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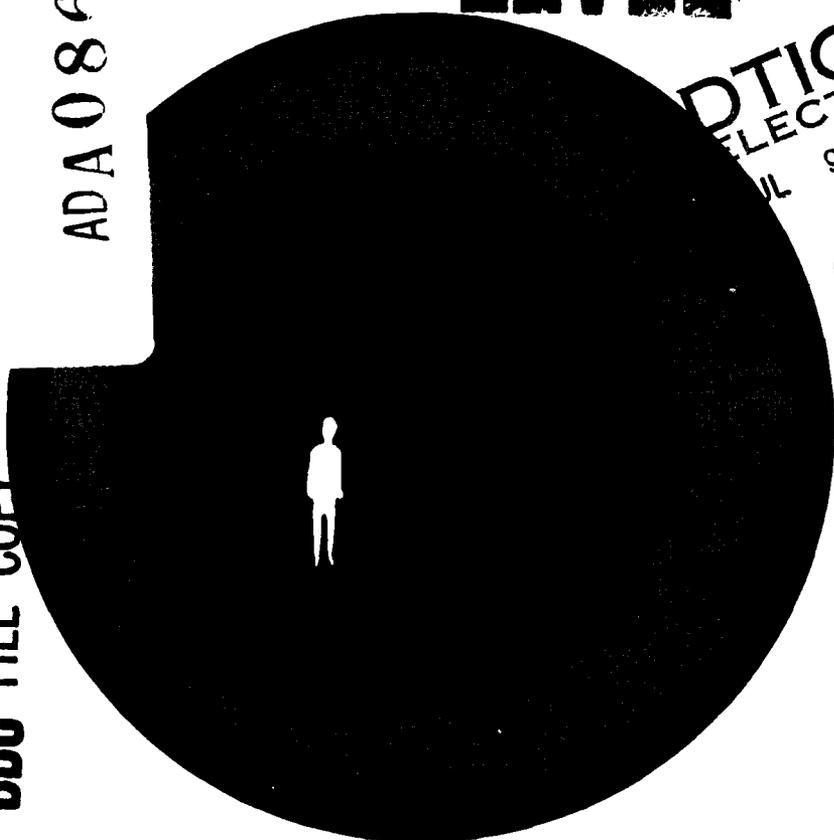
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NAVAL TRAINING EQUIPMENT CENTER
ORLANDO, FLORIDA 32813

NAVTRAEQUIPCEN TAEG REPORT 4

ABSTRACT

ELECTRONIC WARFARE TRAINING ANALYSIS

This report describes the findings from an analysis of the training requirements for electronic warfare equipment operators, and supports the feasibility and desirability of a consolidation of training for operators of air, surface, and subsurface EW equipment. The report contains a proposed curriculum for the consolidated training program and a description of a generalized operator training system. Actions for improving the effectiveness of existing EW training facilities are recommended.

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FOREWORD

This report details the initial effort at an analysis of and a prescription for a Navy-wide EW training system. The work was performed by a six-member interdisciplinary team of the Naval Training Equipment Center's Training Analysis and Evaluation Group (TAEG), working for a period of four months.

This first phase characterizes present and emerging EW training in terms of its personnel structure, the equipments to be manned, and the training curriculum. It demonstrates that major consolidations are both feasible and desirable. It addresses a generalized operator training system incorporating modern educational technology features. Cost and lead time estimates for such a system have been prepared and separately submitted.

Continuing work by the TAEG EW team is concerned with an EW maintenance training system, and a program for officer training.

This report does not contain a detailed task analysis of the EW job. Such an analysis is essential to the detailed description and analysis of the proposed training systems. It is expected that the EW Management Team will make provisions for obtaining these data and that TAEG will participate in this effort.

This analysis was conducted by a team of engineering, psychological, educational, and operations research personnel. They were: L. R. Bauer, W. P. Lane, B. J. McElvenny, E. O. Moore, T. E. Pearson, and W. B. Stubbs.

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SUMMARY

As part of the effort to meet the Navy's increasing electronic warfare requirements and to overcome operator and maintenance personnel deficiencies, the Chief of Naval Training (CNT) has initiated a plan to consolidate electronic warfare training at Corry Field, Pensacola, Florida. In support of this consolidation plan, the Training Analysis and Evaluation Group (TAEG) of the Naval Training Equipment Center (NAVTRAEQUIPCEN) was assigned the task of analyzing the electronic warfare training requirements. Principal objectives of this analysis were to evaluate the feasibility of consolidating electronic warfare training for air, surface, and subsurface areas and to develop preliminary descriptions of equipment characteristics needed to support a consolidated training system for electronic warfare operators. Reports concerning personnel and training requirements for Navy electronic warfare equipment were reviewed and electronic warfare training and related activities of the Navy and Air Force were visited to determine existing concepts, plans, and thinking concerning electronic warfare developments and training needs. An analysis of electronic warfare equipment was made to determine whether commonalities in design characteristics, functions, and operating task requirements existed which would support a consolidation of training curricula and facilities including the feasibility of developing generalized training equipment.

Review of the personnel and training situation existing in the electronic warfare area indicated that the Navy's program to provide a quick-reaction capability led to a production of numerous electronic

warfare systems which was followed by a similar increase in electronic warfare training courses and facilities. These courses have objectives of developing operator and maintenance performance requirements associated with specific equipment or systems, and use operational equipment as training equipment. This training approach was frequently wasteful of both funds and manpower, and contributed to the inadequacies noted in the performances of operator and maintenance personnel. The inadequate training efforts and the practice of assigning less-skilled and inexperienced personnel to the operation and maintenance of electronic warfare equipment was followed by a degradation in the operational readiness of Navy electronic warfare. These conditions led to the establishment of the enlisted rating of Electronic Warfare Technician (EW) and the plan for consolidating training. Also, the review showed that quantitative requirements for maintenance and operator billets, electronic warfare officer billets, and specialized billets, such as instructors and staff personnel, were not specified. Review of the qualitative requirements for electronic warfare billets revealed that existing qualification statements and performance requirements are not job-oriented, but seem to be directed towards advancement in rating and grade requirements. Efforts have been initiated to develop more specific job performance requirements and to identify specific watch-station knowledges and skills.

The premise for the equipment commonality analysis was that certain common design and functional characteristics existed in electronic warfare equipment which imposed common activities or performance demands on the operators. Seven suits of equipment were identified from a list

of electronic warfare equipment currently employed and projected to be employed in the Navy air, surface, and subsurface forces. Results of the commonality analysis by three major classification categories were as follows: (1) Function - 93%; (2) Distinguishing Features - 82%; and (3) Tactical Employment - 78%. Total commonality was at the 83% level. Another measure of commonality was derived by identifying significant operator activities associated with the 16 Distinguishing Features. The range of percentage of commonality was from a low of 29 to a high of 86.

Common subject material, instructional media, and techniques were identified through an analysis of electronic warfare courses. Material of over 117 different operator courses was classified into 20 subject categories which, in turn, were classified into the following four families of related information or training activity: (1) Basic; (2) Theory; (3) Practical; and (4) Evaluation. Results from this analysis suggest that a training curriculum composed of these families of information and activity would provide the operator with proficiency in the theory, concept of operation, techniques of planning, and principles of application involved in electronic warfare.

The findings of commonality among functions, distinguishing features, tactical employment, and operator activities-distinguishing features association, plus the core curriculum training concept, support the proposed plan for consolidation of electronic warfare training curricula and the development of a generalized operator training equipment system to support the consolidated training program. The development of a training system incorporating learning and training principles

and technology, performance measuring capabilities, and systematic evaluation of the training should alleviate a great number of the operator personnel deficiencies and other factors contributing to the low state of electronic warfare readiness of the Navy. Development of this system will require the definition of precise qualitative and quantitative fleet job performance standards, training objectives, subject matter, instructional methods, and instructor personnel requirements.

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**INTRODUCTION &
PROBLEM**

SECTION I

INTRODUCTION AND PROBLEM

Electronic warfare is a principal effort to counter the increasing enemy threat to the Navy's aircraft, ships, and submarines. As the enemy threat has changed, the development of electronic warfare equipment has evolved as quick-reaction procurements to overcome a previously small development program for electronic warfare equipment. That is, there was development of equipment for particular threats, then modification of this equipment to respond to other threats, configured for various installations, followed by development of equipment to counter new and more extensive threats. In addition, the evolution has been from manual operation of equipment to automated equipment with a variety of operating modes. Along with the introduction of new and more complicated equipment, the retirement of older equipment has been slowed due to the time and costs associated with the development of sufficient quantities of new equipment to satisfy the large number of air, surface, and subsurface vehicles requiring electronic warfare capabilities. These conditions have resulted in the need for extensive and expanded operational concepts, personnel skills, maintenance plans, and support programs.

The personnel capabilities for operation and maintenance of electronic warfare equipment have increased at a rate similar to the growth of equipment and systems, and this growth has contributed to the expansion of EW training facilities and courses. These training efforts

have been oriented around the development of training for each particular equipment coming into usage, with emphasis being placed on equipment uniqueness. Due to the quick-reaction development of equipment, the objectives of operation and maintenance training have been hastily and poorly defined, much like the performance goals for many of the equipments. Also, during this period training equipment requirements in support of the training programs have been met primarily through the use of operational equipment. This approach has been costly, and has become even more so as operational equipment becomes more complicated. The use of operational equipment does not provide the most effective training since training methods which incorporate established learning and training principles are not readily incorporated in operational equipment. In summary, the training efforts in electronic warfare have been deficient and frequently wasteful of both funds and manpower.

As part of an attempt to meet the increasing EW requirements and to enhance the EW personnel capabilities, the Navy established the new rating of Electronic Warfare Technician (EW) in 1971. A second attempt to enhance the Navy's EW posture was the development of a long range plan by the Chief of Naval Training to overcome inadequacies in EW training (CNT Msg 262200Z January 1972, and CHNAVPERS Msg 140859Z January 1972). The plan involves improvements in the training facility at Treasure Island as an interim measure, with a long range plan to relocate basic and advanced training, both maintenance and operator, for officer and enlisted personnel to Corry Field, Pensacola, Florida, and to merge common subject matter for training where relationships exist between the requirements for the electronic warfare platforms of

air, surface, and subsurface. Paramount in this consolidation plan is the establishment of an academic atmosphere, where an electronic warfare "education" can be provided as the basis, and a cross-fertilization of all elements will take place in which economics of facilities, support, and manpower will result.

The Naval Training Equipment Center (NAVTRAEQUIPCEN) was tasked by the Chief of Naval Training in March 1972, to conduct a training analysis of electronic warfare which would support the long range plans for electronic warfare training. In response to the tasking letter, an interdisciplinary team of specialists in engineering, education and training, and psychology was assembled in the Training Analysis and Evaluation Group (TAEG) at the NAVTRAEQUIPCEN to assess the Navy's requirements for EW training, and to identify the objectives and characteristics of a training system to support this proposed consolidation of Navy EW training efforts. Although the consolidation plan involves operator and maintenance training at the basic and advanced levels, the initial effort of the TAEG EW Group has been related primarily to the level of the basic operator. The basic maintenance and advanced technician requirements are to be examined as a follow-on effort.

PROCEDURE

SECTION II

PROCEDURE

Representatives of the Training Analysis and Evaluation Group (TAEG) reviewed published reports dealing with the personnel and training requirements for Navy electronic warfare equipment, visited electronic warfare training activities of the Navy and Air Force, and other commands of the Navy concerned with electronic warfare, interviewed a small number of fleet personnel knowledgeable in electronic warfare, and observed at-sea operations during a fleet exercise. The objectives of the preceding efforts were to make an assessment of the current situation in electronic warfare operations and training, to determine the training concepts and techniques employed for electronic warfare, and to identify the concepts, plans, and thinking concerning electronic warfare developments and training programs. This approach provided considerable information concerning the aspects and complexities associated with the development of personnel to perform effectively in the electronic warfare environment.

In addition, a commonality analysis of electronic warfare equipment and operator training curricula was conducted. For the equipment analysis, a list of electronic warfare equipment currently deployed and projected to be deployed in Navy air, surface, and subsurface forces was compiled. The goal of the equipment commonality analysis was to identify common characteristics existing in electronic warfare equipment which would impose certain common activity and/or performance demands upon the operators of electronic warfare equipment. A second analysis was

conducted by examining existing Navy curricula to identify commonality and to make a comparison of Navy electronic warfare instructional objectives and methods with those used by the Air Force. The objectives of the commonality analyses were to determine the existence of common equipment characteristics and common instructional topics and/or methods which would support a consolidation of training efforts for electronic warfare personnel, and the development of a generalized training system for operator personnel.

RESULTS

SECTION III

RESULTS

ASSESSMENT OF SITUATION

PERSONNEL INPUT. The personnel involved in the electronic warfare functions in the Navy have traditionally included the enlisted ratings of Electronics Technician (ET), Radarman (RD), Aviation Electronics Technician (AT), and Communications Technician (Technical) (CTT), and the Electronic Warfare Officer (EWO) assigned to surface and subsurface platforms. Enlisted personnel have been involved in the maintenance and operation of electronic warfare equipment, and officer personnel have been concerned with the operation and/or employment of equipment and tactical decision-making functions. The recognition for more accurate identification and development of the skills required for effective utilization of electronic warfare equipment and techniques led to the examination of several personnel input and training programs associated with electronic warfare. The goal was to enhance the maintenance and operation capabilities of personnel and the employment of electronic warfare equipment, and subsequently, the electronic warfare readiness of the Navy. These efforts included the conduct of gross task analyses, disestablishment of some training courses, a proposal for consolidation of training, and formation of an Electronic Warfare Management Team.

As a result, in September 1971 the Navy established a new general rating of "Electronic Warfare Technician" (EW) for assignment to the surface fleet. The intended scope of functions for the EW rating included

operation and performance of organizational and intermediate level maintenance on Electronic Support Measures (ESM), Electronic Countermeasures (ECM) and associated equipment; interpretation and evaluation of intercepted signals and intelligence reports; and an understanding and application of appropriate EW tactics and doctrine to meet operational needs.

The initial input to the EW rating included the ratings of RD and ET who possessed particular NEC's. These persons in most instances required additional training for conversion to the EW rating. A diagram of the existing plan for the personnel input and training for the EW rating is provided in Figure 1. Planning for the career training in support of the EW rating included the following elements: (a) Basic electricity and electronics; (b) Specialized "A" school with elements of RD and ET "C" courses; (c) Four-year obligor capable of operating and maintaining ESM; (d) Six-year obligor capable of operating and maintaining ECM and ESM equipment; (e) Training curriculum to provide a balanced operator-maintenance emphasis; and (f) Modular training structure to accommodate the four-year and six-year obligors. Another input to the EW rating, shown in Figure 1, is provided from the recruit training sources as part of the Advanced Electronics Field (AEF) input. A review of the two preferred source ratings and six NEC's used for conversion to the rating of EW revealed a preponderant representation of maintenance skills and knowledges over operator qualifications. Thus, even though the EW rating includes the concept of a balanced operator-maintainer, the initial personnel input reflected an emphasis in maintenance capabilities.

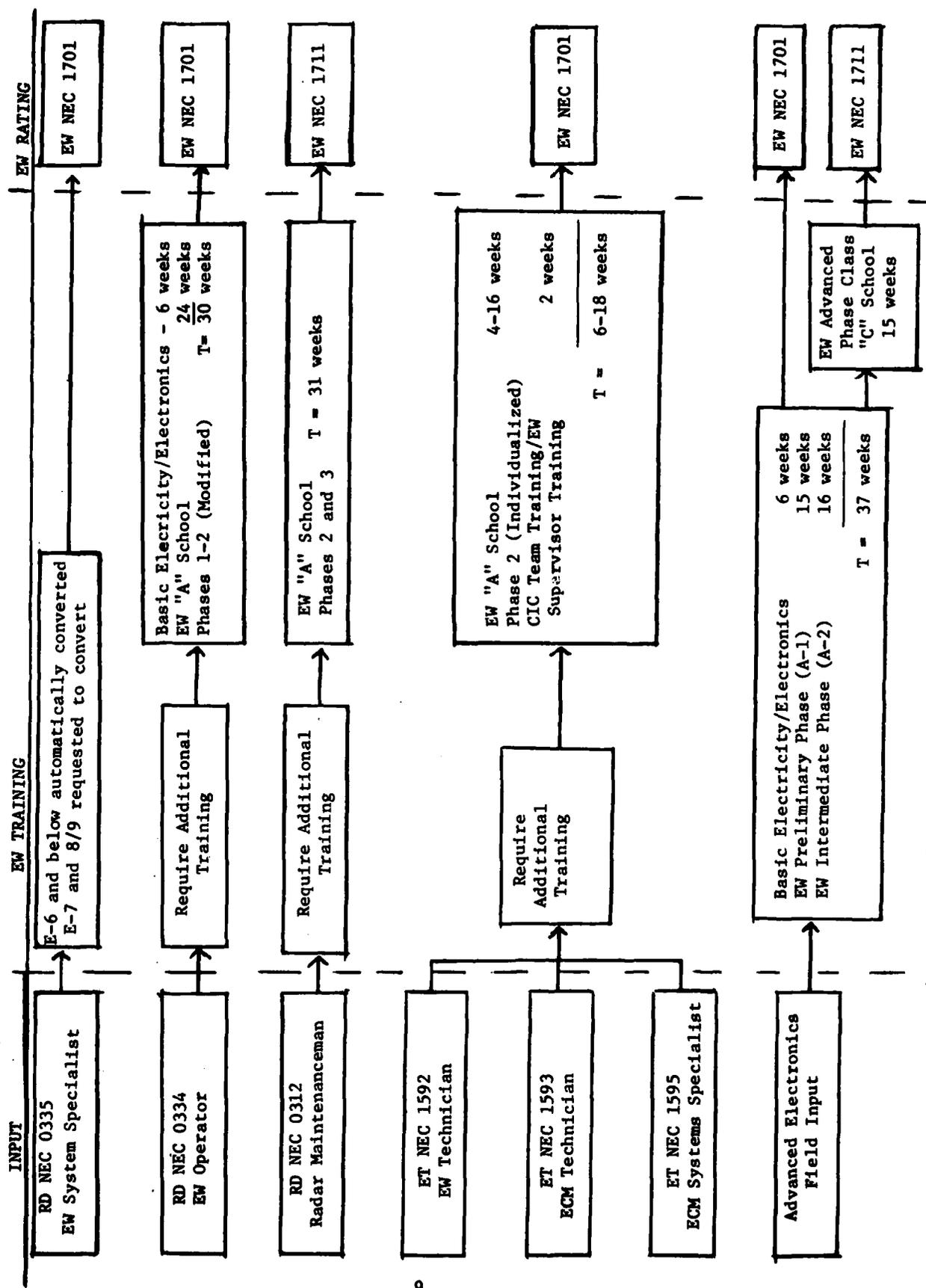


Figure 1. Plan for Personnel Input to Electronic Warfare Technician Rating

SELECTION AND UTILIZATION. General selection criteria for the input personnel include the Navy's test selectors of the General Classification Test (GCT), Arithmetic (ARI), and the Electronics Technician Selection Test (ETST). For the ratings of RD and CTT, the test selectors are the GCT and ARI; for AT and ET, the test selectors are the ARI and ETST; and for the recruit training input, the test selectors are GCT and ARI. Thus, the selection requirements for the EW rating are general and not stated in terms of specific knowledge and skill requirements for the maintenance and operation tasks performed. This lack of definitiveness in selection requirements and in specific knowledge and skill statements can be partly attributed to the finding that the specific tasks and performance requirements of the EW rating have not been defined nor established.

Another element of complexity involved in the personnel development program is the proposed utilization of personnel in the electronic warfare functions of aircraft and submarines. Selection of the EW Technician for use aboard an aircraft or submarine will involve application of the particular training and adaptability requirements peculiar to these platforms. In addition, the assignment of the EW to submarine duty will require the determination of means for the full-utilization or cross-utilization of the EW's capabilities to preclude ineffective assignment. The ramifications of the proposed utilization of EW personnel in the air and surface programs have not been fully identified but are being examined by cognizant personnel. Therefore, the possible and future employment of the EW Technician in these programs could not be accurately determined.

The information concerning the EWO and NFO ALEW designations was found to be less defined than for the enlisted rating of EW. The officer assigned to EWO duties is generally a junior officer who has been recently commissioned and, therefore, possesses only a limited amount of knowledge concerning the Navy's tactical operations and electronic warfare. In many instances, officers assigned to EWO billets have received no formal training in electronic warfare such as the EWO/Operations Course. In addition, this situation was found to be further complicated by the finding that most ships have little or no EW tactical doctrine procedures for guidance of operators and EW Officers. A study of the NFO, including the NFO AELW, has been completed by the Chief of Naval Air Training, but results were not available at the time this report was prepared. The personnel input and training programs for the NFO AELW are considerably more definitive than those for the surface platform EW Officers. The path followed by the NFO AELW consists of 14 hours of training with a VT Squadron, followed by 7.6 weeks in an AELW Course at Naval Air Technical Training Center, Glynco, Georgia. Following this training, the officers are assigned either to a Replacement Air Group (RAG) or to a Fleet Aviation Specialized Operational Training Group (FASOTRAGRU) for 4-20 weeks of evaluation training. In spite of the relatively defined training program and pipeline, the NFO AELW graduate is considered about 15 to 20 percent qualified, while a 70 percent qualification level is stated as being required by cognizant personnel.

Findings by the TAEG EW Project Team indicated that there are 940 NFO AELW officer billets with about 120 or approximately 13 percent of those filled with qualified personnel. Specification of the quantitative

requirements for maintenance and operator billets, electronic warfare billets, and specialized electronic warfare billets in the shore establishment, such as instructors and staff personnel, were poorly defined at the time this report was being prepared. The quantitative requirements for electronic warfare billets in the Navy are being reviewed and defined by personnel at the Naval Personnel Research and Development Laboratory, Washington, D.C. Results of this survey of EW billets for air, surface, and subsurface for ashore and afloat organizations were scheduled for publication in July 1972.

QUALIFICATIONS. Review of the qualification requirements for electronic warfare billets indicated that existing qualification statements and performance requirements are not specifically job-oriented, but seem to be tailored more toward advancement in rating and grade requirements. Efforts are underway to analyze specific job performance requirements and to identify specific watch-station knowledges and skills for specifications of performance requirements. Personnel Qualifications Standards are being developed and OPNAVINST 03431.2 of 5 August 1969 establishes minimum levels of knowledge and proficiency for personnel assigned to electronic warfare billets. As indicated above, these performance standards and proficiency requirements are not quantified, but instead are described for enlisted personnel billets in terminology correlated with Qualifications for Advancement (NAVPERS 18068 series) and Navy Enlisted Classification Codes. The proficiency requirements for officer billets are described in terms of completion of specified EW training courses.

The establishment of a training curriculum without the benefit of detailed task descriptions and the training objectives derived therefrom suggest that the existing training curriculum possesses serious inadequacies. Similarly, the development of training devices in support of the curriculum cannot be substantiated without a detailed conceptualization of the human participation involved in the maintenance and operation of the EW equipment. Quantifiable performance standards for EW officer and enlisted billets could be developed and defined once the tasks required of the personnel are defined in behavioral elements. If the behavioral elements are defined accurately and in detail, then the specification of proficiency or performance standards is reasonably direct and quantifiable. Efforts should be initiated to analyze the tasks, develop the behavioral elements, and specify the proficiency levels of performance required for an effective electronic warfare readiness within the Navy.

COMMONALITY ANALYSIS OF EQUIPMENT

The commonality of tasks, knowledges, and skills associated with the operation of Navy electronic warfare equipment was given consideration in determining whether operator training for electronic warfare could be effectively consolidated. An analysis of electronic warfare equipment from a functional point of view was conducted to determine the most significant characteristics of the equipment and their relationships to the operator's use of the equipment. The assumption was that common functional characteristics would indicate technological commonalities and these commonalities, in turn, would impose certain common activity and/or performance demands upon the operators of the EW equipment.

The first phase of the equipment analysis indicated that electronic warfare can be defined as "the use of the electromagnetic spectrum in support of offensive or defensive military programs by any given country." There are many sub-categories within the broad category of electronic warfare; however, all of these categories can be classified as systems that either convey information to the system operator(s), or attempt to deny information to a potential enemy. Since the systems used to convey information are generally considered own-forces equipment, the second grouping consists of systems that operate against own forces. Turning the situation around, the enemy information-conveying systems become the targets for the systems that attempt to deny the enemy the use of the electromagnetic spectrum. Electronic warfare is a two-way proposition which seems to conform to the law that "for every action there is an equal and opposite reaction." Within the category of systems that are classified as information conveying, a further subdivision can be made into "active" and "passive" systems. Some or all of the information-conveying systems can be used to provide information for use in the operation of the second category of systems--systems that deny effective use of the electromagnetic spectrum for information-conveying purposes. This second category of electronic warfare systems can also be subdivided into "active" and "passive" systems. An identification was made of the systems that fit into these two categories relative to these primary characteristics, and is contained in Appendix A.

The above discussion applies equally well to the air, surface, and with respect to the receiving systems, the subsurface Naval forces. The primary factor that separated the air/surface, subsurface electronic

warfare systems was the hardware packaging configuration necessary to make the equipment compatible with the physical constraints of the particular platform. The technology of the various categories of equipment appeared essentially identical. Tactical doctrine may vary relative to mission goals, but operator requirements on comparable equipments remained essentially the same across the spectrum of Navy activities.

The second phase of the equipment analysis consisted of compiling a list of electronic warfare equipment currently deployed and projected to be deployed in the Navy air, surface, and subsurface forces. The commonality analysis was by electronic warfare equipment suit since the assumption was that operators would be exposed to all pieces of equipment for a particular platform, and therefore, must be capable of operating all components of the suit. A suit was defined as the total electronic warfare equipment complement of a specific platform type. The representative suits are inclusive of the older, more commonly deployed equipments, as well as the new state-of-the-art equipments deployed or under operational evaluation prior to deployment. Seven typical suits, three air, three surface, and one subsurface, were identified. The suits are operated by either enlisted or officer personnel including pilots and Naval Flight Officers.

Three major classification categories for the analysis of the equipment were identified. These were: (1) Function of the Equipment; (2) Distinguishing Features; and (3) Tactical Employment. Results from the commonality analysis for the three major classification categories are summarized in Table 1. As shown, the seven equipment suits were found to have a commonality by Function of 93 percent, by Distinguishing

Features of 82 percent, and by Tactical Employment of 78 percent. A total or overall commonality of 83 percent was determined for the seven

Table 1. Percentage of Commonality by Major Classification Categories

Seven Equipment Suits	Classification Categories			Total
	Function	Distinguishing Features	Tactical Employment	
Percent of Commonality	93	82	78	83

equipment suits. These data showed that a high degree of commonality existed between the seven suits of equipment for the three classification categories. Within the category of Function, the two sub-categories of Electronic Support Measures (ESM) and Electronics Countermeasures (ECM) were identified. For the category of Distinguishing Features, 16 sub-categories were identified and included such features as modes of operation, types of displays, and modes of recording. Two sub-categories of Tactical Employment were used: Directed/Supervised and Autonomous. All of the percentages of commonality for the major categories and sub-categories used for this commonality analysis are given in Appendix B.

Another measure of equipment commonality was derived by identifying significant operator tasks/activities associated with the 16 Distinguishing Features of the seven suits of equipment. This analysis provided a more detailed measure of commonality and complete data are given in Appendix C. A summary of the results from this particular analysis is given in Table 2 and shows a range of percentages of commonality from a low of

29 to a high of 86. The average percentage of commonality for all equipment suits for all task functions associated with the distinguishing features was 55 percent. Review of this analysis showed that the lower percentages of commonality were associated with features applicable to the newer and more sophisticated equipment of a suit and the unique equipment required for specialized missions in electronic warfare, such as video recorders which do not find widespread deployment among operating forces.

Table 2. Percentage of Commonality of Operator Functions by Distinguishing Features

Distinguishing Features of Seven Suits	Manual Operation	Semi-Automatic Operation	Automatic Operation	Warning Display	Panoramic Display	Direction Finding Display	Pulse Analyzer	Audio Output	Video Recording	Audio Recording	Auto Signal Sorting	Auto Threat Reactive System	RF Transmitter	Data Analysis By Operator	Computer Aided	Non-Electronic Defensive Tactics
Operator Activities	57	64	50	55	46	66	57	74	29	57	51	75	52	74	25	86

ANALYSIS OF TRAINING CURRICULA

A review of Electronic Warfare Schools (Surface and Subsurface), NAVPERS 10500, Revised 1 July 1970, indicated that there is a minimum of 35 officer and 117 enlisted sources for electronic warfare training in the Navy. Geographically, these schools and courses are located on each coast in areas of fleet concentration and at centers for submarine training at New London and Pearl Harbor, with a few located inland, primarily at Naval Air Stations. A small number of these training activities, representative of air, surface and subsurface operational areas, were visited by the TAEG EW team to observe class instructional methods and to collect materials. The curricula, courses of study, lesson guides and lesson plans for 12 courses were selected for analysis and review, with the objective of establishing commonality of subject matter and identifying material to include in a consolidated curriculum for EW operators.

The review showed that the course material, even though nearly identical, was identified by 117 different subject titles. For example, the same material was identified as "threats" and "guided missiles" in two different curricula. As part of the analysis, the 117 subjects were classified into 20 groups. Further reduction of the data indicated that the 20 groups could be classified into four categories of interrelated bodies of information/activity. These categories were classified as (1) Basic - containing information of a foundation nature; (2) Electronic Warfare Theory - the concepts of the EW discipline; (3) Electronic Warfare Practical - the application of principles; and (4) Evaluation - determination of student progress and ultimate qualification. The four categories and the topics within each are shown in Table 3.

Table 3. Categories of Electronic Warfare Subjects

A. <u>Basic</u>	B. <u>Electronic Warfare Theory</u>
Basic Electronics	EW Concepts
Fundamentals of Radio	ESM
Fundamentals of Radar	ECM
Logs, Reports, Watch Standing	ELINT
Publications	Equipment
C. <u>Electronic Warfare Practical</u>	Ancillary Equipment
Operation and/or Simulation	Specialized EW Systems
Flight and Flight Planning	Threats
D. <u>Evaluation</u>	Analysis Techniques
Review	Miscellaneous
Testing	New Developments

The length of each course, time distributed between the four categories of information/activity, and the distribution of total time between classroom, laboratory and flight were calculated. Findings from this analysis indicated a wide range of variability in the length of the sampled courses and the distribution of time among the several elements and instructional settings. The length of the 12 sampled courses ranged from 14 to 525 hours. The range of hours and percentages of course time distributed among the categories and settings are given in Table 4. As shown by the data in Table 4, the analysis of the EW courses, admittedly a small sample of those available, highlights the variability in the

Table 4. Summary of Time Distributions for 12 Navy EW Courses

Course Information Activity Category	Total Course			
	Range of Hours		Range of Percentages	
	Low	High	Low	High
Basic	1	42	7	35
EW Theory	13	180	31	92
EW Practical	12	148	19	43
Evaluation	5	72	5	21
Instructional Setting				
Classroom	14	210	42	100
Laboratory	11	243	19	57
Flight ⁽¹⁾		40		11

(1) Since only one course had a flight setting, a range of hours or percentages was not available.

course content and the instructional methods used in the Navy for teaching electronic warfare. Other findings from this analysis indicated that an effort is being made to teach both operator and maintenance skills in one consolidated curriculum at the EW Class A School; however, at other locations the curricula addressed either maintenance or operator skills. In some courses, the instruction was primarily directed towards the development of operator skills, but contained more maintenance information than considered necessary for effective equipment operation. At Fleet Training Centers and Submarine Schools, the operation or

maintenance of a specific equipment is usually addressed by the instruction with the principal instructional mode being the operational equipment. This condition exists to meet the requirement for refresher training and/or initial qualification for a particular EW equipment. However, the variability found in the sampled courses would suggest that even the equipment specific courses could be improved by standardization of course terminology, instructional methods, and incorporation of instructional aids supplemental to the use of actual equipment.

Conditions noted from this analysis included the lack of continuity from year to year and among similar courses. The absence of a corps of permanent educational specialists at the school locations and the periodic rotation of military instructors contribute to a poorly maintained instructional program. Other problem areas noted concerned the absence of fleet performance standards to be used as guides for developing curricula and training objectives, and the lack of a feedback system from the user-activities to the schools to verify and/or modify the training programs.

The findings of common subject-matter content and the wide-range of variability lend support to the concept and plan of a consolidated electronic warfare program. While it appears that the preponderance of the curriculum material would be common in a consolidated course, blocks of instruction will need to be identified with subdivisions so that only applicable portions are given to the appropriate group of students. Implementation of such a concept would require precise division of course components and scheduling of students, but it would provide for faster development of particular skills required for performance in an operational setting.

In one major course of those analyzed, the principal emphasis is on the educational aspects of electronic warfare vice the traditional emphasis on "knobology" which is found in operator courses for specific equipments. The analysis supports a consolidation approach in which basic operator training should be directed away from emphasis on particular EW equipment and towards an education, so that each operator has a thorough understanding of basic EW principles, threats, utilization, employment, and tactics. This approach would provide the basic building blocks upon which to base further and advanced systems training, and would improve the effectiveness and versatility of operators by overcoming the deficiencies which are created by training personnel to operate a particular piece of equipment. Also, the basic training and education should provide personnel with sufficient knowledge, skill, and techniques necessary to acquire additional fleet training oriented towards a specific weapon system. A proposed EW Training Pipeline is shown in Figure 2. In general, the proposed concept and pipeline parallels the approach found in universities. Several different courses or units of study, tailored to particular billet requirements such as an Electronic Warfare Officer aboard a surface ship or a squadron EW Training Officer, would be provided. Basic material, as applicable, would be provided to prepare personnel to perform a specific operational job, such as operate a specific weapon system. During fleet assignment, additional refresher training may be required to maintain proficiency. At the conclusion of the first tour, further training, perhaps on a different weapon system, would be provided as required.

STUDENT INPUT

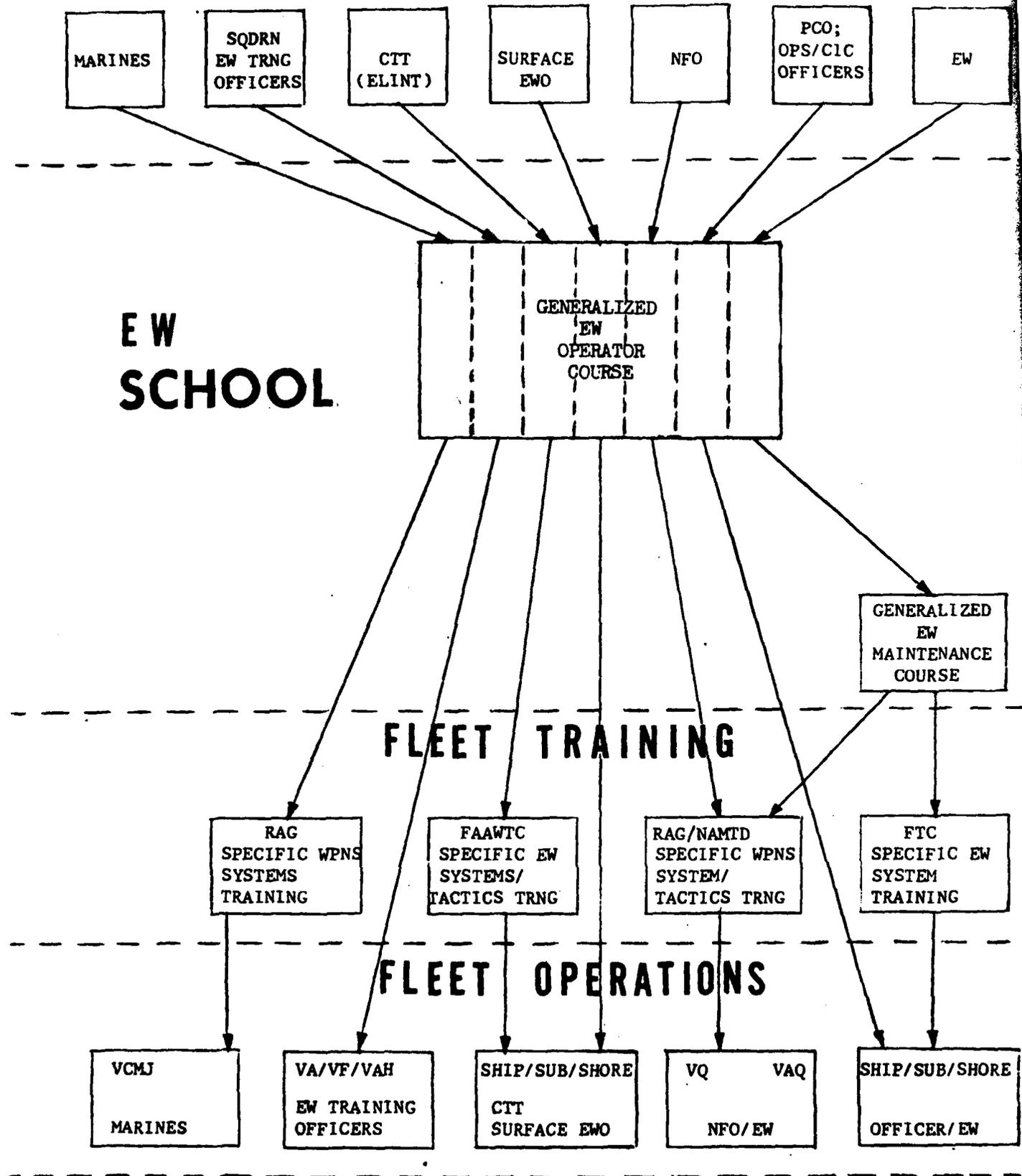


Figure 2. EW Training Pipeline

Appendix D contains a preliminary and proposed curriculum which was prepared to illustrate the analysis of commonality of EW operator functions and education and training, and to obtain a better insight to the required training device systems needed to support a rather formidable EW training problem. It must be emphasized that since job performance standards and subsequent training objectives were not identified, the preliminary curriculum is subject-matter oriented, and does not include degree of subject-matter coverage and/or instructional time allocations. Because of the lack of the job performance standards and training objectives, only general behavioral objectives could be developed rather than the desired specific behavioral objectives. The curriculum is one of a series that will be required to educate and train the many different types of personnel who are envisioned to be enrolled in a consolidated EW training program. Integration of the operator curriculum with a maintenance training curriculum will require further refinement and definition prior to the development of a finalized EW Operator-Maintenance Training Curriculum.

The curriculum takes the form of basic, intermediate, and advanced phases. The concept is that the basic phase, in addition to conveying academic information, will be a period for determining the students' capability to qualify for further training. Additionally, information will be presented that will give the student an understanding of the mission, tasks, and objectives of electronic warfare. The intermediate phase will provide to the student those academic, motor-perceptual, and analytical skills necessary for him to successfully perform the function of an operator of EW equipment(s). The advanced phase will reinforce

those skills learned in the basic and intermediate phases, along with imparting the knowledges necessary for the development of planning skills. Although the average student will probably spend a minimal amount of time performing a planning function, an understanding of the ingredients that make up a good plan is essential. With this understanding, personnel will have greater insight into the total electronic warfare world and, therefore, be more able to perform and accumulate new concepts. The advanced phase will also provide students with information on advanced systems so that when those systems are placed in fleet use, trained personnel will be better prepared to cope with them. Finally, a period of time will be devoted to familiarizing the trainees with various career-enhancement elements.

ANALYSIS OF FLEET TRAINING

The findings regarding electronic warfare training problems in the fleet were gained from discussions with fleet personnel and reflect the major areas of concern in electronic warfare training in the fleet.

(1) The critical shortage of qualified electronic warfare personnel in the fleet has been documented by the Chief of Naval Personnel. However, even the few qualified EW enlisted personnel in the fleet are not always properly utilized. They are sometimes used to augment other ratings, such as Radarmen, and perform duties not directly related to electronic warfare. While this practice may be necessary on some ships due to the shortage of Radarmen and the related knowledge of the EW personnel, the danger exists that it can become standard practice and result in low morale and performance.

(2) While fleet awareness of electronic warfare's increasingly important role in combat readiness is improving, a wide variance in command attention and direction exists. On those ships in which the commanding officer provided specific guidance, direction, and doctrine for the conduct of electronic warfare, including training, the electronic warfare personnel exhibited a high state of readiness and interest. Additionally, the operational equipment was more likely to be maintained in Readiness Condition I. It is evident that increased emphasis on electronic warfare training and employment at the command level will result in a higher state of readiness.

(3) Existing fleet electronic warfare training and exercise capability is seriously deficient and poorly utilized. The fleet electronic warfare training requirements set forth in CHNAVMAT's Consolidated EW Simulation and Training Plan emphasize the urgent need for fleet training facilities that provide standardized scenarios, evaluation of performance, and coordinated training of the total combat systems team in a multi-threat environment. Existing training facilities do not meet these requirements. Present shipboard training is limited to fleet exercises, and although these exercises provide the most realistic and effective electronic warfare shipboard training available, they are limited by the availability of simulation equipment. Furthermore, there is no method for objectively measuring the effectiveness of the training provided.

(4) Figure 3 shows the present inventory of EW training devices in "COG 20." Devices such as Device 15E18 are dedicated to EW training, while other devices provide EW training as a minor function, e.g, F-4J Weapon System Trainer. Most of the dedicated devices were developed in

DEVICE NO.	TITLE	TRAINING OBJECTIVES	TYPE TRAINING
2C15	A-7B Cockpit Procedures Trainer	B, C	I
2D2	Electronic Warfare Training Complex	A, B, C, E	F, H, I
2F28	S-2F Weapon System Trainer (WST)	A	F
2F55	F-4B WST	B, C, D	G, I
2F62	A-4C WST	B, C, D	I
2F66	S-2D WST	A	F
2F66A	S-2E WST	A	F
2F67	A-6A WST	B, C, D	G, I
2F69	P-3A WST	A	F
2F71	SP-2H Tactical Team Trainer	A	F
2F72	F-8 WST Series	B, C, D	I
2F76	A-4E Weapon System Trainer	B, C, D	I
2F84	A-7 WST Series	B, C, D	I
2F88	F-4J WST	B, C, D	I, G
5F8	ESM Threat Signal Recognition Training Programs	A, B, C	F, G, H, I
5F9	The Threat and Friendly Countermeasures	A, B, C	F, G, H, I
5F10	DECM Passive Operator Trainer	B, C	I
5F11	Electronic Warfare Audio/Visual Training Kit	A, B, C, D	F, G
7B1 *	Electro-Magnetic Simulator	A, B, D	F
15C4	Radar Scope Interpretation Trainer	D	G, I
15C9	Phoenix MCO Classroom Trainer	D	G, I
15E1	Field ESM Trainer Series	A, C	F, I
15E2	Radar Signal Video Pulse Simulator	A	F
15E3	ECM Jamming Attachment Tactical Trainer	D	G
15E13/ 15E28	Electronic Warfare Trainer	A, E	F, H
15E15	ECM Trainer	D	G
15E16	Passive ECM Operator Trainer	A	F
15E18	Tactical ECM Trainer	A, B, C, E	F, H, I
15E19	Portable Radar Emitter	A, C	F, I
15E22 *	EA-6B Team Tactics Trainer	A, B, E	F, H
15E24	DECM Operator Trainer	B, C	I
15E27	Passive ESM Signal Recognition Trainer	A, E	F, H
15E30	EKA-3B Part Task ECM Trainer	A, B, E	F, H
15H12	RF-4B Tactics Trainer	B, C, D	G, I
15X6	Radar Countermeasures Trainer	A, C	F, I
15X7	Radar Countermeasures Classroom Trainer	A	F
15X12	Radar Signal Interference Trainer	D	G
15X17	Radar Signal Interference Trainer	D	G
15X18	Radar Signal Interference Trainer	D	G

TRAINING OBJECTIVE LEGEND

A - ESM/Reconnaissance
 B - Defensive Electronic Countermeasures
 C - Radar Homing & Warning
 D - Electronic Counter-Countermeasures
 E - Electronic Jamming

TYPE TRAINING LEGEND

F - Passive Electronic Countermeasures Operator
 G - Radar Operator (ECCM)
 H - Jamming Operator
 I - Pilot

* - Under Development

Figure 3. Cognizance Symbol "20" Electronic Warfare Training Devices

response to a school or fleet requirement for a training media--not as an integrated element of a training system. Consequently, learning objectives which could have been identified during the conduct of a training system analysis are too costly to achieve via the device. Discussions with fleet personnel indicated this performance is affected by the following conditions:

(a) A lack of established EW tactics, policy, and doctrine, particularly in the surface Navy, which results in newly reporting personnel not being adequately trained in electronic warfare concepts.

(b) Lack of shipboard training devices to maintain and enhance operator proficiency.

(c) The EWO is frequently assigned as a collateral duty to a junior officer who seldom has received any formal training in electronic warfare.

(d) The classification of electronic warfare data makes it difficult to insure that all EW personnel are aware of the latest threats, doctrine, and procedures. Also, the lack of an effective feedback system, except in the Air Navy, precludes EW personnel from being knowledgeable in the effective employment of electronic warfare systems against new threats.

(e) Devices such as those listed are introduced into the instructional environment with capabilities which are not efficiently used because the training system is static; i.e., feedback and interaction which produce training system changes are non-existent.

(5) Figure 4 shows utilization averages, as reported in NAVTRADEVEN Report 10171-4 of April 1972, for major dedicated EW devices. Several

DEVICE NUMBER	DEVICE SERIAL NUMBER	LOCATION	TITLE	TRAINING HOURS STANDARD			REMARKS
				MO.	AVERAGE HOURS UTIL. PER	AVERAGE % TNR HRS STN.	
2D2	1	Nevada	EW Training Complex	140	55	39	
2D2	2	Florida	EW Training Complex	140	38	34	
15E1		Various Fleet/Shore	Field ESM Trainer Series	140	*	-	*Approx 50 devices. Utilization range 0 - 23.
15E13/ 15E28	1	FAAWTC SDiego	EW Trainer	140	46	32	
15E13A/ 15E28A	1	FAAWTC DNeck	EW Trainer	140	53	37	
15E16	1	PAC DET Moffett	Passive ECM Operator Tnr	140	48	34	
15E16	2	FASOTRA-GRU Norfolk	Passive ECM Operator Tnr	140	26	18	
15E18	1	NATTC Glynco	Tactical ECM Trainer	140	40	28	
15E18	2	FASOTRA-GRU NORIS	Tactical ECM Trainer	140	42	30	
15E24	2	LANT DET Albany, Ga.	DECM Operator Trainer	140	11	7	Four devices; Utilization reported Ser. No. 2 only
15E30	1	NAS Alameda	EKA-3B Part Task ECM Trainer	140	30	21	

TRAINING HOURS STANDARDS: Standard hours per month are established by the Chief of Naval Operations (OP-596) or (OP-99).

AVERAGE PERCENT OF TRAINING HOURS STANDARD ACCOMPLISHED PAST 12 MONTHS:

Average hours utilization per month for past 12 months divided by training hours standards.

Figure 4. Cognizance Symbol "20" EW Training Device Utilization as Reported in NAVTRADEVCEEN Report 10171-4 (April 1972)

factors are given in the report for such low utilization: unit deployment, trainer does not meet local training requirements, trainer is not reliable, and syllabus limits use of the trainer. Present shorebased training is accomplished primarily at installations such as TACDEW and Device 2D2 sites. These facilities provide multi-threat and team training. Because of command attention, utilization of the TACDEW facilities has shown improvement in recent months. However, this has not been true at the Device 2D2 sites.

Device 2D2, Electronic Warfare Training Complex, is one of the largest and most sophisticated electronic warfare training systems for scoring pilot performance in the Navy's inventory. The total cost of the facilities is in excess of \$45M, including government-furnished equipment. This system has been utilized by Navy, Marine, and Air Force pilots for training in a simulated electronic warfare environment since late 1967. Unfortunately, the full capabilities of the trainer have been utilized a small percentage of this period. This finding is even more significant since the training system has been in continuous support of the air activity in the Southeast Asia conflict. Proper use of this system can enhance the chance for survival of personnel and aircraft in that conflict. The problems associated with this training system are numerous, but the more significant are:

(1) A site-operation concept that defeats the purpose of the device. Typical training situations are as follows:

(a) Pilots receive training from the RF environment only, with no measure of their total performance provided. This type of training is a waste of the systems capabilities and funds since RF environment

training can be provided by other means at a fraction of the cost of the device 2D2 ranges.

(b) Full scoring missions in which the aircraft may or may not enter the lethal threat zones, and with performance measured by uncalibrated subsystems or improperly calibrated subsystems.

(c) Missions involving more aircraft than the device was designed to handle.

(2) Operator personnel perform their duties in such an autonomous way that they have very little, if any, understanding of how their function fits into the overall Device 2D2 concept. The operator personnel are generally inexperienced in the Device 2D2 type subsystems when reporting for duty assignment and, as in the case of the maintenance personnel, rotate at about the time a proficient level is reached.

(3) Maintenance personnel report to duty assignment with little understanding of the system because of the uniqueness of such systems. Those personnel who do attain an adequate level of proficiency through formal and on-the-job training are generally useful only a short period prior to rotation.

In general, the site operations follow the demands of the fleet users rather than the fleet users following a required training criteria that insure optimum training from the ranges. The most glaring deficiency of the approach used at the two training sites is that the use of available debriefing facilities by trainee pilots is not mandatory. It is only through a properly conducted debriefing that a pilot can ascertain the results of his training mission. Table 5 provides a summary of the utilization of the device and debriefing facility for Device 2D2.

Table 5. Utilization Summary for Device 2D2

<u>April 1972</u>	<u>Fallon</u>	<u>Cecil Field</u>
Hours of Utilization (Official)	124	40
Percent Utilization (Official)	88	28
Hours of Debrief Use	23.3	6.5
Percent Use of Debrief Facility	16.6	4.6

The reason for the difference between device use and debriefing use is that each mission over the range is logged as use of the trainer even though many of the system capabilities may be in a "down" state and a debriefing may or may not be accomplished. The following are possible solutions for insuring more effective operation and utilization of Device 2D2.

(1) Stabilize the operation and maintenance of the ranges by providing full-time civilian support personnel who will form a skilled nucleus of personnel to operate and maintain the ranges. Site downtime should be reduced to a minimum and valid system operation will become the rule rather than the exception as is the present case.

(2) Develop a training syllabus that takes full advantage of the training system capability and promulgate directives establishing requirements and criteria for use of the ranges, including mandatory debriefing following the training mission.

(3) Provide a nucleus of Navy personnel who will become the interface between the ranges and the Navy fleet users. These groups should include qualified EW-type flying officers who are familiar with the aircraft types flying the range. These officers, with the aid of counterpart technically oriented civilian personnel, will debrief the missions, providing the continuity of both aircraft capabilities and range capabilities required for meaningful debriefs.

(4) Develop a measurement system that reflects the effectiveness of the training provided. The scoring system employed in the trainer, along with other pertinent hard-copy mission data printout, can provide the basis for this measurement system. Pilot records from mission to mission can be compiled and analyzed for signs of improved performance as exposure time to the training environment accumulates.

(5) Develop a utilization reporting system that provides a method for identification of the degree to which the trainer's total capability has been used; for example:

Level One - RF environment AAA only.

Level Two - RF environment AAA and SAM.

Level Three - Scoring mission without debriefing.

Level Four - Scoring mission with debriefing.

There is much precedent for the above recommended operations. A listing of typical cases that are effectively managed in the above manner are:

Echo Range, China Lake, California

Eglin AFB SADS Program, Fort Walton Beach, Florida

Rome Air Development Center Ranges, Rome/Verona, N.Y.

The AUTEK Range, West Palm Beach, Florida

The Air Force Eastern Test Range, Patrick AFB, Florida

White Sands Ranges, White Sands, New Mexico.

RATIONALE FOR A TRAINING SYSTEM

The review of electronic warfare training indicated that existing systems used to provide training to electronic warfare operators have had the following characteristics:

(1) Operational EW equipment stimulated by free space radiation from or to external equipment. This stimulation equipment includes operational hardware and/or special purpose training systems.

(2) Operational EW equipment stimulated by hard-wired training systems, including digital computers used to generate synthetic data.

The use of operational equipment in electronic warfare training systems has many attendant problems, some of which are delineated below:

(1) The extensive number of EW equipments and the number of each type required to support equipment-oriented training systems contribute significantly to training costs.

(2) Stimulation and simulation systems required to activate operational equipment in training configurations tend to be special purpose and become obsolete as the operational equipment is replaced in the inventory.

(3) Stimulation and simulation systems required to activate operational equipment generally interface via generation of radio frequency signals within the frequency bands appropriate for the specific equipment needs. This approach complicates the signal generation process and introduces stringent radio frequency shielding considerations to meet security requirements.

(4) Operational equipment utilized in training configurations receive more abuse than when in operational settings which leads to rapid equipment deterioration. These conditions and the complex operational systems

increase the requirement for highly skilled maintenance personnel to minimize the interruption of training due to equipment malfunction.

(5) The acquisition cost associated with the newer generation of sophisticated electronic warfare systems virtually prohibits procurement of these systems for use as dedicated training platforms. Thus, consolidation of training for the various elements that encompass the electronic warfare community creates the need for new approaches that depart from existing training concepts. Particularly important, in order to alleviate past and existing deficiencies and problems, is to exclude the use of specific pieces of operational equipment for training.

The EW analysis has shown that general requirements can be established for definitizing the training system(s) for use in the consolidated school. Further delineation of the requirements is contingent upon completion of the task analysis for electronic warfare operators. However, as the basis for defining generalized trainer requirements, the following assumptions or conditions were assumed:

(1) The candidate students for the consolidated EW school will include:

Electronic Warfare Technician (EW)

Communications Technician (Technical) (CTT)

Electronic Technician (ET)

Electronic Warfare Officer (EWO)

Naval Flight Officer (NFO)

Marine EW Officer/enlisted personnel

Squadron EW training officers

Prospective Commanding Officers and Operations/CIC Officers

(2) Enlisted personnel graduates will be assigned permanently within air, surface, or subsurface areas, until career advancement to the subsystem technician level.

(3) The projected input population will be approximately 2500 personnel annually, with the specific mix not currently defined. Consideration must be given to handling peak student loads in excess of the projected 2500 students per year for a period of time adequate to fill the existing gap between available EW personnel and established billets. These peak load requirements have not been completely defined, but such data should be available from CHNAVPERS during FY 1973.

(4) The basic electronic operator role in the fleet is anticipated to evolve from a knobologist operator to an information processor and minor decision maker. The operator will need to possess the capability for quick-reaction independent of direct supervision under critical or emergency situations, with the very minimum qualification at the basic level of operator performance to be a reliable, semi-independent operator.

(5) The training system(s) to support consolidated EW training should provide an "education," with emphasis on EW operational concepts, procedures, and employment rather than technicalities and peculiarities of specific operational equipments. A major element of this training system should be a generalized operator trainer(s) configured to be representative of the concepts and technology found among the broad spectrum of EW equipment in or projected for the Navy inventory. The trainer(s) should not be configured to represent any specific piece of existing or projected EW equipment. The training system(s) must support the objective of the consolidated EW school curriculum. Simulation capability of the training system(s) should include equipment characteristics in Table 6.

Table 6. Simulation Characteristics for the Training System

1. ESM Receivers/Ancillary Equipment
 - a. Swept narrowband receiver
 - b. Multiband scanning receiver
 - c. Broadband discrimination receiver (IFM - Instantaneous Frequency Measuring)
 - d. Pulse analyzer equipment
 - e. Direction finding equipment
 - f. Signal recording equipment
 - g. Computer audio signal analysis capabilities
 - h. Panoramic display equipment
 - i
2. Radar Warning Receiver
 - a. Radar homing and warning receivers
 - b. Threat reaction receiver
3. ECM Systems/Ancillary Equipment
 - a. Manually tuned systems (spot and barrage)
 - b. Automatically tuned system
 - c. Defensive electronic countermeasures (DECM) systems
 - d. Steerable antennas - manual and automatic
 - e. Chaff systems
 - f. Infrared systems
4. ECCM Systems
 - a. Typical Naval Radar Displays/with various types of jamming
 - b. Typical ECCM features/with display responses
5. Real Time Environmental Signal Generation
 - a. Multiple environment gaming simulation
 - b. Multiple platform tracks
 - c. Multiple complex signal environment
 - d. Flexible instructor display/control
 - e. Individual trainee station control
 - f. Communication flexibility
6. Program Control of Training
 - a. Automated trainee response evaluation
 - b. Adaptive training

Training aids should be available to support education in general electronic warfare concepts. These aids should be designed/selected for application to a variety of instructional subjects and should be capable of supporting instructors in routine subjects. Sound/slide programs (Appendix E), new display techniques such as a Universal Display Panel (Appendix F), and computer graphic display systems are typical of what can be provided as effective training aids.

The consolidated EW school must contain a library of source data on current ELINT, current Navy EW platform configurations, current Navy EW doctrine, and EW related textbooks, in addition to EW facilities and equipment. Thus, students can supplement the formal education with independent studies as well as receive indoctrination on the specific EW equipments on board the platforms to which they are assigned, prior to graduation from the EW school. This library of data would, if properly structured, become the "fountain head" for electronic warfare within the Navy. The primary electronic warfare training facility in the Navy is the logical seat for such data.

Engineering considerations for the training system(s) include the following:

1. State-of-the-art computer techniques.
2. Modular unit structure (computer, instructor station, trainee station).
3. Growth capability.
4. Configuration versatility.
5. Adaptive training.
6. Automated trainee performance evaluation.

7. Real time environmental signal generation.
8. Multiple environment jamming simulation.
9. Multiple platform tracks.
10. Multiple signal environment.
11. Flexible instructor control/display.
12. Communication flexibility.
13. Individual and group trainee station control and monitoring.

Appendix G contains a Proposed Technical Approach for the EW operator training system.

Findings from the training analysis indicated a need for a systems approach to the development of a consolidated electronic warfare training program with a generalized training equipment system. The approach includes identification of the specific behaviors and performances required of the personnel in the job situation, a description of the training program, including training objectives, instructional methods, training media, and the quantitative and qualitative standards of performance required by the training program and in the operational setting. An evaluation program is a part of the training system to provide course and instructor evaluations, to assess attainment of training goals and/or performance levels reached by the trainees, and to assess the performance of the trained man in the operational assignment. Performance of personnel graduating from the training program should be compared with the operational performance standards and differences should be analyzed to identify changes needed in the course content and instructional procedures. Also, any new task requirements should be analyzed to provide new training content and/or objectives. Thus, a feedback loop from the operational setting to the training situation would be established to provide a continuous input to the training program.

RECOMMENDATIONS

SECTION IV
RECOMMENDATIONS

The data and findings from this analysis of electronic warfare training lead to the following recommendations concerning the plan for establishing a consolidated electronic warfare training facility.

1. Commonality in the distinguishing features and characteristics of electronic warfare equipment and in the subject matter content of existing training courses supports the plan to consolidate electronic warfare training.
2. The Chief of Naval Training should develop a plan to orderly and systematically develop the proposed Consolidated Electronic Warfare Training Program. Figure 5 provides suggested actions, responsibilities and milestones for this plan.
3. The objectives of the consolidated training program are to provide an education and understanding in basic electronic warfare principles, employment, tactics, and coordination. A proposed operator curriculum to be used as a planning-base for the consolidated program is contained in Appendix D.
4. A generalized training system for electronic warfare equipment operators is proposed as an essential element of the consolidated training program. A Proposed Technical Approach for the generalized training system is contained in Appendix
5. The consolidated training program requires civilian and military instructors with appropriate support staff. A cadre of these instructors

should conduct an evaluation of the training curriculum in trial courses prior to the establishment of the consolidated training activity.

6. A career-development program for all personnel involved in electronic warfare must be implemented to insure appropriate assignment and utilization of trained EW personnel.

7. Until the supply of trained personnel meets the demand, establish and utilize pools of qualified electronic warfare maintenance personnel to alleviate the existing shortage. Place these personnel on tenders and/or mobile units.

8. The following are recommended interim actions to improve existing EW training capabilities:

a. Develop preliminary job performance and training standards for EW personnel.

b. Revise existing electronic warfare training to incorporate performance and training standards.

c. Implement a preliminary fleet evaluation program to provide feedback to the training program.

d. Modify the utilization of Device 2D2 and other existing training devices, as appropriate, in accordance with actions listed in the Analysis of Fleet Training Subsection of Results, in order to improve the training effectiveness.

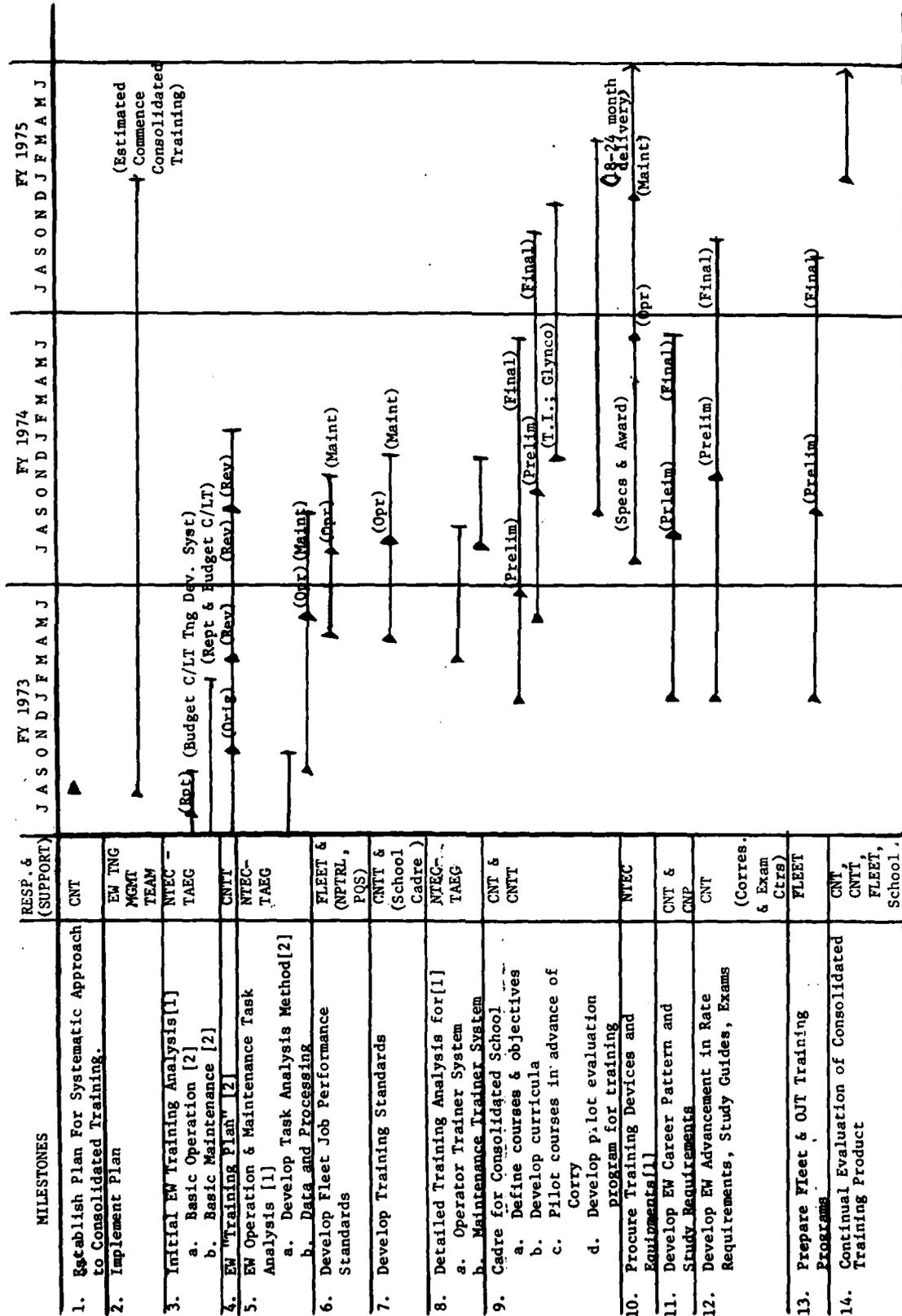


Figure 5. Training Consolidation Plan
Basic Operation & Maintenance

[1] - Estimated Resources:
FY 73: 80 man-months; \$20K Travel
FY 74: 91 man-months; \$15K Travel
[2] - Milestones in Progress

APPENDICES

APPENDIX A
GENERAL CATEGORIES AND CHARACTERISTICS
OF
ELECTRONIC WARFARE SYSTEMS

Electronic Warfare Systems can be classified as information conveying or denying, and distinguished by general characteristics categorized under intended use of and technique used in the system.

1. Information-Conveying Systems

a. Communications Systems

(1) Intended use--provide point-to-point means of information flow.

(2) Technique used:

(a) Low to high power transmitter(s)

(b) Low to high frequency transmitter(s)

(c) Varying types of modulation techniques, such as:

(1) Amplitude modulation

(2) Frequency modulation

(3) Pulse modulation -

- Digital coded data

- Pulse position modulation

(4) Frequency shift keying -

- Radio teletype

(5) Suppressed Carrier modulation -

- Double sideband suppressed carrier

- Single sideband suppressed carrier

b. Radar Systems

(1) Intended use--provide information for:

- (a) Airborne target location
- (b) Surface target location (submarine periscope

considered surface target)

- (c) Identification of friendly forces and location
- (d) Identification of enemy forces and location
- (e) Control of friendly forces by location tracking
- (f) Attack of enemy forces by location tracking

(2) Techniques used:

- (a) Low to high power transmitter(s)
- (b) Low to high transmitting frequencies
- (c) Varying types of modulation techniques, such as:

(1) Continuous wave (CW)

(2) Pulse modulation

(d) Varying types of electromagnetic energy control:

(1) Narrow beam width

(2) Wide beam width

(3) Multiple beam

(4) Fan beams (narrow horizontal wide vertical or

wide horizontal narrow vertical)

(5) Scanning beams

(a) Mechanical scanning by antenna movement

(b) Mechanical scanning by radiating element movement

(c) Electronic scanning (Phased array)

(d) Combination of (a), (b), and (c) above

- (6) Discrete transmitter pulsing rate
- (7) Staggered transmitter pulsing rate
- (8) Random (Jittering) transmitter pulsing rates
- (9) Narrow to wide transmitter pulse width
- (10) Varying transmitter pulse widths
- (11) Discrete transmission frequency
- (12) Multiple transmission frequencies
- (13) Varying transmission frequencies
- (14) Electronic counter countermeasures (ECCM)

techniques for the removal or degradation of intentional (enemy) or non-intentional (friendly or non-man made) interference signals.

c. Passive Receiving Systems (ESM)

(1) Intended use:

(a) Intercept identification, locations, and classification of enemy emitter system

(b) Intercept identification, locations, and classification of friendly emitter systems

(c) Information gathering from intercepted signals

(2) Techniques used:

(a) Low to high frequency broad band radio frequency (RF) tuning units

(b) Selected/selectable band with non-tuned RF units

(c) Automatically tuned RF units

(d) Manually tuned RF units

(e) Panoramic displays of intercepted signals

(f) Display of pulse width of intercepted signals

- (g) Display of pulse rate of intercepted signal
- (h) Display of direction to intercepted signal
- (i) Indication of range to intercepted emitter
- (j) Conversion of intercepted signal to its audio

characteristics

(k) Panel display of:

- (1) Signal type
- (2) Signal frequency
- (3) Signal emitter operating mode

(l) Manual control of system operation to determine

(e) to (k) above

(m) Automatic data processing--hard wired or general purpose computer--to determine (e) to (k) above

(n) Manual operator analysis of information received

(o) Automatic data processing for analysis of

information received

2. Information-Denying Systems

a. Electronic Countermeasures (ECM)

(1) Intended use:

(a) To deny the enemy the use of information-conveying systems by "brute force" methods

(b) To protect own forces from detection or attack by enemy forces

(2) Technique used:

- (a) Low to high power transmitter(s)
- (b) Narrow to wide band signal transmission
- (c) Variable modulation techniques
 - (1) Noise
 - (2) Continuous wave (CW)
 - (3) AM/FM modulation or both
- (d) Manual tuning
- (e) Automatic tuning
- (f) Computer aided target emitter identification and

ECM system activation

- (g) Directional antenna
- (h) Omni-directional antenna
- (i) Steerable antenna
- (j) Non-steerable antenna

b. Deceptive Electronic Countermeasures

(1) Intended use:

(a) To deny the enemy use of information-conveying systems by deceptive techniques

(b) To protect own forces from detection or attack by enemy forces

(2) Technique used:

(a) Variable modulation techniques geared to the characteristics of the threat emitter

(1) Retransmission of threat emitter signal unaltered but of strong signal strength

(2) Retransmission of threat emitter signal with modulation characteristic altered/or added

(3) Transmission of signals to deceive range tracking by threat emitter

(4) Transmission of false targets

(5) Release of passive chaff clouds to clutter threat emitter systems displays

(6) Release of decoy drones with beacon transmitter on board

APPENDIX B

Results of Equipment Commonality Analysis
By Major Classification Categories

CLASSIFICATION CATEGORIES	TYPICAL EQUIPMENT SUITS							PERCENT COMMONALITY ALL SUITS
	A	B	C	D	E	F	G	
PLATFORM								
Air		X		X	X			
Surface	X		X			X		
Subsurface							X	
FUNCTION								
Electronic Support Measures	X	X	X	X	X	X	X	100
Electronic Countermeasures	X	X	X	X	X	X		86
DISTINGUISHING FEATURES								
Manual Operation	X	X	X	X	X	X	X	100
Semi-Automatic	X	X	X	X	X	X	X	100
Automatic	X	X	X	X	X	X	X	100
Warning Display	X	X	X	X	X	X		86
Panoramic Display	X	X	X		X		X	71
Direction Finding Display	X	X	X	X	X	X	X	100
Pulse Analyzer	X	X	X		X	X	X	86
Audio Output	X	X	X	X	X		X	86
Video Recording		X					X	28
Audio Recording	X	X	X				X	57
Auto Signal Sorting	X	X	X	X	X	X	X	100
Auto Threat Reactive System	X	X	X	X	X	X		86
RF Transmitter	X	X	X	X	X	X		86
Data Analysis by Operator	X	X	X	X	X	X	X	100
Computer Aided					X	X		28
Non-Electronic Defensive Tactics	X	X	X	X	X	X	X	100
TACTICAL EMPLOYMENT								
Directed and/or Supervised	X	X	X			X	X	71
Autonomous	X	X	X	X	X			71
PERCENT COMMONALITY ALL CATEGORIES	90	95	90	70	85	75	70	

APPENDIX C

Results of Equipment Commonality Analysis
By Operator Tasks - Distinguishing Features

TASK FUNCTION	SUIT							PERCENT COMMONALITY ALL SUITS
	A	B	C	D	E	F	G	
MANUAL OPERATION:								
1. Primary Operating Mode		X					X	28
2. Secondary Operating Mode	X	X	X	X	X	X	X	100
3. Emergency Operating Mode			X	X	X			43
PERCENT APPLICABLE FEATURES	33	66	65	66	66	33	66	
SEMI-AUTOMATIC OPERATING MODE:								
1. Primary Operating Mode	X	X				X	X	57
2. Secondary Operating Mode		X	X	X	X		X	71
PERCENT APPLICABLE FEATURES	50	100	50	50	50	50	100	
AUTOMATIC OPERATION:								
1. Primary Operating Mode		X	X	X	X	X		71
2. Secondary Operating Mode		X					X	28
PERCENT APPLICABLE FEATURES	0	100	50	50	50	50	50	
WARNING DISPLAYS:								
1. Frequency Band Indicators		X	X	X	X	X		71
2. Threat Operating Mode Indicators		X		X	X			43
3. Spectrum Activity Indicator		X	X	X	X	X		71
4. Automatic Operation		X	X	X	X	X		71
5. Manual Operation			X		X	X		43
6. Threat Type Indicator			X	X	X			43
7. Threat Priority Indicator			X	X	X			43
PERCENT APPLICABLE FEATURES	0	57	86	71	100	57	0	

TASK FUNCTION	SUIT							PERCENT COMMONALITY ALL SUITS
	A	B	C	D	E	F	G	
PANORAMIC DISPLAY:								
1. Single Frequency Band Display	X	X	X			X		57
2. Multiple Frequency Band Display		X			X	X		43
3. Manual Tunable	X	X	X		X	X		71
4. Automatic Tunable	X	X	X		X	X		71
5. Multiple Band Synchronous Scanning		X			X	X		43
6. Multiple Band Non-Synchronous Scanning		X						14
7. Wide Band/Narrow Band Selectable	X	X	X		X	X		71
8. Memory Storage of Selected Frequencies	X		X		X			43
9. Displays Associated ECM/DECM Operating Frequencies					X			14
10. Displays Direction of Arrival of Signals	X		X					28
PERCENT APPLICABLE FEATURES	60	70	60	0	70	60	0	
DIRECTION FINDING DISPLAY:								
1. Quadrature Indicating Lights				X	X			28
2. Polar Coordinate Display	X	X	X	X		X	X	86
3. Antenna Bearing Indicators	X	X	X				X	57
4. Radial Bearing Strobes	X		X	X			X	57
5. Antenna Steering Controls	X	X	X		X		X	71
6. Alpha Numeric Indicators						X		14
7. Direction Finding by Visual Video Amplitude Comparison	X	X				X		43
8. Direction Automatically Displayed	X	X	X	X	X	X	X	100
9. Direction Determined by Manual Control	X	X	X		X	X	X	86
10. Multiple Signals Displayed	X	X	X	X	X	X	X	100
11. Single Signals Displayed		X	X		X	X		43
12. Simultaneous Multiple Frequency Band Display		X	X	X	X	X	X	86
13. Single Frequency Band Display	X	X	X	X	X		X	86
14. Manually Selected Frequency Band Display	X	X	X	X	X		X	86
15. Coordinates Type of Threat with Direction	X	X	X	X	X	X		86
16. Frequency vs. Bearing Display		X			X	X		43
17. Relative Range to Emitter vs. Bearing Display			X	X				28
PERCENT APPLICABLE FEATURES	65	76	70	59	64	59	59	

TASK FUNCTION	SUIT							PERCENT COMMONALITY ALL SUITS
	A	B	C	D	E	F	G	
PULSE ANALYZER:								
1. Manually Tune Receiver for Display of Signal	X	X	X		X	X	X	86
2. Receiver Automatically Displays Selected Signal	X	X	X		X	X	X	86
3. Signal Automatically Synchronized for Display						X		14
4. Signal Manually Synchronized for Display	X	X	X		X		X	71
5. Pulse Width and PRF Displayed Simultaneously	X	X	X		X	X	X	86
6. System Automatically Determines Pulse Width						X		14
7. Operator Determines Pulse Width	X	X	X		X		X	71
8. System Automatically Determines PRF						X		14
9. Operator Determines PRF	X	X	X		X		X	71
PERCENT APPLICABLE FEATURES	67	67	67	0	67	67	67	
AUDIO OUTPUT:								
1. Audio Supplied to Equipment Operator	X	X	X	X	X		X	86
2. Audio Supplied to Recording System	X	X	X				X	57
3. Audio Used as Threat Identification Aid	X	X	X	X	X		X	86
4. Audio Used for Determining Threat Operating Mode	X	X	X	X	X		X	86
5. Audio Used as Alert/Lethal Danger Alarm	X		X	X	X			57
PERCENT APPLICABLE FEATURES	100	80	100	80	80	0	80	
VIDEO RECORDING:								
1. Operator Controlled Recording Times		X					X	28
2. Non-Real Time Data Playback/Analysis		X					X	28
3. Recording of Selected Data		X					X	28
4. Recording of All Video		X					X	28
5. Multiple Track		X					X	28
PERCENT APPLICABLE FEATURES	0	100	0	0	0	0	100	
AUDIO RECORDING:								
1. Operator Controlled Recording Times	X	X	X				X	57
2. Recording of Operator Selected Data	X	X	X				X	57
3. Non-Real Time Data Playback/Analysis	X	X	X				X	57
4. Multiple Track Recording	X	X	X				X	57
PERCENT APPLICABLE FEATURES	100	100	100	0	0	0	100	

TASK FUNCTION	SUIT							PERCENT COMMONALITY ALL SUITS
	A	B	C	D	E	F	G	
AUDIO SIGNAL SORTING:								
1. Sorts Signals by Frequency		X	X	X	X	X	X	86
2. Sorts Signals by PRF		X	X	X	X	X	X	86
3. Sorts Signals by Pulse Width		X		X	X	X	X	71
4. Sorts Signals by Scan Type/Function			X	X	X		X	57
5. Sorts Signals by Multiple Interrelated Frequencies							X	14
6. Sorts Signals by Pulse Group Codes				X	X		X	43
7. Sorts Signals by Intra Pulse Modulation (Chirp-Pulse Compression, etc.)							X	14
8. Sorts Signals by Other Than Pulse Modulation Characteristics (AM, FM, etc.)							X	14
9. Determines Threat of Friendly		X	X	X	X	X	X	86
PERCENT APPLICABLE FEATURES	0	44	44	67	67	44	100	
AUTO THREAT REACTIVE SYSTEM:								
1. Determines if Signal is a Threat		X	X	X	X	X		71
2. Alerts Operator to Threat	X	X	X	X	X	X		86
3. Provides Appropriate Response to Threat	X	X	X	X	X	X		86
a. Auto	X	X	X	X	X	X		86
b. Auto Override		X	X	X	X			57
c. Manual	X	X	X	X	X	X		86
4. Indicates Effectiveness of Countermeasure			X	X	X	X		57
5. Provides Data to Command and Control Positions		X	X	X	X	X		71
PERCENT APPLICABLE FEATURES	80	87	100	100	100	87	0	

TASK FUNCTION	SUIT								PERCENT COMMONALITY ALL SUITS
	A	B	C	D	E	F	G	H	
DATA ANALYSIS BY OPERATOR:									
1. Determines Frequency	X	X	X		X	X	X		86
2. Determines Modulation Type	X	X	X		X		X		71
3. Determines Scan Type By Audio/Video Analysis	X	X	X	X	X		X		86
4. Determines Pulse Repetition Frequency	X	X	X		X	X	X		86
5. Determines Pulse Width	X	X	X		X	X	X		86
6. Determines Bearing to Signal	X	X	X		X	X	X		86
7. Determines Type & Function of Signal	X	X	X		X	X	X		86
8. Logs Data for Further Analysis	X	X	X			X	X		71
9. Records Data (Tape) for Future Analysis	X	X	X				X		57
10. Make Scope Photographs of Signal	X	X	X				X		57
11. Complete Signal Analysis Requiring Multiple Operators/Equipment	X	X	X		X		X		71
12. Evaluates Computer Generated Data					X	X			28
13. Determines Threat Identity by Analysis of All Data	X	X	X	X	X	X	X		100
14. Observes Band Warning for Presence of Signal	X	X	X	X	X	X	X		100
15. Observes Audio Warning for Presence of Signal	X	X	X	X	X		X		86
16. Observes Coded Display for Bearing to Signal					X	X			28
17. Observes Audio/Visual Warning of Variation in Threat Modes	X		X	X	X		X		71
18. Determines Signal Jammer Display Coincidence					X				14
19. Determines Threat Parameters and Boundary Conditions	X		X		X	X	X		71
20. Determines Approximate Distance to Emitter			X	X	X				43
21. Aids in Development of Electronic Order Of Battle	X	X	X	X	X	X	X		100
22. Analysis of Intelligence Data to Aid Operations	X	X	X	X	X	X	X		100
23. Analysis of Friendly Emitters to Aid Operations	X	X	X		X	X	X		86
24. Determines Proper Response to Threat		X		X	X				43
25. Advises Superiors of EW Conditions	X	X	X		X	X	X		86
26. Monitors Own Equipment Status/Capabilities/Limitations	X	X	X	X	X	X	X		100
27. Interfaces with Other Functional Departments	X	X	X	X	X	X	X		100
PERCENT APPLICABLE FEATURES	81	78	85	41	89	63	81		

TASK FUNCTION	SUIT							PERCENT COMMONALITY ALL SUITS
	A	B	C	D	E	F	G	
COMPUTER AIDED:								
1. Variable Program					X	X		28
2. Mission Dependent Program					X	X		28
3. Operator Entered Program						X		14
4. Program Entered By Other Than Operator					X	X		28
5. Real Time Programmable					X	X		28
6. Operator Enters New Data					X	X		28
7. Operator Modifies Old Data					X	X		28
8. Operator Requests Data					X	X		28
9. Program Initialization Data					X	X		28
a. Threat Parameters					X	X		28
b. Defensive Measures Available					X			14
c. System Status					X	X		28
d. Priority of Threats					X	X		28
e. System Priorities					X			14
f. Frequency Lock-Out					X	X		28
g. Frequency Set on Demand					X			14
10. Output Processed Data					X	X		28
a. Provides Display Data					X	X		28
b. Provides Threat Identity					X	X		28
c. Provides Countermeasure Recommendation						X		14
d. Provides Auto Selection of Countermeasures					X	X		28
e. Provides Alpha Numeric Readout					X	X		28
f. Provides Threat Location Data					X	X		28
g. Provides Own System Status					X			14
h. Provides Threat File					X			14
i. Indicates Unidentified Emitters					X	X		28
PERCENT APPLICABLE FEATURES	0	0	0	0	92	80	0	

APPENDIX D

PRELIMINARY CURRICULUM

BASIC EW OPERATOR COURSE

I. BASIC PHASE

A. SCHOOL INTRODUCTION

1. ORIENTATION
2. CHECK IN
3. SCHOOL PROCEDURES
4. ADMINISTRATIVE

B. MATHEMATICS - STUDENT WILL DEMONSTRATE:

1. ABILITY TO SOLVE ALGEBRAIC EQUATIONS

C. BASIC ELECTRONICS

1. DIRECT CURRENT - Student will understand:
 - a. Principles of electrostatic fields
 - b. Principles of voltage
 - c. Conductivity and related electromagnetic fields
2. RESISTANCE AND POWER - Student will understand:
 - a. Principles of resistance
 - b. How current flow causes IR drop
 - c. How power is dissipated by resistors
 - d. OHM's Law
3. SERIES CIRCUITS - Student will:
 - a. Understand Kirchoff's Voltage Law
 - b. Be able to solve for current, voltage and resistance

4. PARALLEL CIRCUITS - Student will:
 - a. Understand Kirchoff's Current Law
 - b. Be able to solve for current, resistance and voltage valleys
 - c. Understand simple series-parallel circuits
5. ALTERNATING CURRENT - Student will:
 - a. Possess familiarity with sinusoidal wave-shape and its generation
 - b. Understand principles of alternating current and voltage
 - c. Possess familiarity with the characteristics of average and effective voltage, current and power
6. TRANSFORMERS - Student will:
 - a. Be familiar with theory of transformers
 - b. Compute output voltage and current of simple transformer
 - c. Understand transformer efficiency
 - d. Understand use of transformers as impedance matching devices
7. INDUCTORS - Student will be familiar with:
 - a. Characteristics of current flow through an inductor
 - b. How voltage varies across an inductor
 - c. Principles of inductive reactance
8. CAPACITORS - Student will be familiar with:
 - a. Characteristics of current flow through a capacitor
 - b. How voltage varies across a capacitor
 - c. Principles of capacitive reactance
 - d. Time constants

9. PARALLEL RESONANCE - Student will:
 - a. Understand principles of parallel resonance
 - b. Be familiar with the frequency selectivity and the "Q" factor of a parallel LC circuit
 - c. Determine resonant frequency of LC circuit
10. RELAYS - Student will be familiar with:
 - a. Switching relays
 - b. Overload and underload relays
11. SOLID STATE PHYSICS - Student will understand:
 - a. Characteristics of quadivalent crystal structures
 - b. Current flow in doped semiconductor
12. DIODES - Student will:
 - a. Understand relationship between current flow and voltage in a PN junction
13. RECTIFIERS - Student will understand operation of:
 - a. Half-wave rectifier
 - b. Bridge rectifier
14. FILTERS - Student will understand operation of:
 - a. Capacitor as a filter
 - b. An inductive choke
15. VOLTAGE REGULATORS - Student will:
 - a. Understand operation of Zener diode as a voltage regulator
16. TRANSISTORS - Student will:
 - a. Be familiar with theory of junction transistor operation
 - b. Understand relationship between emitter, collector and base currents

17. AMPLIFIERS - Student will:
 - a. Understand common emitter amplifier and current/voltage relationship
18. AMPLIFIER CHARACTERISTICS - Student will:
 - a. Understand use of decibels as measure of power
 - b. Be familiar with factors that affect frequency response and bandwidth
 - c. Be familiar with distortion and noise and their effect on amplifier fidelity
 - d. Be familiar with classes of amplifiers; use, frequency, and bias levels
19. OSCILLATORS - Student will be familiar with:
 - a. Function of an oscillator
 - b. Characteristics of tuned-based oscillator
 - c. Characteristics of Wein-Bridge oscillator
20. WAVESHAPING CIRCUITS - Student will understand the diagrams and output waveshapes of:
 - a. Free-running blocking oscillator
 - b. Synchronized blocking oscillator
 - c. Blocked oscillator
 - d. One-shot multivibrator
 - e. Collector-coupled multivibrator
 - f. Gated sawtooth waveshape generator
 - g. Gated trapezoidal waveshape generator
 - h. Biased and unbiased clippers

21. CATHODE-RAY TUBES - Student will:

- a. Be familiar with the principles and operating characteristics of electrostatic and electromagnetic cathode-ray tubes and their use as information-presenting devices

22. BASIC ELECTRONICS EXAMINATION

23. CRITIQUE

D. ELECTRONIC TRANSMISSION AND RECEPTION

1. TRANSMISSION LINES - Student will:

- a. Be familiar with theory of operation of transmission lines
- b. Be able to describe the characteristic impedance of transmission lines

2. REFLECTIONS IN TRANSMISSION LINES - Student will understand:

- a. Reflections created by:
 - (1) Open terminals and terminal impedance greater than characteristic impedance
 - (2) Short circuit terminations and terminal impedances less than the characteristic impedance
- b. Formation of standing waves created by these reflections

3. USE OF TRANSMISSION LINES - Student will be familiar with how transmission lines are used as:

- a. Insulators
- b. Impedance matching devices

- c. Resonant circuits
 - d. Delay lines
 - e. Pulse-forming networks
4. ELECTROMAGNETIC RADIATION - Student will:
- a. Understand how standing waves are formed on a dipole antenna
 - b. Understand basic theory of antenna radiation
 - c. Be able to determine the polarization of an antenna from data pertaining to the antenna's radiated field
 - d. Be familiar with circular polarization
5. BASIC CONTINUOUS WAVE TRANSMISSION AND RECEPTION - Student will:
- a. Be introduced to the electromagnetic frequency spectrum
 - b. Understand signal flow through a block diagram of basic CW transmitter
 - c. Understand theory of operation and requirement for the following stages of a CW transmitter:
 - (1) Buffer amplifier
 - (2) Frequency multiplier
 - (3) Driver amplifier
 - (4) Power amplifier
 - d. Understand the characteristics of a basic CW receiver
 - e. Be familiar with how a tuned radio frequency receiver operates and its advantages

6. CONVENTIONAL AMPLITUDE MODULATION - The student will:
 - a. Be able to define term modulation
 - b. Be able to define term heterodyne
 - c. Understand conventional amplitude modulation
 - d. Understand operation of a diode detector
 - e. Be familiar with the operation of an automatic volume control
7. PULSE MODULATION - Student will:
 - a. Describe how a rectangular wave may be composed of sine waves
 - b. Understand pulse modulation
8. HETERODYNE RECEIVERS - Student will:
 - a. Understand operation of heterodyne receiver
 - b. Be familiar with what images are and how they are produced
9. SINGLE SIDEBAND MODULATION - Student will be familiar with:
 - a. Characteristics of single sideband modulation
 - b. Advantages and disadvantages of single sideband
 - c. How single sideband detection is accomplished
10. FREQUENCY MODULATION - Student will be familiar with:
 - a. The characteristics of frequency modulation
 - b. How frequency modulation detection is accomplished
 - c. Operation of automatic frequency control

11. WAVEGUIDES - Student will:
 - a. Be familiar with the propagation of electromagnetic energy through a waveguide
 - b. Be introduced to methods of inserting and removing electromagnetic energy from a waveguide
 - c. Be familiar with waveguide's size to frequency relationship
 - d. Be familiar with operation and use of duplexers
 - e. Be familiar with operating principles of resonant cavities
12. MICROWAVE AMPLIFIERS - Student will be familiar with operation, capabilities, limitations, and application of:
 - a. Distributed amplifiers
 - b. Parametric amplifiers
13. KLYSTRONS - Student will be familiar with operation, capabilities, limitations, and applications of:
 - a. The Klystron amplifier
 - b. The reflex Klystron oscillator
14. TRAVELING-WAVE TUBE AMPLIFIERS AND BACKWARD-WAVE-OSCILLATORS - Student will be familiar with operation, capabilities, limitations, and application of:
 - a. Traveling-wave tube amplifiers
 - b. "O" type backward-wave oscillators
15. CROSSED-FIELD DEVICES - Student will be familiar with operation, capabilities, limitations, and application of the:

- a. "M" type backward-wave oscillator
- b. Magnetron oscillator

16. MICROWAVE ANTENNAS - Student will:

- a. Be able to define:
 - (1) Isotropic antenna
 - (2) Antenna gain
 - (3) Antenna radiation pattern
- b. Be familiar with representative types of:
 - (1) Parabolic antennas
 - (2) Lens antennas
 - (3) Slot antennas
 - (4) Horn antennas
 - (5) Driven arrays
 - (6) Parasitic arrays

17. ELECTRONIC TRANSMISSION AND RECEPTION EXAMINATION

18. CRITIQUE

E. RADAR SYSTEMS

- 1. RADAR PRINCIPLES - Student will understand the basic theory of operation of a pulsed radar set.
- 2. BASIC RADAR TRANSMITTER-RECEIVERS - Student will be able to understand and/or describe the functions of the following components of a magnetron radar set and resultant parameters:
 - a. Radar Transmitter
 - (1) Timer

- (2) Modulator
 - (3) Magnetron
 - b. Radar Receiver
 - (1) Mixer-local oscillator
 - (2) AFC circuits
 - (3) IF amplifier
 - (4) Second detector
 - (5) Video amplifier
 - (6) STC circuit
 - c. Basic radar parameters
 - (1) Basic pulse recurrence frequency
 - (2) Relationship between radar's PRF and equipment's capability
 - (3) How circular and sector scanning radars operate
 - (4) Sweep/Nod duration on circular and sector scanning radars
 - (5) Relationship of radar's sweep rate to its function
 - (6) Relationship of radar's PRF to its function
 - (7) The differences in parameters for typical early warning, height finder and precision radars
3. BASIC RADAR INDICATORS - Student will:
- a. Be able to describe functions of radar indicator channel
 - b. Be familiar with types of radar displays
4. POWER AMPLIFIER RADARS - Student will be able to:

- a. List advantages of power amplifier radar
 - b. Draw block diagram of a power amplifier radar
5. SPECIALIZED RADAR SYSTEMS - Student will:
- a. Understand principles and advantages of pulse compression
 - b. Understand Doppler effect
 - c. Draw block diagram of basic CW Doppler radar
 - d. Understand FM/CW Doppler principles
 - e. Understand principle of a moving target indicator
 - f. Draw block diagram of a coherent moving target indicator radar
 - g. Be familiar with operation of a non-coherent moving indicator
6. IDENTIFICATION FRIEND OR FOE (IFF) - Student will be familiar with the operation and advantages of beacon systems (IFF).
7. TRACKING RADARS - Student will be able to:
- a. Describe the following tracking radars:
 - (1) Conical scan
 - (2) Monopulse
 - (3) Track-While-Scan
 - b. Compare capabilities and limitations of each type of tracking radar.
8. COMPUTER APPLICATION - Student will be familiar with:
- a. Basic theory of analog and digital computers
 - b. Application of computers to early warning, intercept, traffic control and fire control operations
9. RADAR SYSTEMS EXAMINATION
10. CRITIQUE

II. INTERMEDIATE PHASE

A. ELECTRONIC WARFARE FUNCTION, ORGANIZATION, AND PROCEDURES

1. ELECTRONIC WARFARE FUNCTION

a. Scope - Student will understand:

- (1) Use of EW to determine hostile activity
- (2) Exploitation of hostile use of electromagnetic spectrum
- (3) Naval use of electromagnetic spectrum

b. Divisions - Student will become familiar with:

- (1) Electronic Warfare Support Measures (ESM)
- (2) Electronic Countermeasures (ECM)
- (3) Electronic Counter-Countermeasures (ECCM)

c. Objectives - Student will understand Navy's end objectives to be attained in the use of EW

2. ELECTRONIC WARFARE ORGANIZATION

a. U. S. Navy - Student will understand how the following organizations/commands relate to Electronic Warfare

- (1) Chief of Naval Operations
- (2) Naval Material Command
- (3) Fleet Command and Chiefs
- (4) Type Commanders
- (5) Officer in Tactical Command
- (6) Task Force/Group Commander
 - (a) Operations Officer
 - (b) CIC Officer

- (c) EW Officer
- (d) Watch Officer
- (7) Unit Commanding Officer
 - (a) Operations Officer
 - (b) CIC Officer
 - (c) EW Officer
 - (d) Electronic Maintenance Officer
 - (e) EW Watch Supervisor
 - (f) Intercept Search Operator
 - (g) Assistant Intercept Search Operator
 - (h) EW Reporting Net Recorder
 - (i) EW Plotter
 - (j) Status Board Keeper
 - (k) Weapons Officer
 - (l) ASW Officer
 - (m) Fire Control Officer
- b. U.S. Air Force - Student will be familiar with the EW Mission, task and objectives of this service
- c. U.S. Army - Student will be familiar with the EW mission, task and objectives of this service
- d. U.S. Marines - Student will be familiar with the EW mission, task and objectives of this service
- e. Special Units - Student will understand how the following organizations contribute to the accomplishment of EW

- (1) Intelligence Community
 - (a) Information gathered
 - (b) Publications and use
- (2) Beach Jumper Units
- (3) Fleet Electronic Warfare Support Group

3. EW PROCEDURES

- a. Policy - Student will understand the reason for and policy concerning the following:
 - (1) Emission Control (EMCON)
 - (2) Electronic Intelligence (ELINT)
 - (3) Signal Intelligence (SIGINT)
 - (4) Communications Intelligence (COMINT)
 - (5) Security
- b. Operational Concepts - Student will understand:
 - (1) Significance of EW in manual operations
 - (2) The use of:
 - (a) ESM
 - (b) ECM
 - (c) ECCM
 - (3) The significance of:
 - (a) Planning
 - (b) Establishing requirements for EW
 - (c) Coordination between units/forces
 - (d) Reporting

4. Electronic Warfare Function, Organization, and Procedures
Examination

5. Critique

B. INTRODUCTION TO DEFENSE SYSTEMS

1. ELEMENTS OF DEFENSE SYSTEMS (PART I)

The student will:

- a. Be familiar with general Passive (ESM) detection capabilities
- b. Be familiar with general Active (Radar) detection capabilities

2. ELEMENTS OF DEFENSE SYSTEMS (PART II)

The students will:

- a. Be familiar with an overall view of a typical Naval weapon system; e.g., a typical ship's sensors and weaponry.
- b. Be familiar with an overall view of a typical shore based Air defense system; e.g., a typical shore based Air defense sensors and weaponry.
- c. Be familiar with an overall view of a typical airborne weapon system; e.g., a typical strike aircraft's sensors and weaponry.

3. ELEMENTS OF DEFENSE SYSTEMS (PART III)

The student will:

- a. Be familiar with typical command and control systems which link together the Naval, shore based and airborne defense systems.

- b. Be familiar with typical data processing capabilities found in a typical command and control system.
- c. Be familiar with variations in capabilities typically found in various defense systems.

C. SIGNAL RECOGNITION CONCEPTS

1. INTRODUCTION TO SIGNAL RECOGNITION

The student will:

- a. Understand the need and importance for and use of audio analysis information
- b. Be familiar with basic pulse recurrence frequencies (PRF's)
- c. Understand the relationship between a radar's PRF and its capabilities and limitations

2. BASIC RADAR PARAMETERS

The student will:

- a. Understand how circular and sector scanning radars operate
- b. Be able to measure sweep/nod duration on circular and sector scanning radars
- c. Understand the relationship of a radar's sweep rate to its function
- d. Be able to explain the relationship of a radar's PRF to its function

3. U. S. NAVAL EARLY WARNING RADARS

The student will be:

- a. Familiar with the various types of U. S. Naval surface and airborne early warning (EW) radars

- b. Able to recognize various U. S. Naval surface and airborne EW radars from their audio characteristics

4. U. S. NAVAL HEIGHT FINDER RADARS

The student will:

- a. Be familiar with the various types of U. S. Naval height finder (HF) radars
- b. Be able to recognize U. S. Naval HF radar from their audio characteristics

5. U. S. NAVAL FIRE CONTROL/MISSILE GUIDANCE RADARS

The student will:

- a. Be familiar with the various U. S. Naval fire control (FC)/missile guidance (MG) radars
- b. Be able to recognize U. S. Naval FC/MG radars from their audio characteristics

6. U. S. NAVAL AIRBORNE INTERCEPT RADARS

The student will:

- a. Understand the relationships of radio frequency (RF), pulse recurrence frequency (PRF), and pulse width (PW) used in U. S. Naval airborne intercept (AI) radars
- b. Be familiar with the types of complex scans used with AI radars
- c. Be familiar with U. S. Naval AI radar audio characteristics

7. U. S. NAVAL AIRBORNE INTERCEPT RADARS

The student will:

- a. Be able to recognize AI radar audio characteristics

- b. Be familiar with the various types of U. S. Naval airborne radars
- c. Be able to recognize AI radar signals in a typical complex airborne radar environment

8. U. S. NAVAL SHIPBORNE RADAR SIGNAL RECOGNITION

The student will be able to identify:

- a. All the U. S. Naval radar signals previously introduced
- b. Various types of U. S. Naval radar signals in a complex signal environment

9. SIGNAL RECOGNITION PROGRESS CHECK

The student will be able to identify without assistance the uses of given U. S. Naval radars from their audio presentations

10. HOSTILE NONTREAT RADARS

The student will be able to recognize hostile EW, HF and acquisition radars and their audio characteristics

11. HOSTILE SURFACE-TO-AIR FIRE CONTROL AND SURFACE-TO-AIR MISSILE RADARS

The student will be familiar with the various types of hostile surface-to-air (SAM) radars and their audio presentations

12. HOSTILE SURFACE-TO-AIR FIRE CONTROL AND SURFACE-TO-AIR MISSILE RADAR SIGNAL RECOGNITION

The student will be able to recognize SAM radars from their audio presentations

13. HOSTILE SURFACE-TO-SURFACE FIRE CONTROL/MISSILE-GUIDANCE RADARS

The student will be familiar with the various types of hostile surface-to-surface fire control/missile-guidance radars and their audio presentations

14. HOSTILE SURFACE-TO-SURFACE FIRE CONTROL/MISSILE GUIDANCE RADAR SIGNAL RECOGNITION

The student will be able to recognize hostile surface-to-surface fire control/missile guidance radars and their audio presentations

15. HOSTILE AIRBORNE EARLY WARNING AND AIRBORNE INTERCEPT RADARS

The student will be familiar with the various types of hostile airborne early warning and airborne intercept radars and their audio presentations

16. HOSTILE AIRBORNE EARLY WARNING AND AIRBORNE INTERCEPT RADAR SIGNAL RECOGNITION

The student will be able to recognize hostile airborne early warning and airborne intercept radars and their audio recognitions

17. HOSTILE THREAT AND NONTREAT SIGNALS

The student will be:

- a. Familiar with additional types of hostile signals, including IFF, data link, telemetry, special purpose radars and other nonradar signals
- b. Able to identify the above signals from their audio characteristics

18. SIGNAL RECOGNITION EXAMINATION

The student will demonstrate proficiency in identifying hostile radars from their audio presentations

19. CRITIQUE

The student will be critiqued on any weak areas reflected by the examination

D. ELECTRONIC WARFARE CONCEPTS

1. INTRODUCTION TO ELECTRONIC WARFARE SUPPORT MEASURES (ESM)

The student will:

- a. Be able to define the three division of electronic warfare
- b. Understand the definition and purpose of ESM

2. THE ESM RECEIVER

The student will:

- a. Understand the purpose and characteristics of typical ESM receivers
- b. Be familiar with the block diagram of a typical ESM receiver
- c. Understand the functions of typical operator controls on an ESM receiver

3. THE ESM PULSE ANALYZER

The student will:

- a. Understand the purpose and characteristics of a typical ESM pulse analyzer

- b. Be familiar with the block diagram of a typical ESM pulse analyzer
 - c. Be familiar with typical operator controls on an ESM pulse analyzer
 - d. Understand how to read information from a typical ESM pulse analyzer
4. ESM DIRECTION FINDING (DF) TECHNIQUES AND EQUIPMENT
- The student will:
- a. Understand the need for DF equipment
 - b. Understand the principles of operation of typical DF equipment
 - c. Be familiar with the block diagram of a typical DF set
 - d. Understand how to use a typical DF set
 - e. Be familiar with new DF techniques
5. THE ESM RECORDER
- The student will:
- a. Understand the purpose and characteristics of a typical ESM recorder
 - b. Be familiar with the block diagram of a typical ESM recorder
 - c. Understand how to use a typical ESM recorder and associated equipment
 - d. Be familiar with the principles of typical video recorders

6. ESM COMPUTER APPLICATIONS

The student will be familiar with typical applications of computers to ESM

7. INTRODUCTION TO ELECTRONIC COUNTERMEASURES (ECM)

The student will understand the definition and purpose of ECM

8. ECM RECEIVERS

The student will be familiar with:

- a. The purpose of typical ECM warning and search receivers
- b. The characteristics of ECM warning and search receivers

including:

- (1) Functions of typical operator controls
- (2) Typical scope displays
- (3) Advantages, capabilities and limitations

9. ECM TRANSMITTERS

The student will:

- a. Be familiar with the theory and effects of ECM
- b. Understand the block diagrams and characteristics of typical ECM transmitters
- c. Understand the block diagrams and characteristics of typical ECM modulation equipment
- d. Be familiar with the principles of repeater and transponder equipment
- e. Be familiar with the applications and limitations of ECM

10. MECHANICAL ECM EQUIPMENT

The student will be familiar with the theory, effects, applications and limitation of the following mechanical ECM devices:

- a. Chaff
- b. Reflectors
- c. Decoys
- d. Flares

11. INTRODUCTION TO ELECTRONIC COUNTER-COUNTERMEASURES (ECCM)

The student will be familiar with the principles, applications, and limitations of:

- a. Transmitter ECCM techniques
- b. Receiver ECCM techniques
- c. Receiver antinoise circuits

12. ECM COMPUTER APPLICATIONS

The student will be familiar with typical applications of computers to electronic countermeasures

13. ELECTRONICS WARFARE CONCEPTS EXAMINATION

14. CRITIQUE

E. FUNDAMENTAL ELECTRONIC WARFARE SUPPORT MEASURES (ESM)

1. INTRODUCTION TO FUNDAMENTAL ESM SYSTEMS, THE AUDIO RECORDER, AND THE INTERCOM

The student will understand:

- a. What equipment is necessary for a basic ESM System.
- b. The signal flow through a basic ESM System block diagram.
- c. The following aspects of the recorder and intercom system.

- (1) Their purposes, uses, and characteristics

- (2) The function of each operator control
- (3) Common equipment malfunctions, their operator indications and corrective actions

2. THE SWEPT NARROWBAND RECEIVER

The student will:

- a. Understand the purpose, use and characteristics of the swept narrowband receiver
- b. Be familiar with the function of typical operator controls.
- c. Be familiar with the signal flow through the functional block diagram
- d. Be familiar with common equipment malfunctions, their operator indications and corrective actions.

3. THE MULTI-BAND SCANNING RECEIVER

The student will:

- a. Understand the purpose, use and characteristics of the multi-band scanning receiver
- b. Be familiar with the function of typical operator controls.
- c. Be familiar with the signal flow through the functional block diagram
- d. Be familiar with common equipment malfunctions, their operator indications and corrective actions

4. THE BROADBAND DISCRIMINATOR (INSTANTANEOUS FREQUENCY MEASURING (IFM)) RECEIVER

The student will:

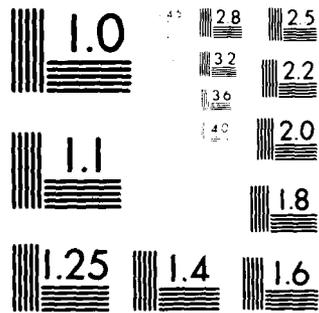
- a. Understand the purpose, use and characteristics of the IFM receiver
- b. Be familiar with the function of typical operator controls
- c. Be familiar with the signal flow through the functional block diagram
- d. Be familiar with common equipment malfunctions, their operator indications and corrective actions

5. THE PULSE ANALYZER

The student will:

- a. Understand the purpose, use and characteristics of the typical pulse analyzer
- b. Be able to read the indicator displays
- c. Be familiar with the function of typical operator controls
- d. Be familiar with the signal flow through the functional block diagram
- e. Be familiar with common equipment malfunctions, their operator indications and corrective action

6. EQUIPMENT READINESS CHECK AND MALFUNCTION DEMONSTRATION



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

The student will:

- a. Understand the purpose, use and characteristics of a typical pulse analyzer
- b. Be familiar with the signal flow through the functional block diagram
- c. Be familiar with the function of typical operator controls
- d. Be familiar with common equipment malfunctions, their operator indications and corrective actions.

7. ESM EQUIPMENT READINESS CHECK AND MALFUNCTION RECOGNITION

The student will understand:

- a. The equipment readiness check procedures for a typical direction finder, typical swept narrowband, multi-band scanning, IFM receivers, and pulse analyzers using an amplified checklist.
- b. Specific (common) direction finder equipment malfunctions, their operator indications and corrective actions.
- c. Specific (common) ESM system equipment malfunctions, their operator indications and corrective actions

8. SIGNAL ANALYSIS

The student will:

- a. Know the general parameters and characteristics of common types of radar to include:
 - (1) Early warning (EW) radars
 - (2) Height finder (HF) radars
 - (3) Surface search (navigation) radars
 - (4) Precision tracking radars

(5) Pulse Code Modulation (PCM)

9. ESM REQUIREMENTS

The student will:

- a. Be able to describe the types of ESM search and search rates
- b. Understand mission planning procedures used with each type of search
- c. Understand operational procedures used with each type of search
- d. Understand operational use of preplanned bearings for specific radar search missions

10. ESM SIMULATOR FAMILIARIZATION

The student will be familiar with the ESM simulator instructor's console, student stations and general signal flow to the student stations.

11. ESM SIMULATION MISSION REQUIREMENTS AND PROCEDURES

The student will:

- a. Be familiar with the publication and materials used in ESM simulator mission planning
- b. Understand ESM simulator mission requirements
- c. Understand ESM simulator procedures

12. ESM SIMULATOR ORIENTATION

The student will:

- a. Be familiar with the operation of the three primary ESM receivers and associated analysis, DF and recording equipment

b. Understand equipment readiness checks for the above ESM simulator equipments

c. Understand common simulated malfunctions which can be encountered during ESM equipment operation

13. ESM MISSION NUMBER ONE

The student will be able to:

a. Perform equipment readiness check of the laboratory ESM systems using the amplified checklist

b. Perform equipment readiness check of the laboratory ESM systems using an abbreviated checklist

c. Recognize common equipment malfunctions and identify the cause

d. Analyze selected signals with maximum assistance

14. SIGNAL ANALYSIS SEQUENCE AND ESM LOG PROCEDURES

The student will:

a. Understand the proper signal analysis sequence

b. Understand how to complete an ESM log

c. Be able to plot bearings to obtain a fix using data obtained from an ESM mission

15. ESM MISSION NUMBER TWO

The student will be able to:

a. Perform equipment readiness check of the laboratory ESM systems using the abbreviated checklist

b. Analyze signals with maximum assistance

c. Complete an ESM log

d. Recognize equipment malfunctions and identify the cause

16. ESM MISSION PLANNING

The student will be able to:

- a. Construct a mission profile and complete a mission chart
- b. Complete an ESM mission plan
- c. Use correct log procedures
- d. Plot signal bearings to obtain fixes using ESM data

17. SIGNAL SEPARATION TECHNIQUES

The student will understand:

- a. The theory of various signal separation techniques
- b. How to use the various signal separation techniques
- c. When to employ various signal separation techniques

18. ESM MISSION NUMBER THREE

The student will be able to:

- a. Perform equipment readiness check of the laboratory ESM systems using the abbreviated checklist
- b. Use correct signal analysis and signal separation techniques to analyze signals
- c. Complete an ESM log
- d. Recognize equipment malfunctions and identify the cause

19. ESM MISSION POST ANALYSIS EQUIPMENT

The student will be familiar with:

- a. The purpose and use of ELINT data
- b. The basic analytic equipments used in electronic intelligence
- c. The capabilities and limitations of commonly utilized analytic equipments

- d. The general procedures utilized in analyzing ELINT data

20. ESM MISSION NUMBER FOUR

The student will be able to:

- a. Perform equipment readiness check of the laboratory ESM systems using the abbreviated checklist.
- b. Analyze signals with maximum assistance
- c. Complete an ESM log
- d. Recognize equipment malfunctions and identify the cause

21. ESM POST ANALYSIS PROCEDURES

The student will:

- a. Perform readiness check of the laboratory signal data analysis equipment using the amplified checklist
- b. Perform readiness check of the laboratory signal data analysis equipment using an abbreviated checklist
- c. Perform analysis of previously recorded (prior lab) signals with maximum assistance
- d. Begin to appreciate the needed quality of recorded data required for adequate ELINT signal analysis

22. U. S. AIRBORNE WEAPON SYSTEMS

The student will be familiar with:

- a. The radar characteristics and parameters of selected (common) U. S. airborne weapon systems
- b. Basic airborne tactical employment

- c. General capabilities and limitations of U. S. airborne weapon systems

23. ESM MISSION NUMBER FIVE

The student will be able to:

- a. Perform equipment readiness check of the laboratory ESM systems using the abbreviated checklist
- b. Analyze signals with maximum assistance
- c. Complete and ESM log
- d. Recognize equipment malfunctions and identify the cause

24. U. S. SURFACE WEAPON SYSTEMS

The student will be familiar with:

- a. The radar characteristics and parameters of selected (common) U. S. shipborne weapon systems
- b. Basic shipborne tactical employment
- c. General capabilities and limitations of U. S. shipborne weapon systems

25. ESM POST ANALYSIS PROCEDURES

The student will:

- a. Perform readiness check of the laboratory signal data analysis equipment using an abbreviated checklist
- b. Understand the purpose and procedures required for basic analysis of signals
- c. Perform analysis of previously recorded (prior lab) signals with maximum assistance

- d. Appreciate the needed quality of recorded data required for adequate ELINT signal analysis

26. U. S. SURFACE-TO-AIR WEAPON SYSTEMS

The student will be familiar with the general capabilities, limitations, and delivery techniques of U. S. Naval surface-to-air weapon systems

27. ESM MISSION NUMBER SIX

The student will be able to:

- a. Perform equipment readiness check of the laboratory ESM systems using the abbreviated checklist
- b. Analyze signals with maximum assistance
- c. Complete an ESM log
- d. Recognize equipment malfunctions and identify the cause

28. ESM POST ANALYSIS PROCEDURES

The student will:

- a. Perform readiness check of the laboratory signal data analysis equipment using an abbreviated checklist
- b. Understand the analysis procedures and techniques required for basic analysis of signals
- c. Perform analysis of previously recorded (prior lab) signals with minimum assistance
- d. Understand and appreciate the needed quality of recorded data required for adequate ELINT signal analysis

29. ESM MISSION NUMBER SEVEN

The student will be able to:

- a. Perform equipment readiness check of the laboratory ESM systems using the abbreviated checklist
- b. Analyze signals with maximum assistance
- c. Complete an ESM log
- d. Recognize equipment malfunctions and identify the cause

30. ESM MISSION NUMBER EIGHT

The student will be able to:

- a. Perform equipment readiness check of the laboratory ESM systems using the abbreviated checklist
- b. Analyze signals with maximum assistance
- c. Complete an ESM log
- d. Recognize equipment malfunctions and identify the cause

31. EXAMINATION

32. CRITIQUE

F. ADVANCED ELECTRONIC WARFARE SUPPORT MEASURES

1. INTRODUCTION

The student will be familiar with the role of Electronic Warfare Support Measures (ESM) in U. S. military operations.

2. UNITED STATES INTELLIGENCE ORGANIZATION

The student will be familiar with:

- a. The national intelligence structure
- b. Functions within the intelligence community at national and command levels

- c. Intelligence requirements
- d. The intelligence process
- e. Intelligence estimates
- f. Intelligence information which affects electronic warfare planning

3. ELECTRONIC INTELLIGENCE (ELINT)

The student will:

- a. Understand the relationships of ESM, electronic reconnaissance, ELINT, and signal intelligence (SIGINT)
- b. Understand the purpose of ELINT
- c. Be familiar with the national ELINT Program
- d. Be familiar with the ELINT structure
- e. Be familiar with ELINT sources

4. COMMUNICATION SECURITY (COMSEC)

The student will:

- a. Understand the need for an application of COMSEC
- b. Be familiar with the COMSEC organization

5. SINO-SOVIET NAVAL SURFACE WEAPON SYSTEMS (PART I)

The student will be familiar with the Sino-Soviet Naval surface force:

- a. Organization
- b. Passive (ESM) systems
- c. Radar defense systems
- d. Electronic Counter-Countermeasures (ECCM) policy and doctrine

- e. Active (ECM) systems
- f. Defense systems (weaponry)

6. SINO-SOVIET NAVAL SURFACE FORCE WEAPON SYSTEMS (PART II)

The student will understand the Sino-Soviet surface force:

- a. Passive (ESM) capabilities
- b. Radar defense capabilities
- c. ECCM capabilities
- d. ECM capabilities
- e. Defense systems (weaponry) capabilities

7. SINO-SOVIET NAVAL SUBSURFACE WEAPON SYSTEMS (PART I)

The student will be familiar with the Sino-Soviet Naval Subsurface force:

- a. Organization
- b. Passive (ESM) systems
- c. Active (ECM) systems
- d. Electronic Counter-Countermeasures (ECCM) policy and doctrine
- e. Radar defense systems
- f. Defense systems (weaponry)

8. SINO-SOVIET NAVAL SUBSURFACE WEAPON SYSTEMS (PART II)

The student will understand the Sino-Soviet Naval Subsurface force:

- a. Passive (ESM) capabilities

- b. ECM capabilities
- c. ECCM capabilities
- d. Radar defense capabilities
- e. Defense systems (weaponry) capabilities

9. SINO-SOVIET NAVAL AIR FORCE WEAPON SYSTEMS (PART I)

The student will be familiar with the Sino-Soviet Naval Air Force:

- a. Organization
- b. Passive (ESM) systems
- c. Active (ECM) systems
- d. ECCM policy and doctrine
- e. Radar defense systems
- f. Defense systems (weaponry)

10. SINO-SOVIET NAVAL AIR FORCE WEAPON SYSTEMS (PART II)

The student will understand the Sino-Soviet Air Force:

- a. Passive (ESM) capabilities
- b. Active (ECM) capabilities
- c. ECCM capabilities
- d. Radar defense systems capabilities
- e. Defense systems (weaponry) capabilities

11. SINO-SOVIET AIR DEFENSE SYSTEMS (PART I)

The student will be familiar with the Sino-Soviet Air Defense system:

- a. Organization
- b. Passive (ESM) systems
- c. Active (ECM) systems
- d. ECCM policy and doctrine
- e. Radar defense systems
- f. Defense systems (weaponry)

12. SINO-SOVIET AIR DEFENSE SYSTEMS (PART II)

The student will understand the Sino-Soviet Air Defense:

- a. Passive (ESM) capabilities
- b. Active (ECM) capabilities
- c. ECCM capabilities
- d. Radar defense capabilities
- e. Defense systems (weaponry) capabilities

13. ELINT COLLECTION DIRECTIVES

The student will be familiar with current short range and long range ELINT collection directives

14. TACTICAL ESM COLLECTION

The student will be familiar with:

- a. Current tactical ESM collection platforms (ships, aircraft, etc.)
- b. Current tactical ESM collection systems

15. STRATEGIC ESM COLLECTION

The student will be familiar with:

a. Current strategic ESM collection platforms (ships, aircraft, etc.)

b. Current strategic ESM collections systems

16. THE TECHNICAL ESM COLLECTION EFFORT

The student will be familiar with:

a. The role of technical ELINT

b. Current technical ELINT collection equipment

17. ESM POST-MISSION REPORTS

The student will be familiar with current ESM post-mission reporting procedures and formats

18. DATA REDUCTION

The student will be familiar with:

a. Principles of data reduction and analysis

b. The capabilities of present data reduction equipment

c. Current recorder systems (photo, audio and video)

19. INTELLIGENCE PUBLICATIONS

The student will be familiar with:

a. Typical EOB/ROB publications

b. Intelligence source reference and digests

20. SINO-SOVIET ESM PROGRAMS

The student will be familiar with Sino-Soviet:

a. ESM efforts

b. ESM systems

21. EXAMINATION

22. CRITIQUE

G. FUNDAMENTAL ELECTRONIC WARFARE SUPPORT MEASURES SIMULATOR MISSIONS

NOTE: Students will accomplish two hours of mission planning prior to each fundamental simulated mission

1. FUNDAMENTAL ESM SIMULATED MISSION PLANNING (PART I)

The student will:

a. Be familiar with early warning/ground-controlled intercept (EW/GCI) elements of an air defense system

b. Understand General Area (GA) requirements

c. Understand mission planning and mission profile construction procedures

d. Be familiar with threat warning procedures

2. FUNDAMENTAL ESM SIMULATED MISSION PLANNING (PART II)

The student will:

a. Understand EW/GCI elements of the ESM simulated mission

b. Be familiar with the ground/surface ship threat environment of the ESM simulator

c. Understand Complex Problem (CP), General Area (GA), and Search and Identify (SI requirements)

d. Be able to plan the mission and construct a mission profile

e. Understand his general areas of weakness on the previous mission

3. FUNDAMENTAL ESM SIMULATED MISSION PLANNING (PART III)

The student will:

a. Understand the EW/GCI and ground/surface ship threat environment

- b. Understand the CP, GA, and SI requirements
- c. Be able to plan the mission and construct a mission profile
- d. Understand his general areas of weakness on the previous mission

4. FUNDAMENTAL ESM SIMULATOR PROFICIENCY CHECK MISSION PLANNING

The student will be able to:

- a. Plan the mission and construct a mission profile without instructor assistance
- b. Exhibit a thorough knowledge of the CP, GA, and SI requirements
- c. Exhibit a thorough knowledge of ESM operating procedures
- d. Exhibit a thorough knowledge of the ESM simulated radar environment

5. FUNDAMENTAL ESM SIMULATED PRACTICE MISSION

The student will:

- a. Be able to perform equipment readiness check procedures using the current checklist
- b. Be able to operate the three primary ESM receivers and associated analysis, DF and recording equipment
- c. Be able to complete a mission log
- d. Understand team coordination procedures
- e. Understand the Sino-Soviet radar environment
- f. Understand his specific areas of weakness

6. FUNDAMENTAL ESM SIMULATOR PROFICIENCY CHECK MISSION

The student will demonstrate proficiency in:

- a. The operation of the three primary ESM receivers and associated analysis, DF and recording equipment
- b. ESM log procedures
- c. Crew coordination procedures
- d. Knowledge of the Sino-Soviet radar environment

H. ADVANCED ELECTRONIC WARFARE SUPPORT MEASURES SIMULATOR MISSIONS

1. ADVANCED ESM SIMULATOR MISSION PLANNING (PART I)

The student will:

- a. Understand priority search requirements
- b. Be familiar with subsurface, surface, and airborne threat requirements
- c. Understand the early warning/ground-controlled intercept (EW/GCI), fire control (FC), and missile guidance (MG) threat environment
- d. Understand how to plan a priority search mission and construct a mission profile

2. ADVANCED ESM SIMULATOR MISSION PLANNING (PART II)

The student will:

- a. Understand priority search requirements
- b. Understand EW/GCI, FC and MG threat environment--shipborne, landbased and airborne
- c. Be able to plan a priority search mission and construct a mission profile

d. Understand his general areas of weakness on the previous mission

3. ADVANCED ESM SIMULATOR PROFICIENCY CHECK MISSION PLANNING

The student will be able to:

- a. Demonstrate proficiency in mission planning procedures for a priority search mission
- b. Exhibit a thorough knowledge of ESM operating procedures
- c. Exhibit a thorough knowledge of the shorebased, airborne and subsurface signal environment

4. ADVANCED ESM SIMULATOR PRACTICE MISSION NUMBER ONE

The student will:

- a. Be able to perform readiness checks on required ESM equipments and operate the ESM equipment in an operational signal environment
- b. Understand his specific areas of weakness

5. ADVANCED ESM SIMULATOR PRACTICE MISSION NUMBER TWO

The student will:

- a. Be able to perform readiness checks on required ESM equipments and operate the ESM equipments in an operational signal environment

6. ADVANCED ESM SIMULATOR PRACTICE MISSION NUMBER THREE

The student will:

- a. Be able to perform readiness checks on required ESM equipments and operate the ESM equipments in an operational signal environment
- b. Understand his specific areas of weakness

7. ADVANCED ESM SIMULATOR PROFICIENCY CHECK MISSION

The student will:

- a. Demonstrate proficiency in the equipment readiness check procedures and operation of all the ESM equipment in an operational signal environment
- b. Understand his specific areas of weakness

8. ADVANCED ESM SIMULATOR MISSION ANALYSIS

The student will understand his general areas of weakness on all the previous simulated missions

I. FUNDAMENTAL ELECTRONIC COUNTERMEASURES

1. INTRODUCTION TO ELECTRONIC COUNTERMEASURES

The student will be familiar with:

- a. The purpose and basic concepts of Electronic Countermeasures (ECM)
- b. The four basic types of ECM:
 - (1) Jamming
 - (2) Deception
 - (a) Manipulative
 - (b) Imitative

2. THEORY OF JAMMING (PART I)

The student will:

- a. Understand the purpose, use, and characteristics of a typical spot, barrage, swept and swept lock-on jammers
- b. Be familiar with signal flow through functional block diagrams
- c. Be familiar with various types of modulation, their characteristics, limitations, and use selection criteria
- d. Understand the following limitations of typical ECM equipments:
 - (1) Bandwidth
 - (2) Energy distribution
 - (3) Bandwidth
 - (4) Tuning requirements/capabilities

3. THEORY OF JAMMING (PART II)

The student will:

- a. Understand how to compute energy distribution for spot and barrage jammers and apply this value to given radar to determine its effectiveness.
- b. Understand the capabilities and limitations of representative types of ECM equipments.
- c. Understand the effects of basic ECM techniques on victim emitters and how these effects may be increased.

- d. Understand common ECM equipment malfunctions, their operator indications and corrective actions.

4. ECM ANTENNAS

The student will:

- a. Understand the characteristics and limitations of typical ECM antennas to include:
 - (1) Effectiveness
 - (2) Efficiency
 - (3) Patterns
 - (4) Polarization
- b. Be able to relate antenna characteristics to effective transmitter employment.
- c. Understand the theory of angle of arrival and phase relationships, as related to homing/warning and steerable antennas.

5. ECM SIMULATOR ORIENTATION

The student will have a general knowledge of the ECM simulator:

- a. Operation and signal generation
- b. Student station configuration
- c. Signal environment

6. ECM MISSION PROCEDURES

The student will be familiar with the simulated:

- a. ECM missions
- b. Procedures and tactics
- c. Pacing requirements
- d. Common equipment malfunctions and corrective actions

7. ECM MISSION NUMBER ONE

The student will:

- a. Understand the required ECM simulator procedures.
- b. Be able to effectively employ multiple jammers to counter a single signal environment with maximum instructor assistance.
- c. Be able to recognize any simulated equipment malfunction encountered and properly document them.
- d. Understand the function of each operator control/display.
- e. Be familiar with the effects of ECM technique on victim emitters.

8. ECM MISSION NUMBER TWO

The student will be able to:

- a. Understand the required ECM simulator procedures.
- b. Understand equipment readiness checks for the ECM equipments being utilized.
- c. Effectively use jammers to counter a multi-signal environment with a minimum of instructor assistance.

- d. Recognize and properly document any simulated equipment malfunctions encountered and properly document them.
- e. Understand the function of each operator control/display.
- f. Understand the effects of ECM techniques on victim emitters.

9. RADAR WARNING RECEIVERS

The student will:

- a. Understand the purpose, use and general characteristics of representative types of radar warning receiver systems.
- b. Be familiar with the signal flow through a typical radar warning receiver functional block diagram.
- c. Understand the characteristics of typical operator displays.
- d. Understand the function of each operator control.
- e. Understand the configuration and characteristics of typical radar warning receiver antenna systems.

10. ELECTRONIC DECEPTION EQUIPMENT

The student will:

- a. Understand the theory of operation of repeaters and transponders.
- b. Be familiar with the signal flow through basic block diagrams of typical repeaters and transponders.

11. ECM MISSION NUMBER THREE

The student will be able to:

- a. Understand the required ECM simulator procedures.
- b. Understand equipment readiness checks for the ECM/DECM equipment.
- c. Effectively use ESM systems and radar warning receiver to recognize immediate threats in multi-signal environment with a maximum of instructor assistance.
- d. Effectively use DECM in conjunction with radar warning receiver (threat reactive systems) to counter immediate threats in a multi-signal environment with a maximum of instructor assistance.
- e. Understand the function of each operator control/display.
- f. Be familiar with the effects of DECM techniques on victim emitters.

12. ECM MISSION NUMBER FOUR

The student will:

- a. Understand the required ECM simulator procedures.
- b. Understand equipment readiness checks for the ECM/DECM equipments being utilized.
- c. Effectively use ESM systems and threat reactive systems to recognize immediate threats with a minimum of instructor assistance.
- d. Effectively use ESM systems and threat reactive systems (ECM/DECM) to counter immediate threats in a multi-signal environment with a minimum of instructor assistance.

- e. Understand the function of each operator control/display.
- f. Understand the effects of DECM techniques on victim emitters.

13. THEORY OF CHAFF, FLARE, AND DECOYS

The student will understand:

- a. The theory of employment for various types of chaff, flares, and decoys.
- b. The nomenclature, description and characteristics of various types of chaff.
- c. The theory of employment of chaff against a typical air defense system.
- d. Employment of flares and why they were developed.
- e. The theoretical use of decoys and their capabilities and limitations.

14. ECM MISSION NUMBER FIVE

The student will be able to:

- a. Understand the required ECM simulator procedures.
- b. Understand equipment readiness checks for the ECM/DECM/Chaff/Flare equipments.
- c. Effectively use ESM systems and threat reactive systems to recognize immediate threats with a maximum of instructor assistance.
- d. Effectively use Chaff/Flare/Decoys in conjunction with the other threat reactive systems to counter immediate threats in a multi-signal environment with a maximum of instructor assistance.

- e. Understand the function of each operator control/display.
- f. Be familiar with the effects of Chaff/Flare/Decoy techniques on victim emitters.

15. ECM MISSION NUMBER SIX

The student will be able to:

- a. Understand the required ECM simulator procedures.
- b. Understand equipment readiness checks for the ECM/DECM/Chaff/Flare equipments.
- c. Effectively use ESM systems and threat reactive systems to recognize immediate threats with a minimum of instructor assistance.
- d. Effectively use Chaff/Flare/Decoys in conjunction with the other threat reactive systems to counter immediate threats in a multi-signal environment with a minimum of instructor assistance.
- e. Understand the function of each operator control/display.
- f. Understand the effects of Chaff/Flare/Decoys on victim emitters.

16. FUNDAMENTAL ELECTRONIC COUNTERMEASURES EXAMINATION

17. CRITIQUE

J. FUNDAMENTAL ECM SIMULATOR MISSIONS

1. FUNDAMENTAL ECM MISSION PLANNING (PART I)

The student will:

- a. Be familiar with the simulated ECM mission planning procedures.

- b. Be familiar with any team coordination and communication procedures.
- c. Understand how to prepare a mission chart, communication log and ECM log with maximum instructor assistance.
- d. Understand the specific activity to be accomplished in this mission.

2. FUNDAMENTAL ECM MISSION PLANNING (PART II)

The student will:

- a. Understand the simulated ECM mission planning procedures.
- b. Understand the team coordination and communication procedures.
- c. Be able to prepare a mission chart, communication log, and ECM log with minimum instructor assistance.
- d. Understand the specific activity to be accomplished on this mission.
- e. Understand his general areas of weakness as noted on the previous mission planning.

3. FUNDAMENTAL ECM MISSION PLANNING (PART III)

The student will:

- a. Be able to prepare a mission chart, communication log, and ECM log with minimum instructor assistance.

- b. Know the specific activity to be accomplished on this mission.
- c. Understand his general areas of weakness as noted on the previous mission planning.

4. FUNDAMENTAL ECM MISSION PLANNING PROFICIENCY CHECK

The student will:

- a. Demonstrate proficiency in the preparation of a mission chart, communications log and ECM log.
- b. Be able to brief the specific activity to be accomplished on the mission.

5. FUNDAMENTAL ECM MISSION NUMBER ONE

The student will:

- a. Be familiar with the operation of receivers, transmitters and Chaff/IR dispensers in the simulator.
- b. Be familiar with the equipment readiness check procedures in accordance with the detailed checklist.
- c. Be familiar with signal and transmitter presentations on the ECM simulator's receiver.
- d. Be familiar with common simulated equipment malfunctions and the proper corrections.
- e. Understand his specific areas of weakness.

6. FUNDAMENTAL ECM MISSION NUMBER TWO

The student will:

a. Be familiar with equipment readiness check procedures in accordance with current checklists.

b. Be familiar with prescribed procedures required to complete training requirements.

c. Be familiar with recognition and correction of equipment malfunction.

d. Be familiar with team coordination and communication procedures.

e. Be able to maintain an ECM log and communications log.

f. Understand his specific areas of weakness.

7. FUNDAMENTAL ECM MISSION NUMBER THREE

The student will:

a. Be able to perform equipment readiness checks in accordance with current checklists.

b. Understand prescribed procedures required to complete training requirements.

c. Be able to recognize and correct equipment malfunctions.

d. Understand team coordination and communications procedures.

e. Be able to maintain ECM and communications logs.

f. Understand his specific areas of weakness.

8. FUNDAMENTAL ECM MISSION PROFICIENCY CHECK

The student will:

a. Demonstrate proficiency in the equipment readiness check procedures using current checklists.

- b. Demonstrate proficiency in the prescribed ECM mission procedures.
- c. Demonstrate proficiency in team coordination and communications proceeding.
- d. Demonstrate proficiency in recognizing and correcting equipment malfunctions.
- e. Be able to maintain ECM and communications logs.
- f. Understand his specific areas of weakness.

K. ELECTRONIC COUNTER-COUNTERMEASURES

1. INTRODUCTION TO ELECTRONIC COUNTER-COUNTERMEASURES

The student will understand:

- a. The purpose of ECCM
- b. The uses of ECCM
- c. The importance of the role he has in ECCM

2. EMPLOYMENT OF ECCM

The student will understand how the following optimizes the capabilities of the Navy's own forces by employment of:

- a. EMISSION CONTROL (EMCON), including control of:
 - (1) All electromagnetic radiations
 - (2) All electro-acoustic radiations
 - (3) All electronic equipment (air, surface & sub-surface) in vicinity of the task force.
- b. TACTICAL EVASION, based on:
 - (1) Enemy equipment capabilities
 - (2) Propagation characteristics

- (3) Tactical requirements of own force
 - (4) Capabilities and limitations
- c. ANTIJAMMING TECHNIQUES, general capabilities and limitations of:
- (1) Automatic Gain Control
 - (2) Automatic Video Noise Limiting
 - (3) Coverage Contour
 - (4) Detector Balanced Bias
 - (5) Dicke Fix
 - (6) Fast Time Constant
 - (7) Instantaneous Automatic Gain Control
 - (8) Jammer Amplitude Versus Azimuth
 - (9) Jammer Amplitude Versus Elevation
 - (10) Linear-Logarithmic Amplifier
 - (11) Logarithmic Amplifier
 - (12) Moving Target Indicator (MTI)
 - (13) Coherent MTI
 - (14) Non-Coherent MTI
 - (15) Gated MTI
 - (16) Automatic Moving Target Indicator
 - (17) Pulse Amplitude Discrimination
 - (18) Polarization Cancellation
 - (19) Pulse Compression/Expansion
 - (20) Pulse Edge Tracking
 - (21) Pulse Width Discrimination

- (22) Range Rate Memory
- (23) Sensitivity Time Control
- (24) Side Lobe Suppression
- (25) Side Lobe Blanking
- (26) Variable Pulse Recurrence Frequency
- (27) Video Integration
- d. ECCM SYSTEM TECHNIQUES
 - (1) Circuits to prevent overloading of radar receivers
 - (2) Target/jamming signal discriminators
 - (3) Direction of jamming circuits
 - (4) Target tracking circuits
- e. FREQUENCY DIVERSITY
 - (1) U. S. Naval Electronics systems
 - (2) Sino-Soviet Naval Electronics systems
- f. FREQUENCY AGILITY
 - (1) U. S. Naval Electronics systems
 - (2) Sino-Soviet Naval Electronics systems
- 3. ECCM OPERATING TECHNIQUES AND PROCEDURES

The student will understand the importance of:

 - a. Recognizing interference, jamming, or deception
 - b. Reporting and identification of the type of jamming
 - c. Proper reaction to enemy ECM
 - d. Proper data retrieval, logs and reports
- 4. ECCM MISSION NUMBER ONE

The student will be familiar with the indications/effects of mechanical ECM on typical U. S. Naval:

- a. Air Search Radars
- b. Surface Search/Navigation Radars
- c. Fire Control/Missile Guidance Radars
- d. Air Intercept Radars

5. ECCM MISSION NUMBER TWO

The student will be familiar with:

- a. The purpose, use and characteristics of the different types of electronic ECM modulation techniques
- b. The indication/effects of the electronic ECM modulation types on typical radar systems
- c. The indications/effects of the electronic ECM modulation types on typical ESM receivers

6. ECCM MISSION NUMBER THREE

The student will be familiar with the indications/effects of electronic ECM and typical ECCM features on typical

U. S. Naval:

- a. Air Search Radars
- b. Surface Search Radars
- c. Fire Control/Missile Guidance Radars
- d. Air Intercept Radars
- e. Voice/data communications systems

7. ECCM MISSION NUMBER FOUR

The student will understand the indications/effects of electronic ECM and typical ECCM features on typical

U. S. Naval:

- a. Air Search Radars
- b. Surface Search Radars
- c. Fire Control/Missile Guidance Radars
- d. Air Intercept Radars
- e. Voice/data communications systems

8. ECCM MISSION NUMBER FIVE

The student will understand the indications/efforts of Mechanical ECM and typical ECCM features on typical

U. S. Naval:

- a. Air Search Radars
- b. Surface Search Radars
- c. Fire Control/Missile Guidance Radars
- d. Air Intercept Radars

9. SINO-SOVIET ECCM CAPABILITIES AND LIMITATIONS

The student will be familiar with the ECCM capabilities and limitations on typical Sino-Soviet:

- a. Air Search Radars
- b. Surface Search Radars
- c. Fire Control/Missile Guidance Radars
- d. Air Intercept Radars
- e. Voice/data communications systems

10. ECCM MISSION NUMBER SIX

The student will be familiar with the indications/effects of mechanical ECM and typical ECCM features on typical Sino-Soviet:

- a. Air Search Radars
- b. Surface Search Radars
- c. Fire Control/Missile Guidance Radars
- d. Air Intercept Radars

11. ECCM MISSION NUMBER SEVEN

The student will be familiar with the indications/effects of electronic ECM and typical ECCM features on typical Sino-Soviet:

- a. Air Search Radars
- b. Surface Search Radars
- c. Fire Control/Missile Guidance Radars
- d. Air Intercept Radars
- e. Voice/data communications systems

12. ECCM MISSION NUMBER EIGHT

The student will understand the indications/effects of Mechanical ECM and typical ECCM features on typical Sino-Soviet:

- a. Air Search Radars
- b. Surface Search Radars
- c. Fire Control/Missile Guidance Radars
- d. Air Intercept Radars

13. ECCM MISSION NUMBER NINE

The student will understand the indications/effects of Electronic ECM and typical ECCM features on typical Sino-Soviet:

- a. Air Search Radars
- b. Surface Search Radars
- c. Fire Control/Missile Control Radars
- d. Air Intercept Radars
- e. Voice/data communications systems

14. ECCM EXAMINATION

15. CRITIQUE

III. ADVANCED PHASE

A. MISSION OPERATIONS

1. PLANNING

a. Documents - Student will acquire a thorough working knowledge of the following:

- (1) STIC Publications
- (2) NSA ELINT Manual
- (3) NSA Reference Manual

b. Publications - Student will be familiarized with the content and use of:

- (1) Representative operations plans/orders
- (2) Appropriate tactical publications
- (3) Appropriate communications publications
- (4) Appropriate instructions
- (5) FMFM2-3 signal intelligence and electronic warfare

operations

c. Planning Factors - Student will understand the importance of having a thorough knowledge of:

- (1) Mission of own force
- (2) Enemy threat to assigned mission
- (3) Own intercept equipment capabilities and status
- (4) Tactical communications, radar surveillance and

weapon systems required

- (5) Force/group disposition
- (6) SIGINT requirements
- (7) The effect of interference from electro-magnetic

equipment

- (8) Intercept assignments
- (9) Guard responsibilities
- (10) Intercept probability
- (11) Performance considerations
- (12) Intercept range probability
- (13) Effect or speed of advance
- (14) Advantages/disadvantage of various platforms
- (15) Use of:
 - (a) PENAID
 - (b) BRIGAND
 - (c) BIG LOOK
- (16) Coordinated efforts
- (17) Reports
 - (a) Log maintenance
 - (b) Tactical EW reports
 - (c) Strategic EW reports
- (18) EW status board and plotting procedures
- (19) Interrelationship of AAW, ASW and EW

d. Mission Planning (air, surface, sub-surface) - Student will develop EW plans (US, EUROPE, SEASIA MED) incorporating the following and using criteria from A. 1. c. above:

- (1) Evaluation of EW environment
- (2) Mission constraints and operational considerations
- (3) Selection of EW tactic(s):
 - (a) Defensive action
 - (b) Tactical evasion

(c) Jamming and deception

(d) Antijam and antideception

(4) Electronic and radar order of battle

2. PLAN EXECUTION - USING OPERATIONAL TRAINER STUDENT WILL EXECUTE THE FOLLOWING ADVANCED ELECTRONIC WARFARE SIMULATED MISSIONS

NOTE: The student will accomplish three hours of formal mission planning prior to MISSION ONE and one hour prior to each subsequent mission.

a. ELECTRONIC WARFARE SIMULATOR MISSION PLANNING

The student will:

- (1) Be familiar with the ESM/ECM/DECM/Chaff/Flare simulated mission planning procedures
- (2) Be familiar with team coordination, communication, and EW procedures
- (3) Understand how to prepare a mission chart and ESM/ECM log
- (4) Understand the anticipated activity for this mission

b. ELECTRONIC WARFARE SIMULATOR MISSION PLANNING

The student will:

- (1) Be able to prepare a mission chart and ESM/ECM log
- (2) Understand the anticipated activity for this mission
- (3) Understand his general areas of weakness as noted on the previous mission

c. ELECTRONIC WARFARE MISSION PLANNING PROFICIENCY CHECK

The student will:

- (1) Demonstrate proficiency in preparation of the mission chart and ESM/ECM logs

- (2) Understand anticipated activity for this mission
- (3) Understand his general areas of weakness as noted on the previous mission

d. ELECTRONIC WARFARE OPERATIONS MISSION NUMBER ONE

The student will:

- (1) Be able to perform equipment readiness checks in accordance with current checklists
- (2) Understand the prescribed ESM/ECM/DECM/Chaff/Flare procedures and tactics.
- (3) Understand team coordination and communications tactics
- (4) Be able to maintain the required forms/logs
- (5) Understand his specific areas of weakness

e. ELECTRONIC WARFARE OPERATIONS MISSION NUMBER TWO

The student will:

- (1) Be able to perform equipment readiness checks in accordance with current checklists
- (2) Understand the prescribed ESM/ECM/DECM/Chaff/Flare procedures and tactics
- (3) Understand team coordination and communications tactics
- (4) Be able to maintain the required forms/logs
- (5) Understand his specific areas of weakness
- (6) Be able to recognize and correct equipment malfunctions

f. ELECTRONIC WARFARE OPERATIONS MISSION NUMBER THREE

The student will:

(1) Be able to perform equipment readiness checks in accordance with current checklists

(2) Understand the prescribed ESM/ECM/DECM/Chaff/Flare procedures and tactics

(3) Understand team coordination and communications tactics

(4) Be able to maintain the required forms/logs

(5) Understand his specific areas of weakness

(6) Be able to recognize and correct equipment malfunctions

g. ELECTRONIC WARFARE OPERATIONS MISSION NUMBER FOUR

The student will:

(1) Be able to perform equipment readiness checks in accordance with current checklists

(2) Understand the prescribed ESM/ECM/DECM/Chaff/Flare procedures and tactics

(3) Understand team coordination and communications tactics

(4) Be able to maintain the required forms/logs

(5) Understand his specific areas of weakness

(6) Be able to recognize and correct equipment malfunctions

h. ELECTRONIC WARFARE SIMULATOR PROFICIENCY CHECK MISSION

The student will:

(1) Demonstrate proficiency in the equipment readiness checks of all the EW equipment in accordance with the prescribed checklist

(2) Demonstrate proficiency in the use of the prescribed
ESM/ECM/DECM/Chaff/Flare procedures

(3) Demonstrate proficiency in team coordination and
communications procedures

(4) Demonstrating proficiency in filling out the required
forms

(5) Understand his specific areas of weakness

B. ADVANCED SYSTEMS

1. ELECTRO-OPTICS - THE STUDENT WILL HAVE AN UNDERSTANDING OF:

- a. Geometry of optics
- b. Application of optics
- c. Television guidance systems
- d. Principles of light
- e. EW countermeasures application
- f. Effects of optical devices on light beams

2. LASERS - THE STUDENT WILL HAVE AN UNDERSTANDING OF:

- a. Theory of lasers
- b. Safety precautions
- c. Laser construction & principles
- d. System operation
- e. System application

3. INFRARED - THE STUDENT WILL HAVE AN UNDERSTANDING OF:

- a. Fundamentals of infrared
- b. Guidance and control systems
- c. Operational application

C. CAREER INFORMATION - THE STUDENT WILL BE FAMILIARIZED WITH:

1. Advancement potential
2. Career Path
3. Associated educational programs
4. Fleet training
5. Shipboard training
6. Information sources
7. Post-training evaluation
8. Shipboard, air squadron organization

D. EXAMINATION

E. CRITIQUE

APPENDIX E

EW RELATED SOUND/SLIDE PROGRAMS

<u>Program No.</u>	<u>Title</u>	<u>Classification</u>
4B37/1	EA-6B AYA-6 Computer	
	Part 1 - Computer Fundamentals	U
	Part 2 - Functional Use & Internal Operation(T)	U
	Part 3 - Operational Interface Requirements(T)	C
	Part 4 - CCI TJS Application	C
4B37/2	EA-6B SIR and Communications Jamming Equipment (Update will be SN classification)	C
4B37/3	EA-6B Navigation System	
	Part 1 - Equipment Familiarization	U
	Part 2 - Equipment Checkout	U
	Part 3 - Equipment Operation	U
4B37/4	EA-6B APQ-129 Radar Set	
	Part 1 - Equipment Familiarization	U
	Part 2 - Operation	U
4B37/5	EA-6B Built-in-Test Equipment	U
4B37/6	EA-6B Electronic Warfare Theory	
	Part 1 - Exponents, Logs, Decibels	U
	Part 2 - Basic Antenna Theory	U
	Part 3 - Bandwidth and the J/S Ratio	U
	Part 4 - The Geometry of Jamming	U
	Part 5 - Universal Mutual Jamming Curves	C
4B37/7	EA-6B Mission Related Equipment - Degraded Systems Operation	C
4B37/8	EA-6B Tactical Jammer Pods Equipment Familiarization	C
4B37/9	EA-6B Tactical Jamming System	
	Part 1 - Introduction	C
	Part 2 - Modes	C
	Part 3 - Sub-modes	C
	Part 4 - Routines	C
5F8/1	Emitter Threat Signals (Tape Only)	C
2	APR-23	S
3	Emitter Threat Signals (Tape Only) (Multi- Environment)	S
4	APR-27	SN
4A	APR-27 (Rev 1)	SN
5	APR-30	S
5A	APR-30 (Rev 1)	S
6	APR-25	SN
6A	APR-25 (Rev 1)	SN
6B	APR-25 (Rev 2)	SN
7	ALQ-91	SN

<u>Program No.</u>	<u>Title</u>	<u>Classification</u>
Device		
5F8/8	ALE-29A	U
8A	ALE-29A (Rev 1)	U
9	ALR-15	C
10	APR-18	C
11	ALE-18	C
12	ALQ-55	SN
12A	ALQ-55 (Rev 1)	SN
13	ALQ-81/100	SN
13A	ALQ-81/100 (Rev 1)	SN
13B	ALQ-81/100 (Rev 2)	SN
14	ALQ-51A	SN
14A	ALQ-51A (Rev 1)	SN
15	ALQ-41/88	SN
16	ALQ-61	SN
17	ALQ-71	SN
19	ALR-26	S
20	ALQ-86	SN
21	Chaff	S
23	ALQ-76	SN
* 24	2D2 EW Range	SN
* 24A	2D2 EW Range (Rev 1)	SN
25	ALE-32	U
* 27	Shrike	C
* 29	Walleye	C
* 30	F-4 (2 Parts)	SN
* 30A	F-4B (Rev 1)	
* 31	EA-6A (3 Parts)	SN
32	APX-76	C
32A	APX-76 (Rev 1)	
33	ALH-6	SN
* 34	A-4 (2 Parts)	SN
* 35	RA-5C (2 Parts)	S
* 35A	RA-5C (2 Parts) (Rev 1)	S
* 36	A-6A (2 Parts)	SN
* 36A	A-6A (2 Parts) (Rev 1)	SN
* 37	A-7A (2 Parts)	S
* 38	EA-3B (2 Parts)	SN
* 39	F-8H, J	SN
* 40	EKA-3B (4 Parts)	SN
* 40A	EKA-3B (Rev 1)	
* 41	AWG-10 (5 Parts)	C
	Part 6	
* 42	F-4J (2 Parts)	S
43	ALQ-91A	SN
43A	ALQ-91A (Rev 1)	SN
44	ALQ-78	
47	EA-6B	SN
48	EA-3B (Sea Wing) (2 Parts)	SN
49	A-7E (2 Parts)	SN

*Updates will be redesignated in 4B Series

<u>Program No.</u>	<u>Title</u>	<u>Classification</u>
Device		
5F8/51	ALQ-108	SN
54	Friendly Signals (Ship)	
55	Friendly Signals (Land)	
56	Friendly Signals (Air)	
* 58	F-14	
59	ALR-50	SN
60	A-4M	
63	ALR-45	SN
64	Charger Blue Threats (2 Parts)	SN
65	ALQ-120	SN
5F9	Threats and Countermeasures (7 Parts)	
5F9A	Threats and Countermeasures (7 Parts)	
5F9B	The Enemy Threat and Friendly Countermeasures (9 Program Parts)	S and SN
5F9B1	The Threat	SN
5F9B2	Surface-to-Air Missile Threat	SN
5F9B3	Anti-Aircraft Artillery Threat	SN
5F9B4	Air-to-Air Threat	SN
5F9B5	Fighter and Attack Aircraft Electronic Warfare (2 Parts)	SN
5F9B6	Support Aircraft Electronic Warfare	SN
5F9B7	Equipment Application (2 Parts)	SN
5F9C	The Enemy Threat and Friendly Countermeasures	SN
5F11/1	Radar Fingerprints (3 Parts) (Phase I follows)	U
2	Circular Scan Recognition	U
3	Sector Scan Recognition	II
4	Raster/Palmer Scan Recognition	U
5	Conical Cosro Spiral Scan Recognition	U
6	Lobe Switching Loro Scan Recognition	U
7	V Beam Stacked Beam Scan Recognition	U
8	Unidirection Sector TWS/TWSRO Scan Recognition	U
9	Monopulse Scan Recognition	U
10	Frequency Scan Recognition	U
11	ULQ-6 (3 Parts)	SN/S
12	OSA/KOMAR (2 Parts)	SN
13	Kynda/Kresta (2 Parts)	SN
14	Scan Recognition Test	U
15	Complex Modulation (Phase II follows)	U
16	WLR-1 (7 Parts)	C/U
17	Samlet (2 Parts)	SN
18	SS-N-3 (2 Parts)	SN
19	Badger (3 Parts) (Phase II follows)	SN
20	Bear (2 Parts)	SN
21	Blinder (2 Parts)	SN
22	Kilden/Krupny (2 Parts)	SN
23	Kotlin (2 Parts)	SN
24	Kashin (2 Parts)	SN
25	Moskva (2 Parts)	SN

APPENDIX F

UNIVERSAL DISPLAY PANEL

GENERAL DESCRIPTION

1-1. GENERAL.

1-2. The Universal Display Panel, Device 3C127A, figure 1-1, is a portable backlighted device that presents illustrations on individual overlays attached to the face of the back-lighted area. Each overlay has associated with it one plugboard and two program switch drums which are preprogrammed for the training application. Device 3C127A is an improved version of Device 3C127.

1-3. The Universal Display Panel has a unique feature for allowing the instructor to change the 4-foot by 7-foot overlay and associated operational program in minutes. The 1/8-inch thick plastic overlay is removed from the storage area at the rear of the device and attached on the face of the panel. The program patchboard and program drums are removed from the storage area under the panel and plugged into their respective receivers.

1-4. The advantages of this device over current non-universal backlighted display panels are as follows:

- a. Reduces number of display panels required at a school or activity.
- b. Reduces storage area for each panel.
- c. Reduces instructor device learning time.
- d. Increases instructors training effectiveness by better understanding the device and by faster device-operation.
- e. Reduces modification cost by permitting school or activity to modify illustrations or make new illustrations and programs.
- f. Reduces procurement time and cost per device illustration and associated program equipment, due to commonality of design.

1-5. LEVEL OF TRAINING.

1-6. The Universal Display Panel, Device 3C127A, is designed for classroom use and may be viewed simultaneously by as many as 40 trainees. The device is instructor-operated and may be operated remotely. It is a versatile training device and may be utilized for basic or advanced instruction in system and component operation. System diagrams overlaid on the illuminated panel may be organized, charts, schedules, block diagrams, electronic circuit diagrams, PERT charts, flow charts,

or other complex illustrations.

1-7. The presentation is organized into sequential steps. The length of time spent on each step depends on illustration complexity and students' capability. In the event students have a question, the instructor can select a previously presented training step sequence by use of the select switches. When the question is answered, the instructor can return to the current step. Program selection is by random access select switches or by manual single step control. When the instructor feels the student understands the instruction or illustration, the instructor may have the student operate the illustration by use of jack pins through the illustrated overlay. Line segments and logic blocks can be backlighted as required for proper overlay illustration.

1-8. DEVICE DESCRIPTION.

1-9. PACKAGING. The portable display panel has motorized adjustable height. It has provision for storing three overlays at the rear of the device and compartments are provided under the backlighted area for the program system, spare program components, power supply, and spare parts.

1-10. CAPABILITY. The 4-foot by 7-foot backlighted area has 966 eggcrate type square holes, each containing a lamp. The overlay can contain any type of illustration that can be put on a 4-foot by 7-foot overlay with the layout on a 23 by 42, 2-inch-square, grid scale. The system capability provides up to 120 control switch closures per step and a simultaneous operation of 500 lamps. Each program may have up to sixty steps in its sequence. The programming of these lamps, as required for each overlay, is accomplished by use of a removable patchboard and two removable program drums. The patchboard selects the lamps to be operated and the program drum activates the selected lamps in accordance with a preprogrammed sequence.

1-11. PROGRAM DRUMS. The two removable program drums are used to provide the 120 separate switch closures per step to control the backlighted area lamps selected by the patchboard. The program drum system can be stepped to any of the 60 preprogrammed steps in the training sequence. The removable drum has movable actuators to change the desired program without difficulty. Changes to the program equipment should correspond to changes made on the overlay. Either one

or both program drums may be used. This provides either 60 or 120 switch closures per step for operating the lamps.

1-12. CONTROL PANEL. The control panel at the left of the backlighted area is used to control the operational program for each overlay. After the overlay is attached in front of the backlighted area and the associated patchboard and program drum are plugged in, the power may be turned on by the switch provided. By depressing any of the 60 sequence SELECT switches on the control panel, the program drum will move to the selected step of the training sequence and operate the corresponding programmed lamps. The program system may also be single stepped to the desired training sequence. The illumination of one or a group of lights, as required for progression and continuity of information depicted on the overlay, will then be indicated through the transparent area of the overlay. The program system may also be single stepped with a remote control cord. The LIFT switch, BLINK switch, DIMMER control and FUSE are also located on the control panel.

1-13. JACK PIN CONTROL. The device also has means for student participation. An open-circuit two-pole jack is placed in each window of the backlighted area, which coincides with a hole in the information area of the overlay. By placing an actuator pin through this hole into the two-pole jack, the backlighted area lights. After operation of the illustrated circuit, the instructor can have the student repeat the same operation by using the pin control from the face of the overlay.

1-14. TEST FEATURE. The device can be programmed to test the operational circuits associated with each overlay, prior to each training period, by programming step number 60 to light all lamps for any given illustration. In addition, a maintenance patchboard and

program drums will be used to block activate all the lamps in the backlighted area to allow a periodic test of all circuits.

1-15. PHYSICAL DESCRIPTION.

1-16. Device 3C127A is 98-1/2 inches long and 30-1/2 inches deep (front to back). The overall height is adjustable from approximately 6 feet 2 inches to 8 feet 6 inches. The device, complete with the normal complement of overlays, program switch drums, plugboard, and spare parts, weighs 800 pounds.

1-17. POWER REQUIREMENTS.

1-18. A power source of 115v 60 Hz at 20 amperes is required for operation of Device 3C127A. Under maximum load, the device will require 20 amperes input current.

1-19. ACCESSORIES SUPPLIED.

1-20. Device 3C127A is designed as a universal display panel. It operates in conjunction with an overlay, programmed plugboard, and two program drums. Supplied with Device 3C127A are one plugboard and two program switch drums preprogrammed for lamp testing.

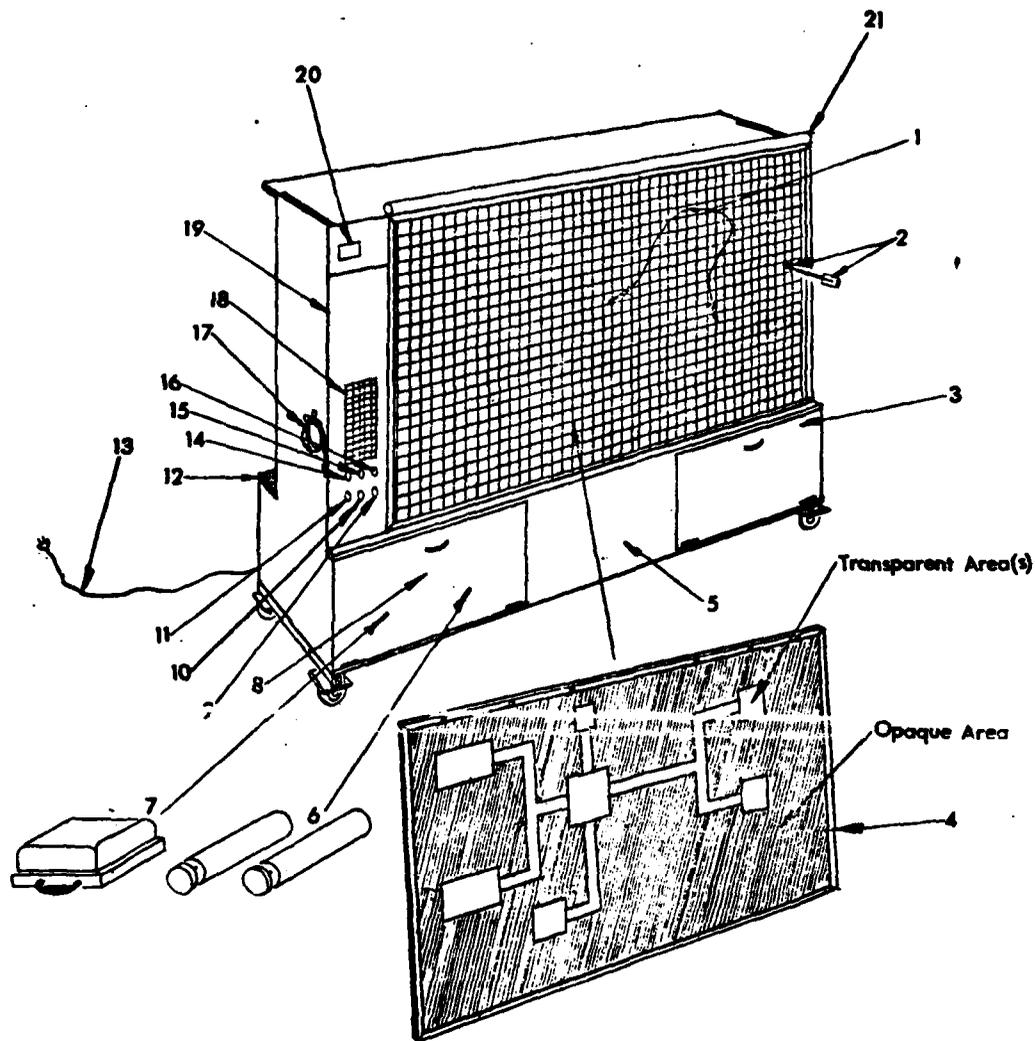
1-21. In addition to the overlays, plugboards, and drums, student participation may be allowed through the use of shorting pins. One hundred pins are supplied with Device 3C127A.

1-22. A kit of spare lamps, relays, and switches is supplied.

1-23. A power cord and a remote control cord are supplied.

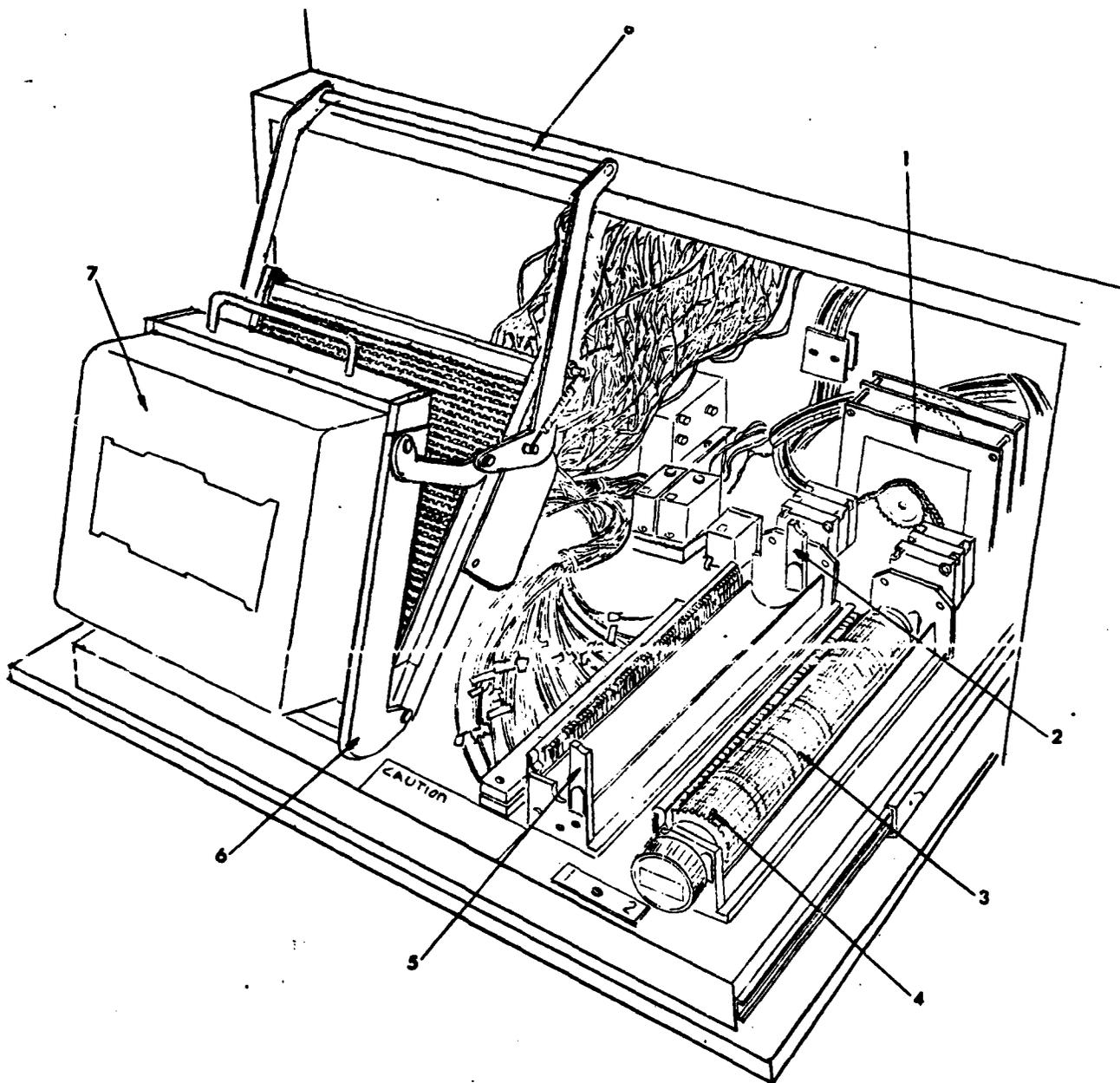
1-24. ACCESSORIES NOT SUPPLIED.

1-25. Overlays, plugboards, and program switch drums for each training sequence are not supplied.



- | | | |
|---|--|--------------------------|
| 1. Backlighting Panel | 7. Plugboard (One test plugboard supplied) | 14. Step Button |
| 2. Pin Switch and Jack Pin (Typical) | 8. Programmer Compartment | 15. Fuse |
| 3. Program Storage | 9. Lift Switch | 16. Dimmer Control |
| 4. Overlay (Typical) (Not Supplied) | 10. Power Indicator | 17. Remote Control Cable |
| 5. Power Supplies (Door in rear) | 11. Power Switch | 18. Select Keyboard |
| 6. Program Switch Drums (Two test drums supplied) | 12. Overlay Storage Tracks | 19. Control Panel |
| | 13. Power Cord | 20. Nameplate |
| | | 21. Dust Cover |

Figure 1-1. Universal Display Panel, Device 3C127A, and Typical Overlay, with Associated Plugboard and Program Switch Drums.



- | | |
|-------------------------|-----------------------------|
| 1. Tap Switch | 5. Drum Shaft Lock-Front |
| 2. Drum Shaft Lock-Rear | 6. Plugboard Receiver |
| 3. Program Drum | 7. Plugboard |
| 4. Drum Actuator | 8. Plugboard Locking Handle |

Figure 1-2. Programmer Compartment with drawer pulled out.

APPENDIX G

PROPOSED APPROACH FOR A CONSOLIDATED ELECTRONIC WARFARE OPERATOR TRAINING SYSTEM

1. SUMMARY

The consolidated electronic warfare training facility, to be located at Corry Field, Pensacola, Florida, requires a more definitive statement of training requirements prior to development of more definitive parameters. Where this definition is lacking, assumptions have been made upon which to base system configuration. The configuration is, therefore, only as valid as the assumptions upon which it was based. The proposed training system is based upon the assumptions made for the training requirements analysis cited in paragraph 2 below. The system is composed of the following elements:

- a. Six traditional classrooms (includes small groups).
- b. 220 carrels.
- c. EW Operator Trainer (individualized/team training capabilities).
- d. Computer Managed Instruction (Including debriefing facility hardware).

2. CONSIDERATIONS AND ASSUMPTIONS

This report, related to Electronic Warfare training, provides recommendations relative to the structure and content of the Corry Field training facility. Definitive training requirements are projected though not validated. Equipment commonality, curriculum, student

input population, and training media requirements are addressed. Therefore, the applicable portions of this report were utilized as the substantive material upon which the training systems derived herein are based. The following constitute major extractions from the body of this report:

a. Statement of the Problem. The task of the EW (Electronic Warfare) operator has become significantly more challenging in the past decade. The effect has been felt not only in the fleet operational units, but also by the training agencies whose mission is to prepare the human element to be proficient in the theory, concept of operation, principles of application, and techniques involved in all phases of electronic warfare. Chief of Naval Personnel studies have indicated that training of approximately 2500 officer and enlisted personnel annually is required to attain and maintain an adequate naval EW posture.

Past EW operator training systems have relied heavily on the use of operational EW equipments as training devices. This approach to satisfying operational needs of the fleet in EW has proven to be inadequate due to acquisition and support costs of operational equipment. In addition, operational equipments are not readily available for use as training devices. A more effective EW operator training system is required.

b. Assumptions

(1) A major element of the EW operator training system will be generalized operator trainer(s) that will provide operator training in ESM (Electronic Support Measures), ECM (Electronic Counter Measures), and ECCM (Electronic Counter Countermeasures) equipment capabilities and applications which were found to have a large percentage of

commonality. (See Section III, page 13) The operator trainer(s) should also provide a means whereby cognizant personnel can effectively learn ESM and ECM mission operations planning and execution.

(2) Student loading will be a maximum of 2500 student graduates per year.

(3) Input population to include:

- (a) Naval Flight Officers
- (b) Marine electronic warfare specialist/officer
- (c) Commanding officers
- (d) Operations officers
- (e) Combat information center officers
- (f) Surface vessel electronic warfare officers
- (g) Squadron electronic warfare training officers
- (h) Enlisted Electronic Warfare Technicians (EW)
- (i) Enlisted Communications Technicians (CTT)
- (j) Enlisted Radarman (RD)

(4) Course curriculum (per Appendix D)

(5) Definitive training objectives will be available prior to contract award for the operator trainer.

(6) Operator trainer(s) will provide generalized representations of the functions of major present and projected electronic warfare equipment as determined by the TAEG equipment analysis.

(7) School to operate on a two shift basis: 14 hours per day, five days a week, 50 weeks per year.

3. INSTRUCTIONAL CONSIDERATIONS

In selecting the media for incorporation into the various alternative operator training systems, the following issues were considered:

a. Group vs. individualized instruction. There is a strong trend in military training away from group lecture-type classroom instruction

to a more effective individualized instruction using programmed texts, multi-media carrels, trainers and on-the-job hands-on training. Evaluation of both theoretical and practical experience factors support this trend.

Individualized instruction can incorporate:

(1) Individual pacing - each student proceeds at a rate tailored to his own ability to learn.

(2) Active learning - student is actively engaged in the learning process by making decisions, solving problems, using procedures and answering questions.

(3) Immediate feedback on performance - each event in a student's performance can be evaluated and the student provided with immediate knowledge of results and reinforcement to guide his subsequent performance.

(4) Individually defined remedial instruction - diagnostic routines can be used to identify specific deficiencies in an individual's performance, and remedial instruction can be provided to satisfy these specific deficiencies.

(5) Train to criterion performance - training for an individual stops when, and only when, criterion performance has been achieved. Time to criterion is a factor that influences the requirements for number of classrooms, or carrels, units of media, number of instructors, student costs such as pay and allowances, quarters, etc., and the number of hours of productive time available to the Navy after the student's graduation.

b. Traditionally managed instruction vs. computer managed instruction. Computer managed instruction (CMI) offers a useful and powerful management technique to reduce training time where individualized instruction is

used. It also can solve the difficult scheduling problem and certain other management problems introduced by individualized instruction.

4. OPERATOR TRAINING SYSTEM ALTERNATIVES

The NAVTRAEQUIPCEN TAEG Training Effectiveness and Cost Effectiveness prediction model, from TAEG Report No. 1, was applied in the selection of operator training system alternatives as follows:

The pertinent instructional functions and associated training technique options, as specified by Table 1 (page 142), were used in analyzing the proposed Basic EW Operator Course curriculum outline, Appendix D, to establish training technique options per curriculum element. Table 2 (page 143) is the result of that analysis. From Table 2 data, three alternative training systems were configured, Table 3 (page 144), that can support the operator training requirements for the consolidated EW school, projected in this report.

Table 3 EW OPERATOR TRAINING SYSTEM ALTERNATIVES	
Operator Training System	Training Techniques
Alternative 1	Traditional classroom Operator Trainer (Locked-Step) Team Trainer
Alternative 2	Carrel Small group Traditional classroom Operator Trainer (Locked-Step) Team Trainer CMI Debrief facility
Alternative 3	Carrel Small group Traditional classroom Operator Trainer (individualized) Team Trainer CMI Debrief facility

Table 1

LEVEL OF UTILITY OF VARIOUS TRAINING TECHNIQUES
FOR SPECIAL INSTRUCTIONAL FUNCTIONS 1

Instructional Functions	OPTIONAL TRAINING TECHNIQUES							
	Traditional Classroom	Small Group	Carrel	CAI	Operator Trainer (individualized)	Team Trainer	Operator Trainer (locked-step)	
1. Academics	Low	-	Medium	High	-	-	-	
2. Maintenance of Recall of Facts and Principles	Low	-	Medium	High	-	-	-	
3. Signal Recognition Drill and Practice	Low	-	Medium	High	High	-	High	
4. Equipment Operation	-	-	Low	Medium	High	-	High	
5. Mission Planning	Low	Medium	Medium	High	-	-	-	
6. Mission Performance	-	-	-	Medium	High	High	High	
7. Post Mission Critique	-	-	-	Medium	High	High	High	
8. Attitude Development	-	High	-	-	-	-	-	
9. Career Planning and Program Orientation	Medium	-	-	-	-	-	-	

Note: This table denotes the extent that a training technique can facilitate the use of a set of learning guidelines appropriate for a given task:

- = none or few guidelines can be used
- Low = up to 1/3 of the appropriate guidelines can be used
- Medium = between 1/3 and 2/3 of the appropriate guidelines can be used
- High = over 2/3 of the appropriate guidelines can be used.

1. See TAEC Report 1, Sept. 1972.

CURRICULUM PHASES WITH TASK CATEGORIES AND OPTIONAL TRAINING TECHNIQUES

CURRICULUM PHASES	TASK CATEGORIES	OPTIONAL TRAINING TECHNIQUES						
		TRADITIONAL CLASSROOM	SMALL GROUP	CARREL	CAI	OPERATOR TRAINER (INDIV.)	TEAM TRAINER	OPERATOR TRAINER LOCKED-STEP
I. BASIC PHASE								
A. School Introduction	Recalling facts and principles Recalling procedures	High	-	-	-	-	-	-
B. Mathematics - Academics	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-
Drill	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-
C. Basic Electronics Academics	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-
Drill	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-
D. Electronics Transmission and Reception Academics	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-
Drill	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-
E. Radar Systems Academics	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-
Drill	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-

OPTIONAL TRAINING TECHNIQUES

CURRICULUM PHASES	TASK CATEGORIES	TRADITIONAL CLASSROOM	SMALL GROUP	CAREER	CAI	OPERATOR TRAINER (INDIV.)	TEAM TRAINER	OPERATOR TRAINER LOCKED-UP
II. INTERMEDIATE PHASE								
A. Electronic Warfare Function, Organization and Procedures Academics	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-
Drill	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-
B. Introduction to Defense Systems Academics	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-
Drill	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-
C. Signal Recognition Concepts Academics	Recalling facts and principles Non-verbal identification Using principles	Low	-	Med	High	-	-	-
Drill	Non-verbal identification Using principles	Low	-	Med	High	High	-	High
D. Electronic Warfare Concepts Academics	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-
Drill	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-
E. Fundamental Electronic Warfare Support Measures Academics	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-
Drill	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-

OPTIONAL TRAINING TECHNIQUES

CURRICULUM PHASES	TASK CATEGORIES	OPTIONAL TRAINING TECHNIQUES						
		TRADITIONAL CLASSROOM	SMALL GROUP	CAREER	CAT	OPERATOR TRAINING (INDIV.)	TEAM TRAINING	OPERATOR TRAINER LOCKED-STEP
Equipment Operation	Recalling procedures Positioning and serial movement	-	-	Low	Med	High	-	High
Mission Planning	Making decisions Written verbalization	Low	Med	Med	High	-	-	-
Mission Practice	Recalling procedures Using principles Positioning and serial movement Non-verbal detection Non-verbal identification Oral verbalization	-	-	-	Low	High	-	High
Post Missions Critique	Positioning and serial movement Using principles Making decisions	Low	-	-	Med	High	-	High
Attitude development	Attitude - willingness to perform	-	High	-	-	-	-	-
F. Advanced Electronic Warfare Support Measures Academics	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-
Drill	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-
Attitude development	Attitude - willingness to perform	-	High	-	-	-	-	-
G. Fundamental EW Support Measures Simulator Missions Mission Planning	Decision Making Written verbalization	-	-	-	-	-	-	-
Mission Practice	Recalling procedures Using principles Positioning and serial movement Non-verbal detection Non-verbal identification Oral verbalization	-	-	-	Med	High	-	High

OPTIONAL TRAINING TECHNIQUES

CURRICULUM PHASES	TASK CATEGORIES	OPTIONAL TRAINING TECHNIQUES						
		TRADITIONAL CLASSROOM	SMALL GROUP	CARREL	CAI	OPERATOR TRAINER (INDIV.)	TEAM TRAINER	OPERATOR TRAINER LOCKED-STEP
Post Mission Critique	Positioning and serial movement	-	-	-	Med	High	High	High
	Using principles	-	-	-	Med	High	High	High
	Making decisions	-	-	-	Med	High	High	High
H. Advanced Electronic Warfare Support Measures Simulator Missions	Decision making	Low	Med	Med	High	-	-	-
	Written verbalization	-	-	-	-	-	-	-
	Mission Planning	-	-	-	-	-	-	-
Mission Practice	Recalling procedures	-	-	-	Med	High	-	High
	Using principles	-	-	-	Med	High	-	High
	Positioning and serial movement	-	-	-	Med	High	-	High
Post Mission Critique	Non-verbal detection	-	-	-	Med	High	-	High
	Non-verbal identification	-	-	-	Med	High	-	High
	Oral verbalization	-	-	-	Med	High	-	High
I. Fundamental Electronic Countermeasures Academics	Positioning and serial movement	-	-	-	Med	High	High	High
	Using principles	-	-	-	Med	High	High	High
	Making decisions	-	-	-	Med	High	High	High
Drill	Recalling facts and principles	Low	-	Med	High	-	-	-
	Using principles	Low	-	Med	High	-	-	-
	Mission Planning	Low	-	Med	High	-	-	-
Equipment Operation	Recalling procedures	-	-	-	Low	Med	High	High
	Positioning and serial movement	-	-	-	Low	Med	High	High
	Making decisions	-	-	-	Low	Med	High	High
Mission Planning	Written verbalization	Low	Med	Med	High	-	-	-
	Making decisions	Low	Med	Med	High	-	-	-
	Written verbalization	Low	Med	Med	High	-	-	-

OPTIONAL TRAINING TECHNIQUES

CURRICULUM PHASES	TASK CATEGORIES	OPTIONAL TRAINING TECHNIQUES						
		TRADITIONAL CLASSROOM	SMALL GROUP	CARREL	CAD	OPERATOR (INDIV)	TEAM TRAINER	OPERATOR LOCK-STEP
Mission Practice	Recalling procedures Using principles	-	-	-	Low	High	High	High
	Positioning and serial movement Non-verbal detection	-	-	-	Low	High	High	High
	Non-verbal identification Oral verbalization	-	-	-	Low	High	High	High
Post Mission Critique	Positioning and serial movement Using principles Making decisions	-	High	-	-	-	-	-
Attitude Development	Attitude - Willingness to perform	-	-	-	-	-	-	-
J. Fundamental ECM Simulator Missions								
Mission Planning	Decision making Written verbalization	Low	Med	Med	High	-	-	-
Mission Practice	Recalling procedures using principles Positioning & serial movement Non-Verbal Identification Non-Verbal Detection Oral Verbalization	-	-	-	Med	High	High	High
Post Mission Critique	Positioning and serial movement Using principles Making decisions	-	-	-	Med	High	High	High
K. Electronic Counter-Countermeasures Academics								
Drill	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-
	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-

OPTIONAL TRAINING TECHNIQUES

CURRICULUM PHASES	TASK CATEGORIES	TECHNIQUES						
		TRADITIONAL CLASSROOM	SMALL GROUP	CARREL	CALL	OPERATOR TRAINER (INDIV.)	TEAM TRAINER	OPERATOR TRAINER LOCKED-STEP
Equipment Operation	Recalling procedures Positioning and serial movement	-	-	Low	Med	High	-	High
Mission Practice	Recalling procedures Using principles Positioning and serial movement Non-verbal detection Non-verbal identification Oral verbalization	-	-	-	-	High	-	High
Post Mission Critique	Positioning and serial movement Using principles Making decisions	-	-	-	Med	High	High	High
Attitude Development	Attitude - willingness to perform	-	High	-	-	-	-	-
III. ADVANCED PHASE								
A. Mission Operations Academics	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-
Drill	Recalling facts and principles Using principles	Low	-	Med	High	-	-	-
Mission Planning	Making decisions Written verbalization	Low	Med	Med	High	-	-	-
Mission Practice	Recalling procedures Using principles Positioning and serial movement Non-verbal detection Non-verbal identification Oral verbalization	-	-	-	Med	High	High	High

OPTIONAL TRAINING TECHNIQUES

CURRICULUM PHASES	TASK CATEGORIES	OPTIONAL TRAINING TECHNIQUES						
		TRADITIONAL CLASSROOM	SMALL GROUP	CARETEL	CAI	OPERATOR TRAINER (INDIV.)	TEAM TRAINER	OPERATOR TRAINER LOCKED-STEP
Post Mission Critique	Positioning and serial movement	-	-	-	Med	High	High	High
	Using principles	-	-	-	-	-	-	-
	Making decisions	-	High	-	-	-	-	-
Attitude Development	Attitude - willingness to perform	-	-	-	-	-	-	-
	Recalling facts and principles	Med	-	-	-	-	-	-
B. Advanced Systems	Career planning and program orientation	Med	-	-	-	-	-	-
	Recalling facts and principles	Med	-	-	-	-	-	-
C. Career Information	Career planning and program orientation	Med	-	-	-	-	-	-
	Recalling facts and principles	Med	-	-	-	-	-	-

The training techniques for the three alternative training systems, Table 3, are defined as follows:

a. Traditional classroom - an instructor with 15 students supported by an overhead projector with transparencies, and sound slide programs supporting 20% of the classroom time.

b. Small group - an instructor possessing extensive fleet experience in EW, with 10 students, to discuss actual EW missions. Limited audio-visual media support required.

c. Multi-media carrel - an individual study booth equipped with slide projector, tape deck, synchronizing system for sound slide programs and 8mm sound motion picture projector supported with programmed instruction, tests and appropriate audio-visual media units.

d. Operator Trainer (Locked-Step) - a training device in which student stations, generalized to represent functional capabilities of present and projected electronic warfare equipment, are slaved together in groups of 15. All students in each group progress through the training problem at the same rate. Any group can pace through a curriculum independent of the others. The system features active learning and immediate feedback on performance.

e. Operator Trainer (individualized) - a training device in which student stations, generalized to represent functional capabilities of present and projected electronic warfare equipment provide individualized pacing. The system features student self pacing through each curriculum element, active learning, immediate feedback and individually defined remedial instruction.

f. Team Trainer - similar to the individualized operator trainers, above, except that student stations are slaved together, on a selectable basis, to provide team training. Any team can pace through a training problem independent of the other. The system features self pacing, active learning, immediate feedback and individually defined remedial instruction.

g. Debriefing Center - a facility for student/instructor interface to critique individual/team performance on simulated mission problems. Critique aids are inclusive of computer printout of individual mission performance and evaluation data, computer generated mission profile plots, and optimized problem scenario solutions.

h. Computer Managed Instruction System - an optical scanner to score chemical test type score sheets, and punch data on ADP cards.

- time shared central data processor.

- communication terminal for students or instructor to communicate with central data processor, to receive assignments, etc.

i. Computer Assisted Instruction (CAI) - involves the use of computers in highly individualized and interactive tutorial instruction. A form of CAI is incorporated in the operator trainer recommended in this report. Expansion of this capability is possible once experience is obtained with the system and as the state of the art in CAI advances.

5. OPERATOR TRAINER PROPOSED TECHNICAL APPROACH

The time compression factors from Table 4 were applied to the curriculum outline, Appendix D. Table 5 (page 153) is the result of this analysis. The data in Table 5 were used to derive the number of units per training technique per training system alternative shown in Table 6 (page 155).

Table 4

ASSUMPTIONS CONCERNING RELATIVE TIME REQUIRED
TO ACHIEVE A TRAINING OBJECTIVE USING VARIOUS TRAINING TECHNIQUES*

Types of Instruction	Tradi- tional Classroom	Small Group	Carrel	CAI	Operator Trainer	Operator Trainer (Indivi- dualized)	Team Trainer	Debrief- ing Facility
Academies	1		0.7	0.6				
Drills to Maintain Recall	1		0.7	0.6				
Equipment Operation			1	0.8	0.9	0.6		
Mission Planning		1	0.8	0.7				
Mission Practice (Operator Training)					1	0.7		
Mission Practice (Team Training)							1	
Post Mission Critique (Operator Training)	1				1	0.7		
Post Mission Critique (Team Training)							1	0.7

* These assumptions are estimates made by knowledgeable media specialists. In each case it is assumed that the noted amount of time compression can be achieved if the media are designed to function efficiently. Example in 7 hours of carrel instruction the same learning objectives can be reached that would require 10 hours of traditional classroom instruction to attain. The estimates were intentionally made conservative to avoid over stating the case. It is anticipated that a training system defined by use of this data will be considerably more efficient than projected herein.

Table 5

Curriculum Hours (per student)
for three Alternative Training Systems
for the proposed

Consolidated Electronic Warfare Operator Training Facility

Alternative	Training Technique Mix (hours)							
	Total Hours	Traditional Classroom Hours	Small Group Hours	Carrel Hours	Operator Trainer (Locked Step) Hours	Operator Trainer (Individualized) Hours	Team Trainer Hours	Debriefing Facility Hours
1. Traditional Classroom Operator Trainer (Locked Step) Team Trainer	675	518	-	-	123	-	30	4
2. Carrel Small group Traditional Classroom Operator Trainer (Locked Step) Team Trainer CMI	502	30	8	320	105	-	30	4
3. Carrel Small group Traditional Classroom Operator Trainer (Individualized) Team Trainer CMI	470	30	8	320	-	78	30	4

Three configurations of operator trainers are identified in Table 6. For Training Systems 1 and 2, a locked step trainer with 90 student stations and a team trainer with 30 student stations are required. For Training System 3, an individualized trainer with 60 student stations and a team trainer with 30 student stations are required. It has been found to be technically feasible to incorporate the team trainer into the physical configuration of both the locked-step and individualized operator trainers. The proposed technical approach for the locked step and the individualized operator trainers, presented below, includes the team trainer requirement. To facilitate technical description, the individualized operator trainer is discussed first.

a. Individualized Operator Trainer Proposed Technical Approach

(1) System Description - The proposed trainer, Figure 1 (page 156), is a computer controlled generalized device that will provide operator training in ESM, ECM and ECCM equipment capabilities and applications. The trainer contains 90 student stations configured by hardware and software design to function as completely independent units or in groups, instructor selectable, for team training. Students progress through curriculum segments at their own pace. Each student is evaluated and scored independently. Trainer features are inclusive of:

- (a) Digitally generated synthetic signal environment
- (b) High fidelity signal presentations
- (c) Computer assisted instruction

Table 6

Minimum Number of Units¹ per Training Technique
for Three Alternative Training Systems
for the proposed

Consolidated Electronic Warfare Operator Training Facility

Alternative Training Systems	Media Mix						
	Traditional Classroom	Small Group	Carrels	Operator Trainer (Locked Step)	Operator Trainer (Individualized)	Team Trainer	Debriefing Facility
1. Traditional Classroom Operator Trainer (Locked Step) Team Trainer	32	-	-	88 (90) ²	-	22 (30) ²	1 (1) ²
2. Carrel Small Group Traditional classroom Operator Trainer (Locked Step) Team Trainer CMI	2 (6) ²	Yes (incl. in classroom requirement)	203 (220) ²	80 (90) ²	-	22 (30) ²	1 (1) ²
3. Carrel Small Group Traditional classroom Operator Trainer (individualized) Team Trainer CMI	2 (6) ²	Yes (incl. in classroom requirement)	203 (220) ²	-	56 (60) ²	22 (30) ²	1 (1) ²

¹Numbers in () recommend a higher number of units, to provide flexibility in scheduling and engineering consideration related to the number of units driven by a single computer.
²Units refer to, e.g., number of classrooms, carrels, training stations, etc.

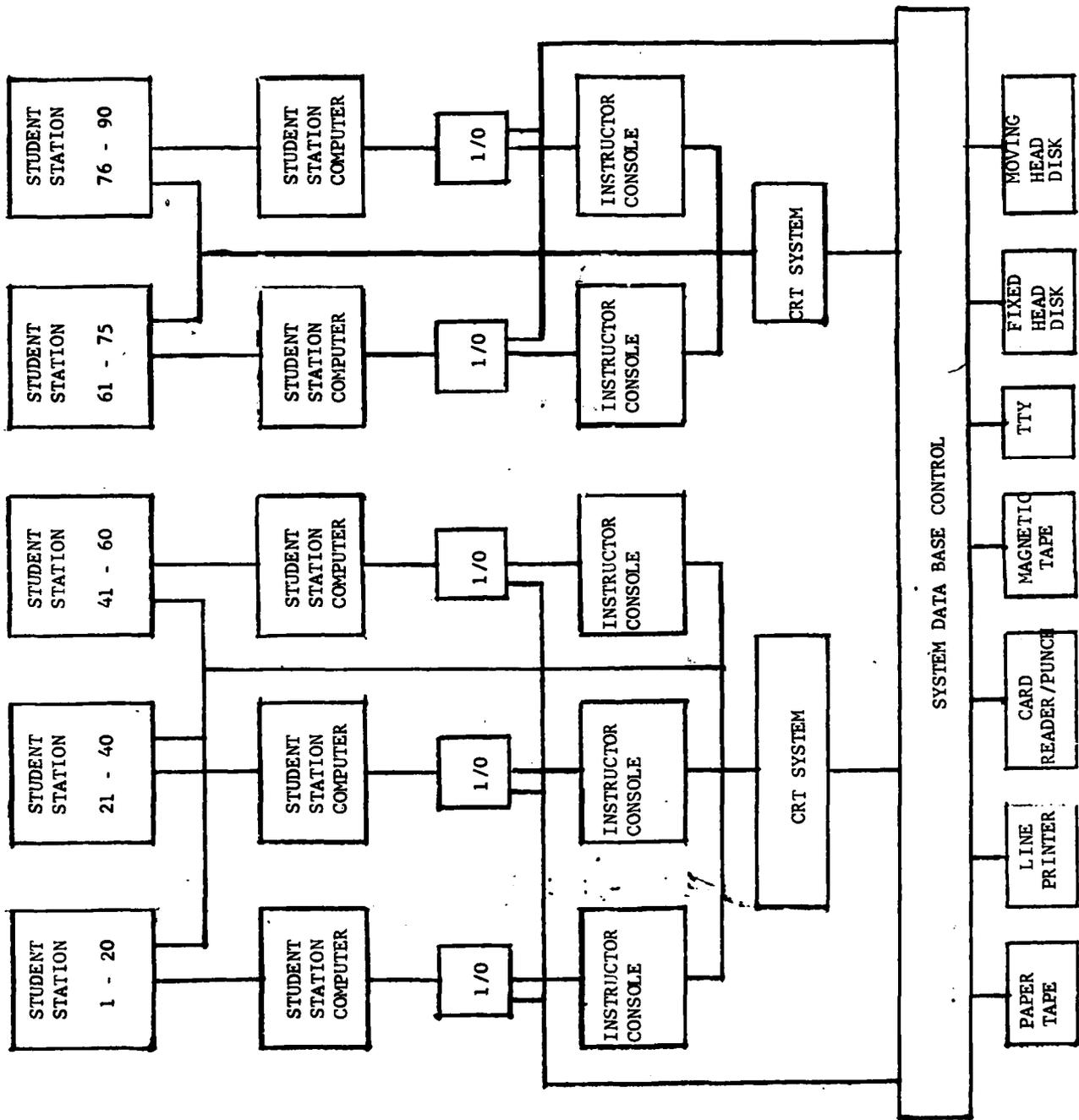


Figure 1. Generalized Electronic Warfare Operator Trainer (Individualized).

(d) Individualized instruction

(e) Independent student problem solution

(f) Real time performance evaluation

(g) Student stations configured to be representative of current and projected ESM, ECM, and ECCM equipment functions and capabilities.

(h) Low instructor to student ratio (1:10)

(2) Major Trainer Component Functions

(a) System Data Base Control (SDBC) - acts as system manager for the trainer. All trainer program elements, in modular software form, reside at the SDBC and are processed to other trainer subsystems as required.

(b) CRT System - provides digital TV data to the student stations and instructor consoles. Primary use is for instructional data display at the student station and student evaluation data display at the instructor console. Problem alphanumeric and graphics are provided to the student stations where curriculum segments involve operation of equipment possessing alphanumeric and graphic capabilities.

(c) Instructor Console - provides the primary interface between the instructor and student. Each instructor console requires two instructors; each instructor monitors 10 students. Via a CRT display system, computer derived student performance and evaluation data are provided the instructor. During training sessions computer activated console indicators continuously inform instructors of student progress during training, i.e., fast, normal, slow, requires assistance.

(d) Student Station Computer - Each computer controls twenty student stations as exclusively independent units with independent training problems.

(e) Student Station - a console unit containing generalized equipment faceplate configurations representative of present and projected electronic warfare hardware. Air, surface, and subsurface EW equipment types are depicted. A CRT display is provided for computer generated instructional data display. Each student station contains a synthetic signal source that generates, under computer control, the total signal environment for that station. A maximum of 75 signals simultaneously can be generated at a student station. The signal parameters are selectable from a stored signal library representing up to 1000 different emitter signatures.

(3) System Operational Concept - Individualized Operator Trainer - Each student will receive his appropriate curriculum element identification number and a student station assignment prior to each training session. Upon entering the student station, the student will enter the curriculum segment number, by key set, into the trainer computer system. This action initiates a data transfer from the system data base control to the student station computer that has problem control over the student's console. The curriculum element requested is transferred to the student station computer and the training period begins for that particular student. A CRT display at the student station instructs the student. The student utilizes specified ESM, ECM and ECCM equipments contained in

the student station console to respond to the computer generated situations. The student interacts with the trainer by answering questions, entering data, and manipulating controls.

When the student enters the curriculum element number into the computer system, an instructor console indicator registers that number, to advise the instructor of the curriculum element being taught. The instructor monitors the student's progress by observing the student progress status indicators and/or by requesting student evaluation data from the data base computer, where this data is continuously being stored as the training session progresses. Data request is by key set entry. During the training session, the student station computer may momentarily freeze the problem for a particular student, independent of all others, to provide the student with additional instructional information, when student response to problems is in error. This condition will be indicated at the instructor console. If the student's response to a given situation is continuously in error, the computer will halt the problem for that student and alert his instructor. The instructor can communicate with the student as well as request pertinent problem parameter data for display on his CRT system. The instructor will aid the student in making the proper response. The instructor will clear the computer halt for that student station and the training session will continue where it left off.

At the end of the training session, the student's performance, his score and pertinent mission data is stored in the system data base control. This data will be retrieved by the instructor via line printer copy.

b. Locked Step Operator Trainer Proposed Technical Approach

(1) System Description - The proposed trainer, Figure 2 (page 155) is a computer controlled generalized device similar to the individualized trainer, with the following exceptions:

(a) The trainer contains 120 student stations. Thirty stations function independently, in the same manner as the student stations in the individualized trainer. These 30 stations can be configured for team training. Ninety student stations are configured by hardware and software design to function in six groups of 15 stations each. In operation, all 15 stations per group are locked-in to working the same problem. Individual students in each group of 15 can complete a problem segment independently. However, students will not progress to new curriculum segments until all 15 students in a group are ready.

(b) The five student station computers of the individualized trainer are replaced by one simulation computer. This computer controls six independent training problems simultaneously for the six groups of student stations.

(c) Ninety student stations do not contain individual synthetic signal sources as in the individualized trainer. In lieu of this, six synthetic signal sources are provided, one per each group of 15 student stations. The synthetic signal source functions identical to the one described for the individualized trainer. This configuration will degrade system capability for those curriculum segments requiring student derived ECM and ECCM. For those situations, the 75 available synthetic

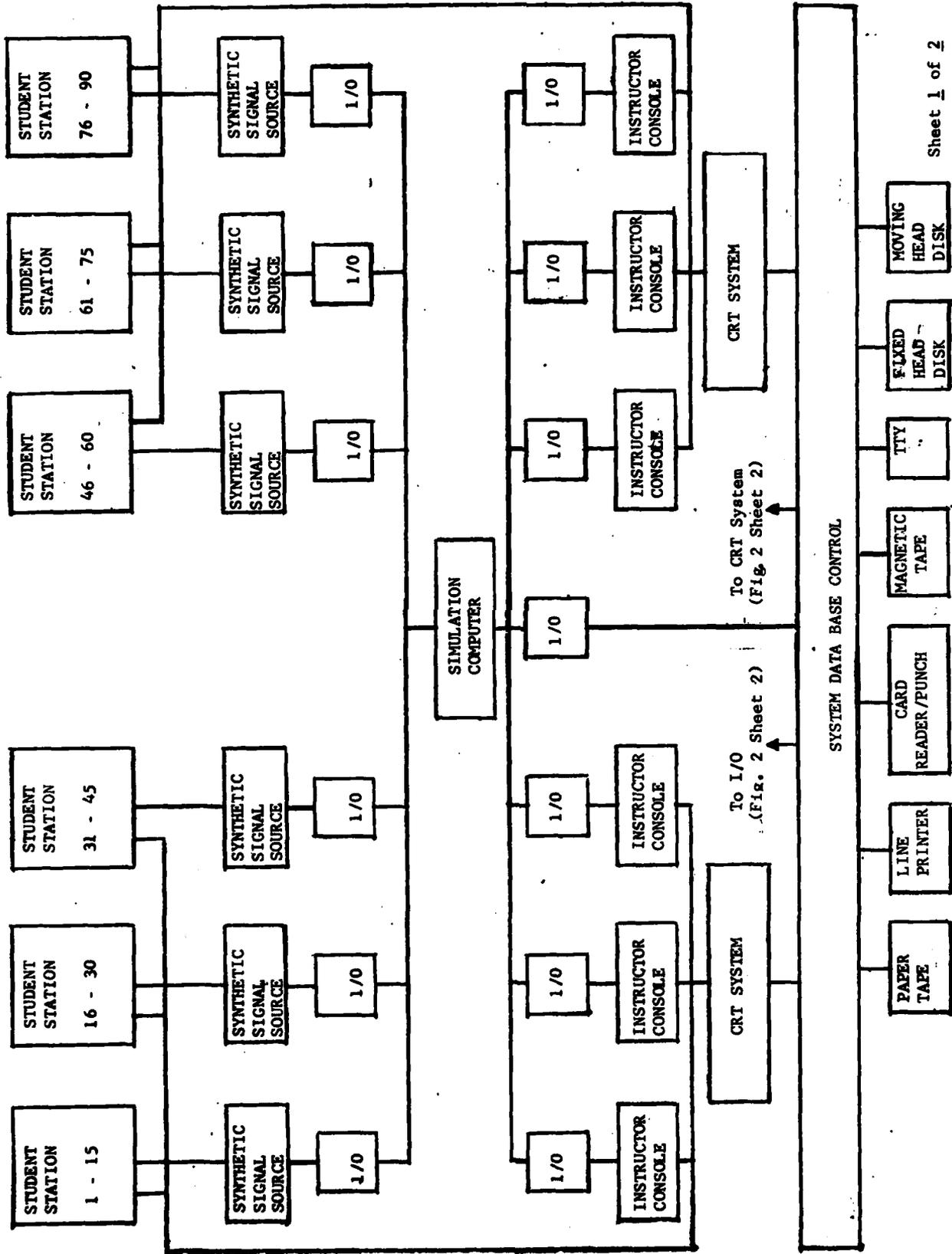
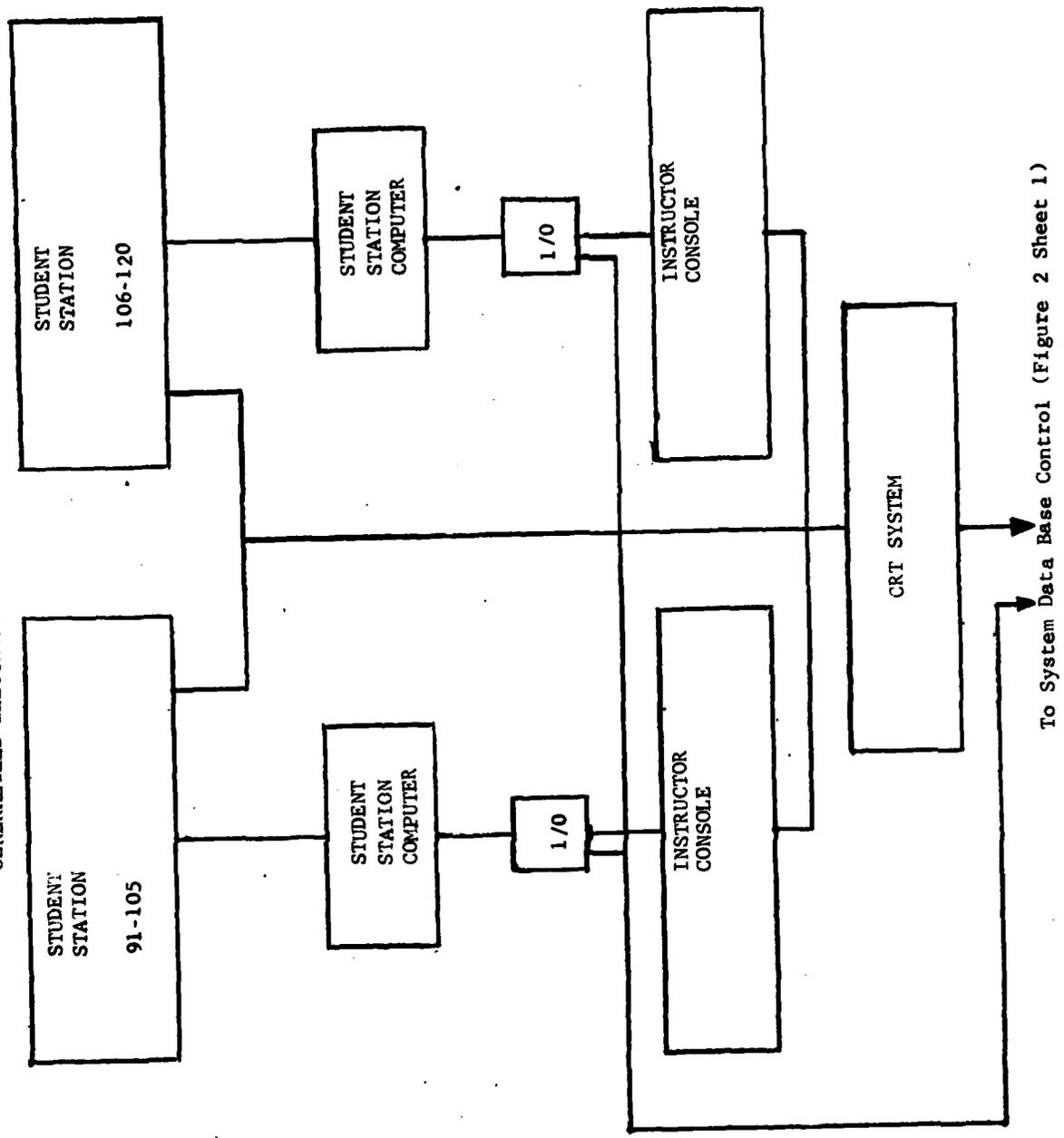


Figure 2. Generalized Electronic Warfare Operator Trainer (Locked Step).

GENERALIZED ELECTRONIC WARFARE OPERATOR TRAINER (LOCKED STEP)



signals will be grouped into 15 groups of five signals each. Each group of five signals will be routed to separate student stations, under program control. Each student station will see only those five signals assigned and the student will respond to only those signals, independently of other students.

7. RECOMMENDATIONS

It is recommended that the Chief of Naval Training consider alternate operator training system 3, Table 3, page 141, proposed in this report as the prime candidate for meeting the operator training requirements for a consolidated EW training facility. Budgetary cost and lead time data with life cycle cost analysis developed for the alternative operator training proposed herein and submitted to CNT under separate cover, has identified operator training system alternative 3 as the most cost effective of the alternatives proposed. Procurement of the operator trainer (individualized) should be preceded by a contract definition phase. Contract definition should be limited to no less than two contractors.

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Training Analysis and Evaluation Group ✓ Naval Training Equipment Center Orlando, Florida 32813	2a. REPORT SECURITY CLASSIFICATION [REDACTED] 2b. GROUP
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3. REPORT TITLE

(d) **Electronic Warfare Training Analysis** (9) **Final Repts**

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Final Report

5. AUTHOR(S) (First name, middle initial, last name)

(10) **William P. Lane, Bernard J. McElvenny, Willard B. Stubbs, Edward O. Moore, Jr., Ted E. Pearson, and Lawrence R. Bauer.**

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
(11) 1972	170	0

8a. CONTRACT OR GRANT NO. b. PROJECT NO. NTEC Work Assignment No. 1012 c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) TAEG Report 4 ✓ 9b. OTHER REPORT NUMBER (Any other numbers that may be assigned this report) 14 TAEG-4
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10. DISTRIBUTION STATEMENT

Approved for Public Release; Distribution is unlimited.

(12) **2682**

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
None	Training Analysis and Evaluation Group Naval Training Equipment Center Orlando, Florida 32813

13. ABSTRACT

This report describes the findings from an analysis of the training requirements for electronic warfare equipment operators and supports the feasibility and desirability for a consolidation of training for operators of air, surface and subsurface EW equipment. The report contains a proposed curriculum for the consolidated training program and a description of a generalized operator training system. Actions for improving the effectiveness of existing EW training facilities are recommended.

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KEY WORDS

LINK A LINK B LINK C
ROLE WT ROLE WT ROLE WT

Training Analysis
Training Technology
Generalized Training
Training Commonality
Equipment Commonality
Training Curriculum
Training Effectiveness