery System (RACER), and the Reversible Reduction Gear (RRG) (ATC Instruction 5400.1B, 1991 and Bowen, 1992).

The preceding information was presented to emphasize how large the AEGIS training community has become since its inception in 1985. As the construction of the Arleigh Burke class of AEGIS guided missile destroyers increases, the demand for AEGIS-trained personnel to operate and maintain the complex AEGIS weapon system will surely increase. This increase in demand for trained personnel, in an era of reduced budgets and manpower resources, reinforces the requirement that every dollar spent on training these personnel be spent in the most efficient and productive manner. It is hoped that this study will help the AEGIS training community achieve this objective.

III. LITERATURE REVIEW

This literature review is divided into two sections. The first section discusses the research literature that investigated the feasibility of using 3-M and CASREP systems data to measure training effectiveness and deficiencies. The second section discusses the research literature that describes how to conduct an effective job analysis.

A. MEASURING TRAINING DEFICIENCIES WITH 3-M/CASREP DATA

A thorough review of the previous literature yielded only one research effort by Keeler and Guynn (1986) that dealt specifically with using a 3-M systems data base to measure training effectiveness and deficiencies. The remaining literature used this information to measure equipment reliability and maintenance effectiveness. Keeler and Guynn's research efforts on this subject provided a framework from which to begin this research effort.

In 1986, the Naval Training Systems Center, Orlando, Florida was tasked by the Navy Inspector General, via the Chief of Naval Education and Training (CNET), to determine the feasibility of using the 3-M and CASREP data base to develop a set of tools for extracting data relevant to maintenance training effectiveness or deficiencies (Keeler and Guynn, 1986, p.2). Keeler and Guynn divided their study into two different categories, CASREP and 3-M systems.

1. CASUALTY REPORTING SYSTEM

These authors found the CASREP system to be very useful in identifying equipment failures and the effect of these failures on the mission capabilities of the reporting activity. However, the CASREP system information was not found to be a very useful tool to identify training deficiencies because its information is not formatted and codified to the extent that the data in 3-M systems are encoded. This limitation restricts the CASREP data to alerting the analyst to specific problem areas or systems. Systems identified in this manner could then be subjected to a more intensive analysis using the 3-M data approaches to determine training deficiencies.

To overcome this limitation, the authors recommend that the analyst conduct a key-word search of the narrative block of the CASREP form. This search would consist of words that are related to training issues and problems.

2. 3-M SYSTEMS

The authors divided the 3-M systems study into four parts based on the types of analysis which could be performed on a 3-M data base to extract information related to training deficiency indicators:

- Direct Indicator Analyses

- Manpower Utilization Analyses
- Equipment/Parts Utilization Analyses
- Maintenance Effectiveness Analyses

The authors described the procedures required to perform each of these analyses and then discussed their strengths and weaknesses in predicting training effectiveness and deficiencies. Of the four mentioned analyses, the direct indicator and manpower utilization analyses are of interest for this thesis, therefore, they will be the only analyses discussed.

To conduct a direct indicator analysis, the authors examined the data elements of blocks 8, 9, and 35 of the 2-KILO maintenance action form. Appendix C is a copy of a blank 2-KILO maintenance action form.

Block 8, Maintenance Action Cause Code, consists of eight single-digit codes (0-7). These codes describe, in the maintenance person's opinion, the cause of the malfunction when the need for the maintenance action was first discovered. Of the eight codes, three are related to training. These codes are: three, lack of knowledge or skill; four, communication problems; and five, inadequate instruction/procedure.

Block 9, Deferral Reason Code, consists of ten single-digit codes (0-9). Each code describes the reason why the maintenance activity is unable to perform the required maintenance action. In this case, three codes are applicable to training related problems. They are codes three, no formal training on this equipment; four, formal training inadequate on this equipment; and five, inadequate school practical training.

Block 35, the Remarks and Description Section, provides a short narrative description of the maintenance problem. The authors used a key-word search of this narrative to look for words that were important to training such as "training," "school," etc.

The authors then developed a computer program to access this information from the 2-KILO's of a randomly chosen 3-M systems data set. The findings of their research indicated the following limitations:

First, the authors were concerned that the direct indicators "lack of knowledge or skill," "no formal training," or "rejected due to lack of skills," could also be an indication of a manning problem rather than a training problem. However, they believed that this limitation could be examined further by reviewing the rate block of the applicable 2-KILO. The purpose for reviewing the rate block is to determine the rating of the individual who wrote the maintenance action form. This information could then be used to analyze which ratings were unable to perform the maintenance action.

Second, the authors believed that the direct indicators "Formal Training Inadequate," and "Inadequate Practical Training," were less ambiguous; however, they were concerned that the technicians writing the 2-KILOS would be unwilling to report that they did not know something that they were supposedly taught. This unwillingness to submit a negative report against oneself would thus bias the report.

Finally, the direct indicator, "Inadequate Instruction or Procedure," could be a techn ıl documentation problem rather than a training deficiency.

To conduct a manpower utilization analysis, the authors used the following information from the 3-M data to make inferences regarding training effectiveness:

- rate/rating
- mean corrective man-hours (MCMH)
- % corrective maintenance actions deferred for assistance (%CMDA)
- active maintenance time*
- % man-hours trouble shooting*

* selected equipment list (SEL)[6]

Rate/rating. Block 39 of the 2-KILO maintenance form contains the rate of the senior person performing the maintenance action. By reviewing this information, the authors

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[6]SEL is a list developed by NAVSEALOGCEN (Code 86) to further identify those equipments which require special reporting procedures. There are certain equipments and systems in the fleet which have proven unreliable, are new and/or for which data are required to permit determination of reliability, or for other reasons are of significant interest to logistic managers. Such items are designated as "Selected Equipment" in the context of the Navy 3-M Systems. From the data provided by the fleet on these equipments, maintenance histories are compiled for review, analysis, problem identification, and initiation of action to correct problems (OPNAVINST 4790.4B CH-1, 1987, p. 9-4).

attempted to measure the skill level of the maintenance technician who deferred the maintenance action. The authors hypothesized that a junior rating would be more likely to defer a maintenance action than a senior rating.

MCMH/Percent CMDA. To facilitate the measurement of these two variables, the authors developed a maintainability analysis flow chart. The procedures used in this analysis will lead to an audit of the formal training associated with out-of-tolerance maintainability conditions for a particular system or equipment under appropriate conditions (Keeler and Guynn, 1986, p.6).

Active Maintenance Time/Trouble Isolation. For selected equipments, the authors used a flow chart similar to the one developed for MCMH and %CMDA data. The goal of this information was to measure the variance in the time expended to trouble-shoot items on the SEL. Since training is designed to reduce differences in performance regardless of experience (or innate ability), large variations in trouble shooting time may be indicative of training deficiencies.

The authors believe the following limitations need to be considered prior to using the information obtained from a Manpower Utilization Analysis:

- The rating indicator could be an indicator of a manning problem.
- Due to their complexity, the procedures based upon the MCMH and %CMDA require care in interpretation and analytical skills normally provided by individuals highly

skilled in statistical methods, operations research, and quality control methodologies.

- Active maintenance time and trouble isolation time information is not available for all equipment.
- The researcher needs to know why the equipment is on the SEL.

Based upon the findings of their study, the authors drew the following conclusions:

- The CASREP and 3-M data systems contain information important to the training community regarding maintenance training deficiencies.
- There are four levels of analysis which may be performed to extract information significant to training deficiencies from the CASREP/3-M data.
- Manpower and equipment/parts utilization analysis is most likely to identify training deficiencies with the expenditure of reasonable amounts of analytical resources.
- The usefulness of the information regarding training deficiencies will be limited by the availability of training pipeline documentation linking maintained equipment to the courses supporting that maintenance.
- CNET lacks the resources for developing and refining the analytical tools which will be required prior to institutionalizing the analytical capabilities.

(Keeler and Guynn, 1986, p.10-13)

B. JOB ANALYSIS REVIEW

The primary reason for conducting a job analysis is to allow the employer the opportunity to identify the criteria or performance dimensions of a job (Muchinsky, 1990, p.70). The employer then uses this information as a screening device when hiring new employees. To conduct a thorough job analysis, Muchinsky divided the work to be performed into the following component parts: the tasks that are performed, the work environment, and the human qualities needed to perform the work. Additionally, Muchinsky identified four methods for analyzing jobs. They are:

- **Interview**. Employees are asked questions about the nature of their work by a trained interviewer. They may be interviewed individually, in small groups, or through a series of panel discussions.

- **Structured questionnaires or inventories**. The questionnaire lists the activities that may be required of the employee while performing the job. The employee rates these activities on several scales, as to how often they are performed, how important they are, etc.

- **Direct observations**. Employees are observed by a specially trained job analyst while performing their jobs.

- **Logbooks or work Diaries**. Employees are required to record their work activities in logbooks or work diaries. The analyst then studies these books to infer the nature of the work being performed.

(Muchinsky, 1990, p. 70-73)

Muchinsky recommends that the job analyst use a combination of the above methods when conducting a job analysis (Muchinsky, 1990, p. 72).

C. CONCLUSION

In this study, the 3-M/CASREP maintenance data file is considered to be an example of the logbook method of job analysis described by Muchinsky. The 3-M systems data file contains the written documentation of the types and frequencies of the unscheduled maintenance actions that are of interest to the training planners at the ATC. The intent of this study is to use Muchinsky's procedures for conducting a written logbook job analysis in conjunction with the methodology provided by Keeler and Guynn (1986) to analyze the types of unscheduled maintenance actions conducted by the technicians in the fleet. It is hoped that this information will then prove to be helpful when determining how many training hours, within the technician's training curriculum, should be devoted to each piece of equipment.

The literature reviewed in this chapter has provided the foundation upon which the methodology used in the remaining parts of this study are based.

IV. DESCRIPTION OF DATA AND METHODOLOGY

A. RESEARCH DESIGN

The primary objective of this study is to determine if the maintenance technicians who graduate from the AEGIS Training Center receive an appropriate amount of training for each item of equipment in their curriculum when compared to the number of unscheduled maintenance hours required to maintain that item of equipment in the fleet. Subsidiary purposes of this study are:

1. To determine if an analysis of the AEGIS 2-KILO maintenance data will indicate any areas where formal AEGIS repair training is insufficient.

2. To determine if an analysis of the AEGIS technical assistance CASREP data will uncover any areas where formal maintenance training has been insufficient.

The author's assumptions and expectations prior to beginning this study were:

- The percentage of instructional training hours provided should approximately match the percentage of maintenance hours spent repairing that equipment. When the difference is small, a positive indication exists that sufficient training is being provided.

- This study will identify those EIC's for which the percentage of maintenance hours performed does not approximately match the percentage of training provided.

- Maintenance training may be decreased with minimum risk when the percentage of training is larger than the percentage of maintenance performed.
- Maintenance training may need to be increased when the percentage of maintenance performed is larger than the percentage of training provided.
- This information will be of assistance to the ATC when determining the percentage of the training time that should be devoted to specific EIC's within a curriculum.
- This study will identify EIC's for which no non-deferred maintenance actions were reported.

The remaining parts of this chapter will describe the data set and the methodology used to achieve these objectives.

B. DATA DESCRIPTION

The data set for this thesis was obtained from the Naval Sea Logistics Center (NAVSEALOGCEN) located in Mechanicsburg, Pennsylvania. It contained the unscheduled maintenance actions performed by the maintenance technicians onboard AEGIS Ticonderoga class ships. Appendix B is a listing of the these ships by hull number and unit identification code (UIC). The data covers the time period between July, 1987, and September, 1992 (Sgrignoli, 1992).

Only those maintenance actions with equipment identification codes (EIC's) listed in Appendix A were analyzed during this study. These EIC's pertain to the equipment for which maintenance training is conducted at the ATC. This maintenance training is accomplished in four separate curricula. These curricula are: SPY-1A, Display, Computer, and FCS/ORTS.

The data set consisted of two types of maintenance actions, deferred[7] and non-deferred[8]. Each maintenance action is described by several different records, with each record containing 80 characters of information (Bear, 1992). This information is derived from the appropriate section of the 2-KILO maintenance form that was written by the maintenance technician. Appendix C is an example of a blank 2-Kilo maintenance form. The data set contained 448,258 records.

Each record was identified by its 'record type' code. This alphanumeric code, characters 79-80, served several purposes. First, it was used to identify the type of maintenance action, 'B1' for deferred and 'M1' for non-deferred. Second, this code was used to ensure the maintenance action contained the mandatory records and to check for closure of the maintenance action. Finally, this code allowed the author to delete those records which were irrelevant for this study. Table 1 provides a list and a description of the 'record type' codes that were used in the data set.

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[7] A maintenance action that requires some form of assistance from a maintenance activity external to the ship.

[8] A maintenance action that is performed by the ship's crew without any assistance from an external maintenance activity.

TABLE 1
RECORD TYPES

RECORD TYPE	**DESCRIPTION OF RECORD INFORMATION**
'B1' * 'M1' 'S1'	Identifies a deferred maintenance action (DMA) Identifies a non-deferred maintenance action (NDMA) Identifies a IMA maintenance action
'B2' *	Identifies additional deferral information applies to DMA's only
'B3' 'M3'	Optional information for a DMA Optional information for a NDMA
'B4' 'M4'	Optional information for a DMA Optional information for a NDMA
'C5' * 'M5'	Identifies closure of a DMA Identifies closure of a NDMA
'S5'	Identifies IMA maintenance activities
'BA-BT' 'MA-MT'	Provides narrative information for a DMA Provides narrative information for a NDMA
'CA-CT'	Provides action taken narrative remarks when the technician closes the maintenance action.
'UN' 'UF' 'UP'	These record types contain parts information for the maintenance action.

Source: (Bear, 1992)
* Mandatory record

The number of optional records used was determined by the amount of information provided by the maintenance person and by the number of parts that were ordered against the maintenance action. Tables 2 and 3 list the record types and the character location of the variables, by maintenance type, that were used, during this study.

TABLE 2
DEFERRED MAINTENANCE ACTION

<table>
<tr><td colspan="3">1-13 JCN</td><td rowspan="2">14-17
ACTN
DATE</td><td rowspan="2">57-63
EIC</td><td rowspan="2">64
WND</td><td rowspan="2">65
STA</td><td rowspan="2">66
CAS</td><td rowspan="2">67
DFR</td><td rowspan="2">79-80
'B1'</td></tr>
<tr><td>1-5
UIC</td><td>6-9
WC</td><td>10-13
JSN</td></tr>
<tr><td colspan="3">1-13 JCN</td><td rowspan="2">14-17
ACTN
DATE</td><td rowspan="2">43-46
RATE</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">79-80
'B2'</td></tr>
<tr><td>1-5
UIC</td><td>6-9
WC</td><td>10-13
JSN</td></tr>
<tr><td colspan="3">1-13 JCN</td><td rowspan="2">14-17
ACTN
DATE</td><td rowspan="2">45-46
SFAT</td><td rowspan="2">47-50
MHRS</td><td rowspan="2">55-
57
AMT</td><td rowspan="2">58
TI</td><td rowspan="2">MTR
RDG</td><td rowspan="2">79-80
'C5'</td></tr>
<tr><td>1-5
UIC</td><td>6-9
JCN</td><td>10-13
JSN</td></tr>
<tr><td colspan="3">1-13 JCN</td><td rowspan="2">14-17
ACTN
DATE</td><td rowspan="2" colspan="3">18-77
NARRATIVE
INFORMATION</td><td rowspan="2" colspan="3">79-80
'BA-BT'
'CA-CT'</td></tr>
<tr><td>1-5
UIC</td><td>6-9
WC</td><td>10-13
JSN</td></tr>
</table>

Source: (Bear, 1992)

TABLE 3
NON-DEFERRED MAINTENANCE ACTION

<table>
<tr><td colspan="3">1-13 JCN</td><td rowspan="2">14-17
ACTN
DATE</td><td rowspan="2">57-63
EIC</td><td rowspan="2">64
WND</td><td rowspan="2">66
CAS</td><td rowspan="2"></td><td rowspan="2">79-80
'M1'</td></tr>
<tr><td>1-5
UIC</td><td>6-9
WC</td><td>10-13
JSN</td></tr>
<tr><td colspan="3">1-13 JCN</td><td rowspan="2">14-17
ACTN
DATE</td><td rowspan="2">45-46
SFAT</td><td rowspan="2">47-50
MHRS</td><td rowspan="2">55-57
AMT</td><td rowspan="2">58
TI</td><td rowspan="2">79-80
'M5'</td></tr>
<tr><td>1-5
UIC</td><td>6-9
WC</td><td>10-13
JSN</td></tr>
<tr><td colspan="3">1-13 JCN</td><td rowspan="2">14-17
ACTN
DATE</td><td rowspan="2" colspan="3">18-77
NARRATIVE
INFORMATION</td><td rowspan="2" colspan="2">79-80
'MA-MT'</td></tr>
<tr><td>1-5
UIC</td><td>6-9
WC</td><td>10-13
JSN</td></tr>
</table>

Source: (Bear, 1992)

Definition of variables

- **<u>Job Control Number (JCN)</u>**. The JCN is the key identification for a maintenance action and its related supply documents. The JCN is used to identify the maintenance action and to relate all of the parts used when a ship reports a maintenance action. The JCN consists of a Unit Identification Code (UIC), a work center code (WC), and a Job Sequence Number (JSN).

- **UIC**. The five digit code of the activity originating the form.

- **WC**. A four digit code used to identify the department and the work center within the department.

- **JSN**. The four character job sequence number assigned by the work center supervisor. This entry is assigned sequentially from the Work Center Work List (WCWL)/JSN log.

- **Action Date (ACTN DATE)**. The Julian date for when the maintenance action was written, 'B1'; deferred, 'B2'; closed, 'C5'; written, 'BA-BT' and 'CA-CT'. (Bear, 1992)

- **Equipment Identification Code (EIC)**. The EIC identifies the system, subsystem, or equipment for which the maintenance is reported. It is a seven-character code: The first position identifies the system; the second identifies the subsystem; and the third and fourth identify the equipment category in that system. The remaining three characters provide greater definition of the equipment.

- **When Discovered (WND)**. A code that identifies when the need for the maintenance was discovered.

- **Status Code (STA)**. The code which describes the effect of the failure or malfunction on the operational performance capability of the equipment or system when the need for maintenance was first discovered.

- **Cause (CAS)**. The code describing, in the maintenance person's opinion, the cause of the failure or malfunction when the need for the maintenance was first discovered.

- **Deferral (DFR)**. A code which best describes the reason maintenance cannot be accomplished at the time of deferral.

- **Rate**. The rate of the senior person actively involved in the maintenance action.

- **Action Taken (SFAT)**. The code that best describes the action taken to complete the maintenance.

- **Man-hours (MHRS)**. The total number of man-hours, to the nearest whole hour, maintenance personnel expended in completing the maintenance action.

- **Active Maintenance Time (AMT)**. The total clock hours to the nearest whole hour during which maintenance was actually performed on the equipment.

- **Trouble Isolation (TI)**. The percentage of AMT expended troubleshooting.

- **Meter Reading (MTR RDG)**. If the equipment has a time meter, the reading (to the nearest whole hour) at the time of failure.

- **Narrative Definition**. These records contain the description of the problem and what action was taken to correct it.

- **Action Date (ACTN DATE)**. The Julian date for when the maintenance action was written, 'M1'; closed, 'M5'; written, 'MA-MT'.

(Bear, 1992) and (OPNAVINST 4790.4B CH-1, 1987)

C. METHODOLOGY

To answer the primary and subsidiary research questions described at the beginning of the chapter, the initial data set was divided into two subsets by type of maintenance action, deferred and non-deferred. The non-deferred data set was used to answer the primary thesis question. The deferred data set was used to answer the first subsidiary question. The second subsidiary question was answered with assistance from personnel at the Port Hueneme Division of the Naval Surface Warfare Center (PHD NSWC), code 4C31, located in Port Hueneme, California, and from personnel at the NAVSEALOGCEN.

1. Primary Research Question

To answer the primary research question, the procedure was divided into three separate stages.

The first stage consisted of calculating the total number of maintenance hours performed on each piece of equipment. This total was calculated by first dividing the non-deferred data set into four separate data subsets, one for each curriculum, by EIC.

Second, each data subset was then sorted by UIC and EIC to identify the total number of maintenance hours performed on each piece of equipment by the individual ships that reported maintenance observations. From this information, a population mean and standard deviation was calculated for each EIC.

The third step consisted of identifying the outliers within each EIC. These outliers were identified as ships that have reported maintenance hour totals that lie outside the range of plus or minus one standard deviation from the population mean.

The second stage of this process consisted of calculating the percentage of curriculum hours that are devoted to each piece of equipment within each of the four curricula. Appendix D provides the results of these calculations.

The third stage of this process compared the results of the second stage with those of the first stage. The objective of this comparison was to identify those EIC's for which the percentage of hours spent repairing the equipment does not correspond with the percentage of instructional training hours.

2. Subsidiary Research Questions

a. First Subsidiary Question

To answer the first subsidiary question, the deferred maintenance data was used. The methodology consisted of using a procedure similar to the direct indicator analysis described in the research conducted by Keeler and Guynn (1986).

The procedure consisted of examining the data elements of Blocks 8, 9, and 35 of the 2-KILO maintenance action form. The information contained in these blocks is described in the following three paragraphs:

Block 8, Maintenance Action Cause Code, consists of eight single-digit codes (0-7). These codes describe, in the maintenance person's opinion, the cause of the malfunction when the need for the maintenance action was first discovered. Of the eight codes, three are of interest to this study. These codes are: 3, lack of knowledge or skill; 4, communication problems; and 5, inadequate instruction/procedure.

Block 9, Deferral Reason Code, consists of ten single-digit codes (0-9). Each code describes the reason why the maintenance activity is unable to perform the required maintenance action. In this study, three codes are applicable to training related problems. They are codes 3, no formal training on this equipment; 4, formal training inadequate on this equipment; and 5, inadequate school practical training.

Block 35, the Remarks and Description Section, provides a short narrative description of the maintenance problem.

The first step of this procedure divided the deferred data subset into four separate data sets, one for each curriculum by EIC. Each data set was analyzed to identify those maintenance observations that contained the Block 8 and 9 elements previously discussed. Once these maintenance actions were identified, the next step consisted of reviewing the narrative section of each maintenance observation.

The purpose for this review was to determine why the maintenance person used the block 8 or 9 element code. It is the author's hypothesis that the written description of the problem can be used to further identify the training-related issue that caused the maintenance person to use the Block 8 or 9 element code.

b. Second Subsidiary Question

The procedure used to answer the second subsidiary question was based upon the technique described in Keeler and Guynn (1986). Keeler and Guynn attempted to identify training deficiencies by conducting key-word searches of the narrative section of a CASREP. The key-word search focused on words that were related to training.

This part of the analysis was divided into three steps:

The first step utilized the assistance of personnel from PHD NSWC, code 4C31. This department maintains the data set that contains a copy of all CASREPS reported by AEGIS Ticonderoga class ships. This data set was searched to identify those technical assistance CASREP's that were reported against the EIC's that are of interest to this thesis. Each CASREP was identified by its EIC. The objective of this step was to identify the number of observations for each EIC.

The next step consisted of conducting a key-word search of the narrative section of the CASREP's identified in the previous step. The key-word search was conducted by personnel at the NAVSEALOGCEN because the facilities needed to do this key-word search are not available at either the Postgraduate School or at PHD NSWC.

The final step of this procedure reviewed the results of the previous step to determine if the information found would be of any value to the curriculum-planning officer at the ATC.

V. RESEARCH RESULTS

This chapter describes and analyzes the results of this research effort. To accomplish this task, the chapter is divided into three parts. The first part describes the results that answer the primary research question. The second and third parts describe the results pertaining to the first and second subsidiary questions, respectively.

A. PRIMARY RESEARCH QUESTION RESULTS

The non-deferred data set consisted of 31,541 completed maintenance observations[9]. Appendix E provides a listing of the results by curriculum.

The following variables were used in Appendix E to describe the results of each curriculum:

- **Percentage of Curriculum Hours (% CURRIC HRS)**. Represents the ratio of curriculum training hours devoted to this specific EIC to the total number of curriculum hours.
- **Percentage of Total Maintenance Hours (% TOTAL MAINT HRS)**. Represents the percentage of total maintenance hours reported against this EIC.
- **Percentage of Total One Standard Deviation (% TOTAL 1 STD)**. Represents the percentage of maintenance hours reported against this EIC within one standard deviation from the population mean.

[9] Open maintenance observations were deleted from the data set.

* **<u>Percentage of Total Two Standard Deviations (% TOTAL 2 STD)</u>**. Represents the percentage of maintenance hours reported against this EIC within two standard deviations from the population mean.

* **<u>Correlation of Variables (CORR)</u>**. This statistic measures the strength and direction of the linear relationship between the variables (Studenmund, 1992 p.42). In this case, the variable "% CURRIC HRS" will be correlated with each of the other three variables.

The following criterion was used to designate EIC's for further analysis:

* EIC's for which the percentage of reported maintenance hours differed from the percentage of training hours by more than five percent.

The five-percentage-point difference was chosen for several reasons. First, this figure provides a starting point from which to begin the analysis. The author believes that a percentage difference of less than five-percent provides a strong indication that a sufficient amount of training is being provided for this EIC. It is also assumed that as this difference decreases, the indication that sufficient training is being conducted improves. Second, the five-percent difference provides for a margin of error. This figure may be adjusted to either expand or contract the number of EIC's analyzed.

The following variables were used in Tables 5, 7, 9 and 11 to assist with the analysis of those EIC's identified for further analysis:

* **<u>Number of Observations (NUM OBS)</u>**. This variable represents the number of maintenance observations reported against the components within this EIC.

- **Percent of Total Observations (% TOTAL OBS)**. This variable represents the percentage of total maintenance observations reported against the components within this EIC.

- **When Discovered Code 6 (WND)**. This specific code identifies that the need for the maintenance action was discovered while the technician was performing preventive maintenance (PM). The objective of this variable is to provide a measure of the percentage of maintenance observations that were discovered during PM. This information may indicate that preventive maintenance may need to be increased when this percentage is low.

- **Frequency of Observations (FREQ)**. This variable will be used to analyze trends (upward or downward) in maintenance observations per year over the time period.

- **Ships Force Action Taken Code 4 (SFAT)**. This action taken code identifies that the maintenance action was cancelled. The hypothesis, in this case, is that a large percentage of maintenance action cancellations may be an indication that the technicians require more training in identifying maintenance problems for these components. A high percentage rate also means that the technicians are opening a large percentage of unnecessary jobs. More importantly, each cancelled observation represents an inefficient utilization of man-hours.

The remaining sections of this chapter will discuss only those EIC's within each curriculum that met the criterion for further analysis.

1. Display Curriculum.

Within the display curriculum, there were 5,159 maintenance observations reported. Of the 27 EIC's that are taught within this curriculum, only five EIC's met the criterion for further analysis. Based on this criterion, the technicians appear to be receiving an appropriate amount of training for approximately 82 percent of the EIC'S within the display curriculum. Table 4 is a listing of those EIC's identified for analysis.

TABLE 4
DISPLAY CURRICULUM

EIC	% CURRIC HRS	% TOTAL MAINT HRS	% TOTAL 1 STD	% TOTAL 2 STD
QM93000	.0593	.0003	.0009	.0008
5586000	.1349	.0224	.0326	.0283
5580000	.1727	.0554	.0583	.0507
TB04AAA	.0593	.0915	.1217	.1717
553Q000	.1133	.1224	.1917	.1668
CORRELATION OF VARIABLES		.50389	.60538	.53952

The results described in Table 4 identify three EIC's (QM93000, 5586000, and 5580000) for which the amount of training provided appears to be more than required. Also, the results show two EIC's (TB04AAA, and 553Q000) for which the amount of training may need to be increased.

In this curriculum, there is a high positive correlation between the variable "% CURRIC HRS" and the other three variables. This high correlation provides a good indication that a positive relationship exists between the percentage of training provided and the percentage of maintenance performed.

Table 5 provides the results of the continued analysis.

TABLE 5
DISPLAY CURRICULUM ANALYSIS RESULTS

EIC	NUM OBS	% TOTAL OBS	% EIC OBS WITH WND CODE 6	% EIC OBS WITH SFAT CODE 4	FREQ OF OBS
QM93000	2	0.0	NA	NA	NA
5586000	124	2.4	4.8	6.5	STABLE
5580000	266	5.2	4.5	12.8	STABLE
TB04AAA	612	11.9	15.7	18.1	INCREASING
553Q000	689	13.4	2.6	10.6	INCREASING

Table 5 indicates the following results by EIC:

- QM93000. The very low number of maintenance observations provides a strong indication that this EIC may be a prime candidate for reductions in training hours.

- 5586000. The primary indicator that the number of training hours may be reduced for this EIC is the low number of maintenance observations.

- 5580000. In this case, the low percentage of maintenance observations and the large difference between the variables "% CURRIC HRS" and "% TOTAL MAINT HRS" (Table 4) provide the primary indications that the amount of training for the components under this EIC may be reduced with minimum risk. However, the percentage of job cancellations, 12.8 percent, is the second highest action taken code for this EIC. This figure indicates that 34 of these maintenance observations were cancelled, therefore indicating inefficient use of man-hours.

- **TB04AAA**. In this case, the continued analysis indicates the following: First, a large percentage of maintenance observations (third largest within curriculum). Second, the largest cancellation rate within the curriculum. Third, a high PM discovery rate. The first two results provide positive indications that increased training within this EIC may be needed. Finally, the high PM discovery rate is a good indicator that sufficient PM training is being conducted.

- 553Q000. This EIC has the highest number of maintenance observations within the curriculum. Additionally, ten percent of all jobs written under this EIC were cancelled.

2. SPY-1A Curriculum

Within this curriculum, there were 15,892 maintenance observations. Of the 19 EIC's that are taught within this curriculum, only three EIC's met the criterion for further analysis. Based on this criterion, the technicians appear to be receiving an appropriate amount of training in approximately 85 percent of the EIC's. Table 6 lists those EIC's that required further analysis.

TABLE 6
SPY-1A CURRICULUM

EIC	% CURRIC HRS	% TOTAL MAINT HRS	% TOTAL 1 STD	% TOTAL 2 STD
55A0000	.0633	.0038	.0046	.0058
5500000	.5237	.0167	.0290	.0354
5513AAA	.0290	.6526	.6727	.6290
CORRELATION OF VARIABLES		-.01955	.00195	.01639

The results in Table 6 indicate that the amount of training may be decreased for two EIC's, 55A0000 and 5500000, and that training may need to be increased for EIC, 5513AAA.

In this curriculum, the correlation between the variables is very small, and in the case of the variable " % TOTAL MAINT HRS" the correlation was negative. This absence of correlation indicates that no relationship exists between the percentage of training provided and the percentage of maintenance performed. However, this absence of correlation can be explained.

A review of the SPY-1A curriculum results in Appendix E indicates two interesting percentages. First, the percentage of training devoted to components within the 5500000 EIC is very high, 62 percent. Second, the number of maintenance hours performed against the EIC, 5513AAA, represents approximately 65 percent of the maintenance hours performed. To determine if these two EIC's were causing the low correlation, they were eliminated from the data set. Table 6A displays the correlation results with these two EIC's removed.

TABLE 6A
CORRELATION OF VARIABLES WITH EIC'S REMOVED

	% CURRIC HRS	**% TOTAL MAINT HRS**	**% TOTAL 1 STD**	**% TOTAL 2 STD**
CORRELATION OF VARIABLES		.54382	.60640	.70866

The results in Table 6A indicate that when the high percentage rates of EIC's (550000 and 5513AAA) are removed from the data set a large positive correlation does exists between the variables.

Table 7 provides the results of further analysis.

TABLE 7
SPY-1A CURRICULUM ANALYSIS RESULTS

EIC	NUM OBS	% TOTAL OBS	% EIC OBS WITH WND 6	% EIC OBS WITH SFAT CODE 4	FREQ OF OBS
55A0000	186	0.0	5.9	11.8	DECREASING
5500000	681	4.3	4.8	9.5	DECREASING
5513AAA	9990	62.9	20.7	2.1	STABLE

The results in Table 7 indicate the following by EIC:

- **55A0000**. The primary indicator that training may be decreased for this EIC is the low number of reported maintenance observations.

- **5500000**. For this EIC, the primary indicator for decreasing training is also the low number of maintenance observations reported. However, because of the large difference between the percentage of curriculum hours and the percentage of maintenance hours (Table 6), this EIC becomes a very good candidate for further investigation.

- **5513AAA**. The results of further investigation for this EIC clearly indicate that the number of maintenance observations is the prime indicator for increased training. Also, the high percentage of maintenance observations discovered during PM provides a good indicator that PM training seems to be effective.

3. FCS/ORTS Curriculum

Within the FCS/ORTS curriculum, there were 9,005 maintenance observations reported. Of the 14 EIC's taught, six EIC's met the criterion for further analysis. Based on the criterion, the technicians appear to be receiving a sufficient amount of training for approximately 57 percent of the EIC's. Table 8 is a listing of those EIC's requiring continued analysis.

TABLE 8
FCS/ORTS CURRICULUM

EIC	**% CURRIC HRS**	**% TOTAL MAINT HRS**	**% TOTAL 1 STD**	**% TOTAL 2 STD**
QK0V000	.1490	.0120	.0051	.0113
55A1000	.1386	.0365	.0209	.0170
55A7000	.0816	.0180	.0174	.0141
5557340	.1490	.0777	.0971	.0789
5557100	.1168	.2377	.2214	.3284
4719AAA	.1101	.4917	.4961	.4032
CORRELATION OF VARIABLES		.77932	.55424	.42338

The results in Table 8 indicate that there are four EIC's (QK0V000, 55A1000, 55A7000, and 5557340) where the amount of training provided appears to be more than required. Additionally, two EIC's (5557100, and 4719AAA) have results that indicate training may need to be increased.

In this curriculum, there is a strong positive correlation. This strong positive correlation provides a good indication that a positive relationship exists between the percentage of training provided and the percentage of maintenance performed. Table 9 provides the results of further analysis.

TABLE 9
FCS/ORTS CURRICULUM ANALYSIS RESULTS

EIC	NUM OBS	% TOTAL OBS	% EIC OBS WITH WND 6	% EIC OBS WITH SFAT CODE 4	FREQ OF OBS
QK0V000	270	3.0	2.6	2.6	DECREASING
55A1000	162	1.8	6.2	9.9	DECREASING
55A7000	107	1.2	2.8	5.6	DECREASING
5557340	1,084	12.0	4.2	1.3	STABLE
5557100	1,846	20.5	11.1	3.9	STABLE
4719AAA	3,252	36.1	5.0	4.5	STABLE

The results in Table 9 indicate the following by EIC:

- **QK0V000, 55A1000, and 55A7000.** The primary indication that training may be reduced for these three EIC's is the low number of maintenance observations.

- **5557340.** The results for this EIC did not provide any strong indications that training should be decreased. However, the percentage of maintenance observations was the third highest within this curriculum, and the percentage of maintenance observations discovered during PM was low.

- **5557100 and 4719AAA.** For these two EIC's, the primary indication that training may need to be increased was the high number of maintenance observations. The results indicated that over 50 percent of all jobs written by the technicians in this curriculum were against these two EIC's. Additionally, the percentage of maintenance observations discovered during PM for EIC 5557100 was a good indicator that PM training has been effective.

4. Computer Curriculum

Within the computer curriculum, there were 4,061 maintenance observations reported. Of the 12 EIC's analyzed, six EIC's met the criterion for further analysis. Based on this criterion, the technicians appear to be receiving a sufficient amount of training in 50 percent of the EIC's. Table 10 is a listing of those EIC's requiring further analysis.

TABLE 10
COMPUTER CURRICULUM

EIC	% CURRIC HRS	% TOTAL MAINT HRS	% TOTAL 1 STD	% TOTAL 2 STD
5533000	.1990	.1152	.0496	.0386
5541AAA	.3582	.1800	.1483	.1152
5546000	.0232	.1172	.1047	.0815
553U000	.0240	.0795	.0790	.1212
553V000	.0240	.0752	.0725	.1146
5531AAA	.0597	.1181	.1714	.1407
CORRELATION OF VARIABLES		.77932	.55424	.42338

The results in Table 10 indicate that there were two EIC's (5530000, and 5541AAA) for which the amount of training provided appears to be more than required. Also, there were four EIC's (5546000, 553U000, 553V000, and 5531AAA) that have maintenance percentages that indicate more training may be needed. Table 11 provides the results of the further analysis.

TABLE 11
COMPUTER CURRICULUM ANALYSIS RESULTS

EIC	NUM OBS	% TOTAL OBS	% EIC OBS WITH WND 6	% EIC OBS WITH SFAT CODE 4	FREQ OF OBS
5533000	60	1.5	5.0	20.0	INCREASING
5541AAA	410	10.1	1.0	4.1	INCREASING
5546000	441	10.9	0.7	1.1	INCREASING
553U000	623	15.3	1.0	1.0	INCREASING
553V000	619	15.2	0.3	0.2	INCREASING
5531AAA	604	14.9	0.5	3.8	INCREASING

The results in Table 11 indicate the following by EIC:

- **5533000**. The low number of maintenance observations for this EIC is the prime indicator that training may be decreased with little risk. However, the high percentage of job cancellations may be an indication that technicians are lacking some type of training.

- **5541AAA**. For this EIC, all of the variables provide evidence that training may be decreased with little risk. However, the large difference between the percentage of training provided and the percentage of maintenance performed (Table 10) provides the primary indication that training may be reduced.

- **5546000**. None of the variables for this EIC provide any strong indications as to why training may need to be increased. However, the low number of maintenance observations discovered during PM may be an indication of a need for more PM training.

- **553U000, 553V000, and 5531AAA**. The primary reason for increasing the amount of training for these EIC's is due to the high number of maintenance observations. Additionally, all three EIC's have very low PM discovery percentage rates.

B. FIRST SUBSIDIARY QUESTION RESULTS

The deferred data set consisted of 15,870 completed deferred maintenance observations.[10] Appendix F provides a listing of the results by curriculum.

1. Display Curriculum

The display curriculum deferred data subset consisted of 4,800 maintenance actions. Within this data subset, forty-seven maintenance actions had deferral element codes that were training-related. Table 12 provides a listing of the EIC's that had training-related deferrals reported against them.

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[10] Open deferred maintenance actions were deleted from the data set.

TABLE 12
DISPLAY CURRICULUM DEFERRAL RESULTS

EIC	NUM OF DFR'S WITH CODES 3,4, & 5	% OF DEFERRALS WITH CODES 3, 4, & 5
TB04AAA	23	48.9
5500000	4	8.5
5515AAA	1	2.1
553L000	1	2.1
553N000	2	4.3
553Q000	2	4.3
553R000	3	6.4
553T000	1	2.1
5580000	2	4.3
5586000	1	2.1
5588000	5	10.6
5589000	2	4.3
TOTAL	47	

The results in Table 12 indicate that over forty-eight percent of all training-related deferrals were written against components within the EIC "TB04AAA". Additionally, the number of observations against the remaining EIC's were very few. Therefore, the narrative block of only those maintenance observations written against EIC "TB04AAA" were reviewed.

This review found that of the twenty-three maintenance observations, there were only four cases in which the technician specifically mentioned the need for more training. In about seventy-five percent of the cases, the job either required parts or was not authorized for ship's force work, for example, valve calibration, valve overhaul, and pump overhaul. In these cases, the technician was correct when he used the training related deferral codes. However, application of the deferral codes, 6, 'lack of facilities or capabilities,' or 7, 'not authorized for ship's force overhaul,' may have been more appropriate. Also, the technician inappropriately used the training deferral codes when the maintenance action was deferred for lack of parts. In this case, the use of deferral reason code 2, 'lack of parts,' would have been more appropriate.

2. SPY-1A Curriculum

The SPY-1A deferred data subset consisted of 8,113 maintenance observations. Within this data subset thirty-seven maintenance observations had training-related deferral element codes. Table 13 is a listing of those EIC's.

TABLE 13
SPY-1A CURRICULUM DEFERRAL RESULTS

EIC	NUM OF DFR'S WITH CODES 3,4, & 5	% OF DEFERRALS WITH CODES 3, 4, & 5
55A0000	1	2.7
5500000	4	10.8
551F000	1	2.7
5510000	1	2.7
5511AAA	4	10.8
5513AAA	14	37.8
5514AAA	4	10.8
5515AAA	1	2.7
553L000	1	2.7
553M000	1	2.7
553N000	2	5.4
5531AAA	2	5.4
553T000	1	2.7
TOTAL	37	

The results of Table 13 indicate that thirty-eight percent of all the training-related deferrals were written against components within the EIC, "5513AAA". Because of the low percentage rate of observations against the remaining EIC's, the narratives of those observations were not reviewed.

The findings during this review indicate results similar to those found within the display curriculum. In this case, there were only two jobs with narratives that mentioned the need for more training. The remaining jobs were deferred for calibration or lack of parts. These results indicate that the technicians within this curriculum were also not using the most appropriate deferral reason codes.

3. FCS/ORTS Curriculum

The deferred data subset for this curriculum consisted of 2,905 maintenance actions. Within this data subset only eleven observations had training-related deferral element codes. Table 14 is a list of the results for this curriculum.

TABLE 14
FCS/ORTS CURRICULUM DEFERRAL RESULTS

EIC	NUM OF DFR'S WITH CODES 3,4, & 5	% OF DEFERRALS WITH CODES 3, 4, & 5
4719AAA	4	36.4
55A0000	1	9.1
5550000	2	18.2
5553000	1	9.1
5557100	3	27.3
TOTAL	11	

Because of the low numbers of maintenance observations, no further analysis was attempted within this curriculum.

4. Computer Curriculum

The data subset for this curriculum consisted of 1,282 deferred maintenance observations. This data subset had only nine observations which reported training-related deferral element codes. Table 15 provides a list of these observations.

TABLE 15
COMPUTER CURRICULUM DEFERRAL RESULTS

EIC	**NUM OF DFR'S WITH CODES 3,4, & 5**	**% OF DEFERRALS WITH CODES 3, 4, & 5**
55A0000	1	11.1
5500000	4	44.4
553V000	1	11.1
5531AAA	2	22.2
5546000	1	11.1
TOTAL	9	

Due to the low numbers of maintenance observations, no further analysis was attempted within this curriculum.

C. SECOND SUBSIDIARY QUESTION RESULTS

The results of the first step identified only four EIC's that had a sufficient number of observations to warrant further investigation. These EIC's were (5500000, 5511000, 5513000, and 5514000).

A further investigation identified that a total of 367 technical assistance CASREP's were written against these EIC's between July, 1987 and October, 1992 (Russ, 1992). Of these CASREP's, only eleven had narrative remarks which contained words from the key-word search list. Because the key-word search identified only a small sample of observations, no further investigation on this subject was attempted.

VI. SUMMARY, RECOMMENDATIONS, AND CONCLUSIONS

A. SUMMARY

This study was conducted to determine if the maintenance technicians who graduate from the AEGIS training center receive an appropriate amount of training. To accomplish this task, the percentage of curriculum training hours devoted to the components of a specific equipment identification code (EIC) was compared to the percentage of total maintenance hours spent repairing the components. The objective was to identify the EIC's for which the difference between these two percentages was large.

Additionally, this study had two subsidiary purposes. They were: (1) to determine if an analysis of the AEGIS 2-KILO maintenance data set would indicate any areas where formal AEGIS repair training was insufficient, and (2) to determine if an analysis of the AEGIS technical-assistance CASREP data would uncover any areas where formal maintenance training has been insufficient. The methodology used to answer these subsidiary questions was similar to the direct-indicator-analysis procedure described by Keeler and Guynn (1986).

The scope of this study was restricted to analyzing only those maintenance actions having equipment identification codes listed in Appendix B. These EIC's pertain to the equipment for which maintenance training is conducted at the AEGIS Training Center in Dahlgren, Virginia. This maintenance training is accomplished in four separate curricula. These curricula are: SPY-1A, Display, Computer, and FCS/ORTS.

The data set used during this study was obtained from the Naval Sea Logistic Center (NAVSEALOGCEN) located in Mechanicsburg, Pennsylvania. It contained the unscheduled maintenance actions performed by the maintenance technicians onboard AEGIS Ticonderoga class ships. The data set covered the time period between July 1987, and September 1992.

B. RECOMMENDATIONS

1. Primary Research Question

Based upon the criterion discussed in Chapter IV, the data suggests that the amount of training provided be decreased for the components of eleven EIC's. This recommendation primarily reflects the low failure-percentage-rates for these EIC's. Table 16 is a listing of these EIC's, by curriculum.

TABLE 16
LIST OF EIC's FOR DECREASED TRAINING

EIC	% CURRIC HRS	% TOTAL MAINT HRS	% TOTAL 1 STD	%TOTAL 2 STD	CURRICULUM
QM93000	.0593	.0003	.0009	.0008	DISPLAY
5586000	.1349	.0224	.0326	.0283	DISPLAY
5580000	.1727	.0554	.0583	.0507	DISPLAY
55A0000	.0633	.0038	.0046	.0058	SPY-1A
5500000	.6237	.0167	.0290	.0354	SPY-1A
QK0V000	.1490	.0120	.0051	.0113	FCS/ORTS
55A1000	.1386	.0365	.0209	.0170	FCS/ORTS
55A7000	.0816	.0180	.0174	.0141	FCS/ORTS
5557340	.1490	.0777	.0971	.0789	FCS/ORTS
5533000	.1990	.1152	.0496	.0386	COMPUTER
5541AAA	.3582	.1800	.1483	.1152	COMPUTER

The results of this study also indicate that training may need to be increased for the components within nine EIC's. This recommendation is based on the high percentage of maintenance observations reported for the components within these EIC's. Table 17 is a listing of these EIC's by curriculum.

TABLE 17
LIST OF EIC's FOR INCREASED TRAINING

EIC	% CURR HRS	% TOTAL MAINT HRS	% TOTAL 1 STD	% TOTAL 2 STD	CURRICULUM
TB04AAA	.0593	.0915	.1217	.1717	DISPLAY
553Q000	.1133	.1224	.1917	.1668	DISPLAY
5513AAA	.0290	.6526	.6727	.6290	SPY-1A
5557100	.1168	.2377	.2214	.3284	FCS/ORTS
4719AAA	.1101	.4917	.4961	.4032	FCS/ORTS
5546000	.0232	.1172	.1047	.0815	COMPUTER
553U000	.0240	.0795	.0790	.1212	COMPUTER
553V000	.0240	.0752	.0725	.1146	COMPUTER
5531AAA	.0597	.1181	.1714	.1407	COMPUTER

2. Subsidiary Questions

Because of the low number of maintenance observations that reported training-related Direct-Indicator element codes, no specific EIC's were able to be identified for further training. However, analysis of those maintenance observations that reported training-related element codes indicated that the technicians were not properly using these codes. Therefore, the only recommendation in this case is that the AEGIS Trainers may want to emphasis the importance of using the proper block 8 and 9 element codes when completing the maintenance form.

C. CONCLUSIONS

Based on the criterion developed within Chapter IV of this thesis, the AEGIS Training Center appears to be providing a sufficient amount of training for its technicians in approximately 72 percent of the EIC's that were analyzed. Within the remaining EIC's, a reduction in the amount of training provided is recommended for 15 percent and an increase in the amount of training provided is recommended for the remaining 13 percent. Additionally, the 2-KILO Direct Indicator element codes were found to provide no indications that an insufficient amount of training was being provided.

APPENDIX A

CURRICULA EIC LISTING

DISPLAY	SPY-1A	FCS/ORTS	COMPUTER
QK0V000	55A0000	QK0V000	55A0000
QM93000	5500000	WL3R000	5500000
QW71000	551A000	55A0000	553U000
TB04AAA	551C000	55A6000	553V000
5500000	551D000	55A1000	5531AAA
5515AAA	551F000	55A7000	5533000
553B000	5510000	5550000	5540000
553C000	5511AAA	5557340	5541AAA
553D000	5513AAA	5554000	5545000
553F000	5514AAA	5557100	5546000
553G000	5515AAA	5566000	5591000
553H000	5518000	5551000	5593000
553K000	5519000	5553000	
553L000	553L000	4719AAA	
553N000	553M000		
553Q000	553N000		
553R000	5531AAA		
553T000	5551000		
5537000	553T000		
5538000			

APPENDIX A (CONTINUED)

CURRICULA EIC LISTING

DISPLAY	SPY-1A	FCS/ORTS	COMPUTER
5539000			
5541AAA			
558A000			
5580000			
5586000			
5588000			
5589000			

Source: EIC's provided by the AEGIS Training Center

Notes:

EIC TB04AAA represents EIC's TB04000, TB0400, TB046, TB04700, TB04900, TB049, and TB04600.

EIC 5515AAA represents EIC's 5515000, 5515100, 5515300, 5515400, 5515500, 5515600, 5515800, and 5515900.

EIC 5541AAA represents EIC's 5541000, 5541100, 5541300, 5541400, 5541400, 5541500, 5541600, 5541700, 5541800, and 5541900.

EIC 5511AAA represents EIC's 5511000, 5511100, 5511300, 5511400, 5511500, and 5511600.

EIC 5513AAA represents EIC's 5513000, 5513100, 513300, 5513400, 5513500, 5513600, 5513700, 5513800, and 5513900.

EIC 5514AAA represents EIC's 5514000, 5514100, 5514300, 5514400, 5514500, 5514600, 5514700, 5514800, and 5514900.

EIC 5531AAA represents EIC's 5531000, 5531100, 5531300, 55314, 5531400, 5531500, 5531600, 55317, 5531700, and 5531800.

EIC 4719AAA represents EIC'S 4719000, 471900, 4719100, 4719200, 47193, 4719300, 4719400, and 4719500.

APPENDIX B

TICONDEROGA CLASS CRUISERS

HULL NUMBER	SHIP NAME	YEAR OF COMMISSIONING (FY)	UIC
CG-47	USS Ticonderoga	83	21281
CG-48	USS Yorktown	84	21225
CG-49	USS Vincennes	85	21295
CG-50	USS Valley Forge	86	21296
CG-51	USS Thomas S. Gates	87	21344
CG-52	USS Bunker Hill	86	21345
CG-53	USS Mobile Bay	87	21346
CG-54	USS Antietam	87	21387
CG-55	USS Leyte Gulf	87	21388
CG-56	USS San Jacinto	88	21389
CG-57	USS Lake Champlain	88	21428
CG-58	USS Philippine Sea	89	21429
CG-59	USS Princeton	89	21447
CG-60	USS Normandy	89	21449
CG-61	USS Monterey	90	21450
CG-62	USS Chancellorsville	89	21451
CG-63	USS Cowpens	90	21623
CG-64	USS Gettysburg	90	21624
CG-65	USS Chosin	90	21625
CG-66	USS Hue City	91	21656
CG-67	USS Shiloh	92	21657
CG-68	USS Anzio	91	21658
CG-69	USS Vicksburg	92	21684

Source: Navy Comptroller Manual (NAVSO P-1000-25 VOL. 2 CH.5) and Jane's Fighting Ships (1990-1991).

APPENDIX C
2-KILO MAINTENANCE FORM

OPNAV 4790/2K (Rev 6-78) S/N 0107-LF-047-9011 SHIP'S MAINTENANCE ACTION FORM (2-KILO) COMP DEFL

SECTION I. IDENTIFICATION

JOB CONTROL NUMBER

1. SHIP'S UIC | 2. WORK CENTER | 3. JOB SEQ. NO. | 4. APL/AEL

A. SHIP'S NAME | 5. EQUIPMENT NOUN NAME | 6 WND | 7 STA | 8 CAS | 9 DFR | 10. | 11 | 12

B. HULL NUMBER | 13. IDENT./EQUIPMENT SERIAL NUMBER | 14. EIC

15 SAFETY HAZARD ☐ | 16. LOCATION *(Compartment/Deck/Frame/Side)* | 17 WHEN DISCOVERED DATE YR. DAY

CONFIGURATION CHANGE | FOR INSURV USE

18. ALTERATIONS *(SHIPALT, ORDALT, Fld Chg, etc.)* | 19. */** | 20. INSURV NUMBER | 21. SUFFIX | 22 U | 23. S | 24 P/F

SECTION II. DEFERRAL ACTION

25. S/F MHRS. EXP. | 26. DEFER. DATE YR. DAY | 27. S/F MHRS. REM. | 28 DEADLINE DATE YR. DAY

SECTION III. COMPLETED ACTION

FOR SELECTED EQUIPMENTS ONLY

29. ACT TKN | 30. S/F MHRS. | 31 COMPLETION DATE YR. DAY | 32. ACT. MAINT. TIME | 33. T | 34. METER READING

SECTION IV. REMARKS/DESCRIPTION

35. REMARKS/DESCRIPTION

36 CONT SHEET

37 CSMP SUMMARY

38. FIRST CONTACT/MAINT. MAN *(Print)* | 39. RATE | 40. SECOND CONTACT/SUPERVISOR *(Print)* | 41. PRI | 42. T/A | 43. INTEGRATED PRIORITY

SCREENING

C. DIV INIT. | D. DEPT. INIT. | E. COMMANDING OFFICER'S SIGNATURE | F. TYCOM AUTHORIZATION | 44 IUC | 45 TYCOM

46 SPECIAL PURPOSE | A. | B. | C. | D. | E. | F. | G. | H. | I. | J. | K. | L.

SECTION V. SUPPLEMENTARY INFORMATION

47. BLUEPRINTS, TECH. MANUALS, PLANS, ETC. | AVAILABLE ON BOARD YES NO | 48. PREARRIVAL/ARRIVAL CONFERENCE ACTIONS/REMARKS

SECTION VI. REPAIR ACTIVITY PLANNING/ACTION

49. REPAIR W/C | 50. EST. MHRS. | 51. ASST. REPAIR W/C | 52. ASST. EST. MHRS. | 53 SCHED START DATE YR DAY | 54 SCHED COMP DATE YR DAY

55. REPAIR ACTIVITY UIC | 56. WORK REQ. ROUTINE | 57 EST MANDAYS | 58. EST. MANDAY COST $ | 59. EST. MATERIAL COSTS $

60 EST. TOTAL COST $ | 61. JOB ORDER NUMBER | 62. LEAD P&E CODE | 63 DATE OF EST. YR DAY

APPENDIX D

DISPLAY EQUIPMENT TRKI & II TRAINING HOURS

EIC	TRG HRS/EIC	% CURRIC HRS
QK0V000	16	.0107
QM93000	88	.0593
QW71000	16	.0107
TB04AAA	88	.0593
5500000	80	.0539
5515AAA	16	.0107
553B000	8	.0053
553C000	16	.0107
553D000	8	.0053
553F000	8	.0053
553G000	8	.0053
553H000	8	.0053
553K000	8	.0053
553L000	128	.0863
553N000	104	.0701
553Q000	168	.1133
553R000	64	.0431
553T000	32	.0215
5537000	8	.0053
5538000	24	.0161

APPENDIX D (CONTINUED)

DISPLAY EQUIPMENT TRKI & II TRAINING HOURS

EIC	TRG HRS/EIC	% CURRIC HRS
5539000	2	.0013
5541AAA	8	.0053
558A000	72	.0485
5580000	256	.1727
5586000	200	.1349
5588000	40	.0269
5589000	8	.0053
TOTAL	1,482	

Note: Number of training hours/EIC provided by the AEGIS Training Center.

APPENDIX D (CONTINUED)

SPY-1A EQUIPMENT TRKI & II TRAINING HOURS

EIC	TRG HRS/EIC	% CURRIC HRS
55A0000	244	.0633
5500000	2402	.6237
551A000	13	.0033
551C000	75	.0194
551D000	7	.0018
551F000	10	.0025
5510000	195	.0506
5511AAA	420	.1090
5513AAA	112	.0290
5514AAA	256	.0664
5515AAA	4	.0010
5518000	29	.0075
5519000	14	.0036
553L000	33	.0085
553M000	8	.0020
553N000	8	.0020
5531AAA	9	.0023
5551000	4	.0010
553T000	8	.0020
TOTAL	3,851	

Note: Number of training hours/EIC provided by the AEGIS Training Center.

APPENDIX D (CONTINUED)

FCS/ORTS EQUIPMENT TRKI & II TRAINING HOURS

EIC	TRG HRS/EIC	% CURRIC HRS
QK0V000	157	.1490
WL3R000	69	.0655
55A0000	58	.0550
55A6000	49	.0465
55A1000	146	.1386
55A7000	86	.0816
5550000	16	.0151
5557340	157	.1490
5554000	24	.0227
5557100	123	.1168
5566000	44	.0417
5551000	4	.0037
5553000	4	.0037
4719AAA	116	.1101
TOTAL	1,053	

Note: Number of training hours/EIC provided by the AEGIS Training Center.

APPENDIX D (CONTINUED)

COMPUTER EQUIPMENT TRKI & II BREAKOUT BY EIC

EIC	TRG HRS/EIC	% CURRIC HRS
55A0000	24	.0199
5500000	246	.2039
553U000	29	.0240
553V000	29	.0240
5531AAA	72	.0597
5533000	240	.1990
5540000	29	.0240
5541AAA	432	.3582
5545000	29	.0240
5546000	28	.0232
5591000	24	.0199
5593000	24	.0199
TOTAL	1,206	

Note: Number of training hours/EIC provided by the AEGIS Training Center.

APPENDIX E

DISPLAY CURRICULUM RESULTS

EIC	% CURRIC HRS	% TOTAL MAINT HRS	% TOTAL 1STD	% TOTAL 2STD	
QK0V000	.0107	.0126	.0063	.0149	
QM93000	.0593	.0003	.0009	.0008	*
QW71000	.0107	.0013	.0034	.0029	
TB04AAA	.0593	.0915	.1217	.1717	#
5500000	.0539	.0610	.1011	.1145	
5515AAA	.0107	.0288	.0380	.0503	
553B000	.0053	.0023	.0026	.0022	
553C000	.0107	.0002	.0005	.0005	
553D000	.0053	.0007	.0018	.0015	
553F000	.0053	.0009	.0007	.0020	
553G000	.0053	.0002	.0005	.0005	
553H000	.0053	.00002	.00007	.00006	
553K000	.0053				$
553L000	.0863	.2686	.1111	.0967	
553N000	.0701	.0426	.0328	.0285	
553Q000	.1133	.1224	.1917	.1668	#
553R000	.0431	.0513	.0589	.0512	
553T000	.0215	.0383	.0261	.0227	
5537000	.0053	.0047	.0080	.0069	
5538000	.0161	.0021	.0042	.0047	
CORRELATION		.50389	.60538	.53952	

APPENDIX E (CONTINUED)

DISPLAY CURRICULUM RESULTS

EIC	% CURRIC HRS	% TOTAL MAINT HRS	% TOTAL 1STD	% TOTAL 2STD
5539000	.0013	.0010	.0009	.0007
5541AAA	.0053	.0558	.0593	.0515
558A000	.0485	.0484	.0496	.0431
5580000	.1727	.0554	.0583	.0507 *
5586000	.1349	.0224	.0326	.0283 *
5588000	.0269	.0790	.0797	.0693
5589000	.0053	.0071	.0083	.0156
CORRELATION		.50389	.60538	.53952

Notes:

* Indicates EIC's where the percentage of training provided is greater than the percentage of maintenance reported.

# Indicates EIC's where the percentage of maintenance performed is greater than the percentage of training provided.

$ Indicates that no non-deferred maintenance observations were reported against this EIC.

APPENDIX E (CONTINUED)

SPY-1A EQUIPMENT CURRICULUM RESULTS

EIC	% CURRIC HRS	% TOTAL MAINT HRS	% TOTAL 1 STD	% TOTAL 2 STD
55A0000	.0633	.0038	.0046	.0058 *
5500000	.6237	.0167	.0290	.0354 *
551A000	.0033	.0004	.0008	.0007
551C000	.0194	.0050	.0047	.0123
551D000	.0018	.0001	.0002	.0004
551F000	.0025	.0010	.0012	.0012
5510000	.0506	.0097	.0097	.0169
5511AAA	.1090	.0586	.0567	.0780
5513AAA	.0290	.6526	.6727	.6290 #
5514AAA	.0664	.1215	.1283	.1199
5515AAA	.0010	.0079	.0109	.0155
5518000	.0075	.0012	.0018	.0017
5519000	.0036	.0116	.0048	.0045
553L000	.0085	.0737	.0319	.0293
553M000	.0020	.0039	.0032	.0097
553N000	.0020	.0117	.0094	.0087
5531AAA	.0023	.0100	.0197	.0194
5551[illegible]0	.0010	.0012	.0019	.0031
553T000	.0020	.0105	.0074	.0070
CORRELATION OF VARIABLES		-.01955	.00195	.01639

Notes:

* Indicates EIC's where the percentage of training provided is greater than the percentage of maintenance reported.

\# Indicates EIC's where the percentage of maintenance performed is greater than the percentage of training provided.

APPENDIX E (CONTINUED)

FCS/ORTS CURRICULUM RESULTS

EIC	% CURRIC HRS	% TOTAL MAINT HRS	% TOTAL 1 STD	% TOTAL 2 STD	
QK0V000	.1490	.0120	.0051	.0113	*
WL3R000	.0655	.0190	.0243	.0279	
55A0000	.0550	.0134	.0130	.0143	
55A6000	.0465	.0250	.0386	.0361	
55A1000	.1386	.0365	.0209	.0170	*
55A7000	.0816	.0180	.0174	.0141	*
5550000	.0151	.0245	.0250	.0203	
5557340	.1490	.0777	.0971	.0789	*
5554000	.0227	.0215	.0229	.0261	
5557100	.1168	.2377	.2214	.3284	#
5566000	.0417	.0114	.0031	.0025	
5551000	.0037	.0044	.0055	.0078	
5553000	.0037	.0065	.0088	.0115	
4719AAA	.1101	.4719	.4961	.4032	#
CORRELATION OF VARIABLES		.77932	.55424	.42338	

Notes:

* Indicates EIC's where the percentage of training provided is greater than the percentage of maintenance reported.

\# Indicates EIC's where the percentage of maintenance performed is greater than the percentage of training provided.

APPENDIX E (CONTINUED)

COMPUTER EQUIPMENT CURRICULUM RESULTS

EIC	% CURRIC. HRS	% TOTAL MAINT HRS	% TOTAL 1 STD	% TOTAL 2 STD
55A0000	.0199	.0454	.0404	.0423
5500000	.2039	.1969	.2529	.2565
553U000	.0240	.0795	.0790	.1212 #
553V000	.0240	.0752	.0725	.1146 #
5531AAA	.0597	.1181	.1714	.1407 #
5533000	.1990	.1152	.0496	.0386 *
5540000	.0240	.0145	.0130	.0152
5541AAA	.3582	.1800	.1483	.1155 *
5545000	.0240	.0423	.0489	.0546
5546000	.0232	.1172	.1047	.0815 #
5591000	.0199	.0119	.0156	.0142
5593000	.0199	.0031	.0033	.0047
CORRELATION OF VARIABLES		.77932	.55424	.42338

Notes:

* Indicates EIC's where the percentage of training provided is greater than the percentage of maintenance reported.

# Indicates EIC's where the percentage of maintenance performed is greater than the percentage of training provided.

APPENDIX F

DISPLAY EQUIPMENT DEFERRALS

EIC	NUM OF DFR'S ALL CODES	% TOTAL DFR'S	NUM OF DFR CODES 3, 4, 5	% DFR'S 3,4,& 5
QK0V000	56	1.2		0.0
QM93000	2	0.0		0.0
QW71000	12	0.3		0.0
TB04AAA	1,112	23.2	23	48.9
5500000	576	12.0	4	8.5
5515AAA	106	2.2	1	2.1
553B000	22	0.5		0.0
553C000	7	0.1		0.0
553D000	10	0.2		0.0
553F000	6	0.1		0.0
553G000	0	0.0		0.0
553H000	3	0.1		0.0
553K000	1	0.0		0.0
553L000	201	4.2	1	2.1
553N000	153	3.2	2	4.3
553Q000	700	14.6	2	4.3
553R000	207	4.3	3	6.4
553T000	214	4.5	1	2.1
5537000	45	0.9		0.0
5538000	33	0.7		0.0

APPENDIX F (CONTINUED)

DISPLAY EQUIPMENT DEFERRALS

EIC	NUM OF DFR'S ALL CODES	% TOTAL DFR'S	NUM OF DFR CODES 3, 4, 5	% DFR'S 3,4,& 5
5539000	10	0.2		0.0
5541AAA	90	1.9		0.0
558A000	201	4.2		0.0
5580000	393	8.2	2	4.3
5586000	74	1.5	1	2.1
5588000	503	10.5	5	10.6
5589000	63	1.3	2	4.3
TOTAL	4,800		47	

APPENDIX F (CONTINUED)

SPY-1A EQUIPMENT DEFERRALS

EIC	NUM OF DFR'S ALL CODES	% TOTAL DFR'S	NUM OF DFR'S CODES 3, 4, 5	% DFR'S CODES 3, 4 & 5
55A0000	126	1.6	1	2.7
5500000	576	7.1	4	10.8
551A000	40	0.5		0.0
551C000	88	1.1		0.0
551D000	6	0.1		0.0
551F000	26	0.3	1	2.7
5510000	189	2.3	1	2.7
5511AAA	811	10.0	4	10.8
5513AAA	4516	55.7	14	37.8
5514AAA	596	7.3	4	10.8
5515AAA	106	1.3	1	2.7
5518000	48	0.6		.0.0
5519000	91	1.1		0.0
553L000	201	2.5	1	2.7
553M000	154	1.9	1	2.7
553N000	153	1.9	2	5.4
5531AAA	168	2.1	2	5.4
5551000	4	0.0		0.0
553T000	214	2.6	1	2.7
TOTAL	8,113		37	

APPENDIX F (CONTINUED)

FCS/ORTS EQUIPMENT DEFERRALS

EIC	NUM DFR'S ALL CODES	% TOTAL DFR'S	# OF DFR'S/ CODES 3,4 & 5	% TOTAL DFR'S 3,4 & 5
QK0V000	56	1.9		0.0
WL3R000	239	8.2		0.0
55A0000	126	4.3	1	9.1
55A6000	49	1.7		0.0
55A1000	114	3.9		0.0
55A7000	57	2.0		0.0
5550000	81	2.8	2	18.2
5557340	147	5.1		0.0
5554000	54	1.9		0.0
5557100	592	20.4	3	27.3
5566000	6	0.2		0.0
5551000	4	0.1		0.0
5553000	24	0.8	1	9.1
4719AAA	1,356	46.7	4	36.4
TOTAL	2,905		11	

APPENDIX F (CONTINUED)

COMPUTER EQUIPMENT DEFERRALS

EIC	NUM DFR'S ALL CODES	% TOTAL DFR	NUM DFR CODES 3,4,5	% TOTAL DFR CODES 3,4,& 5
55A0000	126	9.8	1	11.1
5500000	576	44.9	4	44.4
553U000	39	3.0		
553V000	33	2.6	1	11.1
5531AAA	181	14.1	2	22.2
5533000	109	8.5		
5540000	22	1.7		
5541AAA	90	7.0		
5545000	19	1.5		
5546000	28	2.2	1	11.1
5591000	58	4.5		
5593000	1	0.1		
TOTAL	1,282		9	

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