VOL. II

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REPORT

OF THE

AIR-TO-AIR MISSILE SYSTEM

CAPABILITY REVIEW (U)

JULY—NOVEMBER 1968

APPENDIX III

NAVAL AIR SYSTEMS COMMAND

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APPENDIX III

REPORT OF TASK TEAM THREE

Chairman: CDR. B. H. Gilpin, USN, Naval Missile Center, Pt. Mugu

"Do shipboard and squadron organization (afloat and ashore) launch on optimally ready combat Aircraft-Missile System?"

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INTRODUCTION

A. The mission of Task Team Three was to determine if shipboard and squadron organizations (afloat and shore) launch an optimally ready combat aircraft-missile system. Problems reported during the air-to-air symposium were investigated and, during subsequent investigation, additional problems were revealed. This report contains recommended solutions or recommends additional investigation where insufficient information is available.

B. The major portion of the report and the majority of the reported problem areas pertain to the SPARROW missile system. While many of the problems equally affect the SIDEWINDER missile, the lower combat reliability of the F-4/SPARROW and its importance as a primary air-to-air weapon system accentuated the SPARROW problem areas.

C. The following considerations are highlighted in those sections of the report which follow:

1. The manning and performance of CVA missile shops and squadrons suffers from the overall Navy shortage of electronics maintenance personnel. Several problem areas such as inadequate training aids and lack of training equipment require immediate action. Because of SEA (Southeast Asia) operation the experience level in the CVA missile shops and squadrons is presently at the highest level since the introduction of guided missile systems. Training, however, is still largely a 'bootstrap' operation in many areas and a reduction in SEA operations will drastically increase the importance of a comprehensive, coordinated training program in maintaining the proficiency of Fleet enlisted personnel.

2. With the increasing complexity of weapon systems and the multitude of support equipments required to maintain them, the provision of suitable operational and maintenance technical manuals is a major problem. New techniques in information collection and display must be adopted. The preparation of all weapon loading manuals and checklists at one central activity (NWEF) is significantly improving the quality of these documents.

3. An effective air-launched missile technical proficiency inspection for deploying CVA's and squadrons, patterned after the Nuclear TPI, would provide a significant increase in missile system readiness and is considered to be one of the more important recommendations of this report. Implicit in the inspection function is the necessity for follow-up and continuing technical support in the forward area to ensure that deficiencies are, in fact, corrected and that desired performance levels, once attained, are maintained.

4. The attention focused on test philosophy for air-launched missiles, particularly the SPARROW, is attributed to the lack of user's confidence in the overall weapon system reliability. In actuality, varying the test frequencies, or changing the test equipment for missile guidance section testing, has had little effect on the overall system reliability. Reliability improvements are required, however, and must be attacked through better quality control and maintenance and surveillance procedures.

5. Safety requirements for air-to-air missiles aboard CVA's are confusing and contradictory and are in conflict with operational requirements. A thorough study of air-to-air weapons systems safety parameters and requirements must be undertaken, and overall coordination of safety instructions must be improved.

6. There are numerous minor SPARROW logistic problems which should be corrected. The F-8/AIM-9C SIDEWINDER system is not receiving logistic support. The required support should be provided, or the decision should be made to cancel the AIM-9C program.

7. Increased emphasis is required on the development, procurement, and support of adequate shipboard support equipment. The existing problems are attributed to fund limitations and to the lack of overall direction and management.

8. Changes in Navy and Marine Corps policy vis a vis air-to-air weapons system maintenance and employment are required. Of major importance is an increased emphasis on maintainability and reliability problems in the Fleet, with less emphasis, or even a moratorium, on performance improvements.

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I. TRAINING/PERSONNEL

Training and personnel problems involve personnel allowances, the availability of training aids, up-to-date equipment, types of training available, and basic training methodology.

A. Manning of CVA Missile Shops

Discussion and Conclusion

At present there are not enough qualified individuals staffing G/M (Guided Missile) Shops aboard CVA's.

Recommendation

The following minimum personnel allowances be authorized for CVA Air-Launched G/M Shops:

1 - AQC or ATC with NEC-7916
1 - AQ-1 NEC-7916
1 - AQF-2 NEC-7916
3 - AO1
5 - AO2
11 - AO3
20 - AOAN
42 - Total

B. Non-Flying Ordnance Officers for VF Squadrons

Conclusion

An ordnance ground officer should be assigned to both F4 and F8 squadrons to provide the important focus of attention to all of the weapons functions and, in particular, to air-to-air missile capability.

Recommendation

BUPERS assign an ordnance ground officer to all fighter squadrons.

C. Training Aids and Equipment at NAMTRADETS

Discussion

The NAMTRADET courses in missile assembly, handling and checkout utilize borrowed missile sections when available. In some instances the components are not of current configuration. Components, such as inert motors, have been manufactured by the contractors for Air Force classroom training;

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however, the NAMTRADETS are forced to use expended motor cases acquired from NAVMISCEN. Support equipments in use at the NAMTRADETS do not have the latest changes such as that required to test the AIM-7E2.

Conclusion

The training aids and equipments used by the NAMTRADETS in missile training should be of the latest configurations, designed specifically for training use where necessary, and should be procured in adequate numbers. None of these conditions presently exists.

Recommendations

1. The equipment shown in Tab A should be supplied to all NAMTRADETS providing instruction in SPARROW and SIDEWINDER missile systems. This is considered to be the minimum equipment requirements to sustain SPARROW and SIDEWINDER training.

2. NAVAIRSYSCOM (AIR-534) ensure that NAMTRAGRU receives SSE Change Kits prior to their fleet introduction.

3. NAVAIRSYSCOM (AIR-413) provide for training for a minimum of four (4) NAMTRAGRU instructors on all proposed changes to SSE.

D. AIM-7E2 Maintenance Training Film

Discussion

Initial maintenance training for AIM-7E2 will be conducted by Raytheon Company as a part of the contract defined by NAVAIRSYSCOM. This training will start in December 1968. Additional requirements for updating missile assembly crews and missile loading crews exist from a shipboard environment standpoint.

Conclusion

An updated AIM-7E2 SPARROW maintenance training film should be produced, stressing missile assembly, handling, loading and identification of the AIM-7E2 as associated with shipboard missile shops, shipboard handling and loading procedures.

Recommendations

1. The AIM-7E2 SPARROW maintenance training film be produced by Raytheon Company without cost to the Navy. This film will be reviewed by Westinghouse Company, McDonnell Aircraft Company, Naval Missile Center, and Naval Air Systems Command prior to release to fleet squadrons. This training film should be completed as soon as possible and distribution to all fleet squadrons be controlled by Chief of Naval Operations (OP-563).

2. CNO and NAVAIRSYSCOM review requirements for a similar film on SIDEWINDER and direct NAVMISCEN to produce.

E. Device 5F8 SPARROW/SIDEWINDER/F4J AWG-10 Sound/Slide Programs

Conclusion

The 5F8 sound/slide programs for the SPARROW/SIDEWINDER and F4J AWG-10 are extremely valuable in the training of aircrews and maintenance personnel in Naval Aviation Maintenance Training Detachments (NAMTD), Carrier Readiness Attack Wing Squadrons (RCVW's) and Fleet Squadrons.

Recommendation

There is a need to publish a matrix for current and projected 5F8 programs for the SPARROW, SIDEWINDER and F4J AWG-10. Additionally, these sound/slide tapes must be reviewed, revised and updated prior to introducing new missile/weapons systems or modifications thereof in fleet squadrons. These sound/slide tapes should complement and be coordinated with programmed instruction/publications.

F. Visual Training Aids (Dilbert Type Posters)

Conclusion

The posters, or visual training aids, will provide a humorist approach to the problem associated with missile handling, missile buildup, missile loading, and aircrew procedures. The importance of the problem areas will become uppermost to the maintenance crews and aircrews.

Recommendation

The "Dilbert Type" posters should depict problem areas in the Missile/Weapons System that can be controlled by training or increased knowledge of the system. A series of posters, approximately twenty, to be developed using a common characterization of a Navy man doing all the wrong things to the Missile/Weapons System.

A proposal will be submitted by Raytheon Company in November 1968 for the series of posters. Raytheon will provide the art work associated with this training at no cost to the Navy. An alternate proposal will include printing and distribution. Navy distribution will be controlled by Naval Safety Center (Code 70), and the Chief of Naval Operations (Op-562).

G. Programmed Instruction for F4/SPARROW Weapons System

Conclusion

Technical publications are difficult to read and comprehend the information that is presented. Missile publications and weapons systems publications both fall into this category. A series of Manuals that are easily read, understood, and contain systematic examinations for maintenance personnel and aircrews are required during deployments to refresh and instruct personnel in ready rooms and missile spaces without formal classroom instruction.

Recommendation

Programmed instruction manuals should be provided in three areas:

1. Missile Assembly and Testing
2. Missile Handling and Loading
3. Aircrew Procedures

The manuals should be produced in sufficient quantity to insure adequate distribution to operating units, NAVWEPSTAs, and aircraft carriers. A proposal by Raytheon Company will be submitted in November 1968 for the three areas indicated. The distribution of the programmed instruction manuals should be controlled by the Chief of Naval Operations (Op-562).

H. Location of AIM-7 Missile Test Equipment Schools

Discussion

Relocation of the DSM-32/DPM-7 Schools and associated equipments from Jacksonville, Florida to Oceana, Virginia, is necessary to provide better and closer liaison with AIRLANT squadrons and CVA's.

Conclusion

AIM-7 missile test equipments for training are not presently located for best utilization.

Recommendation

NAMTRAGRU move East Coast AIM-7 training assets from NAS, Jacksonville to NAS Oceana as soon as possible.

I. Training of Missile Loading Personnel

Discussion

Poor training and non-standardization of missile loading teams results in excessive missile damage during aircraft rearming. In addition, the lack of training is a significant factor in causing the high misfire rate during combat firings. Presently, there is no mandatory requirement for formal schools, on-the-job training, proficiency inspections, or standards for VF squadron aircrews and missile loading crews. Additionally, there is no missile loading crew concept established in VF squadrons today which clearly defines individuals responsible for air-to-air missile handling loading.

Conclusion

Training and qualification of missile loading teams results in missile damage and misfires. An adequate training and certification program is urgently required.

Recommendations

1. Implement standardized air-to-air missile loading crew training, procedures, and inspections, based on lessons learned in nuclear weapons programs.

2. Type Commanders issue implementing instructions as required by OPNAVINST 3571.3.

3. The Fighter Weapons School in the RCVW's, assisted by VX-4 and NAVMISCEN, ensure that missile loading and unit inspection criteria are complete, valid, and up-to-date.

4. Establish an air-to-air missile loading team course in the RCVW at NAS Oceana and NAS Miramar.

5. Establish missile loading crews in each VF squadron, consisting of 6-9 enlisted, with missile loading designated as a primary responsibility.

J. Schools for Guided Missile and Squadron Ordnance Officers

Discussion

1. Existing schools for CVA Guided Missile Officers and squadron ordnance officers are not adequate. Schools presently provided for G/M personnel consist of test equipment operation and maintenance, and shipboard handling and missile assembly. A summary course designed specifically for G/M officers and squadron ordnance officers is required, encompassing the theory of operation, test equipment, Fleet problems, publications and reporting requirements.

2. There is a lack of supervisors trained in the handling and assembly of the SPARROW missile.

Conclusion

A school in missile systems is required, tailored to the specific requirements of G/M officers and squadron ordnance officers.

Recommendations

1. Establish a one-week course for squadron ordnance officers and a two-week course for CVA G/M officers at NAVMISCEN or at NAMTRADET's at NAS Oceana and NAS Miramar.

2. COMNAVAIRLANT and COMNAVAIRPAC ensure that a minimum of two missile shop supervisors from each CVA have attended the AIM-7 missile handling and assembly course taught by NAMTRADET's.

K. Enlisted Training Plan

Discussion

Adequate numbers of supervisory personnel (CPO/1st/2nd) are not available to meet allowances in critical rates of fighter squadrons and CVA's due to low U. S. Navy reenlistment rates. "A" schools (AO/AQ/AT/AE) are presently operating at 100 percent of capacity, yet annual fleet student graduate requirements are still in excess of "A" school capability. Non-rated personnel (without "A" school) are being assigned to augment these squadron/ship shortages of supervisory personnel.

A review was conducted at the Aviation Ordnance "A" School, NATTC, Jacksonville, Florida, of the syllabus, NAMTRADET specialized training, and BUPERS/USMC procedures for ordering enlisted personnel to CVA's and squadrons. The present AO "A" school capacity is 1500 USN and 500 USMC graduates per year based on a syllabus of 17.6 weeks. The current annual fleet requirements are 2279 for the U. S. Navy and approximately 700 for the U. S. Marine Corps. Based on the present AO "A" school syllabus, this means that there will be a shortage of 779 USN and approximately 200 USMC "A" school graduates during FY 69 due to lack of MILCON and instructor personnel. Additional barracks and mess halls would be required to increase AO "A" school capacity. The review revealed that the present AO "A" school syllabus could reasonably be compressed from 17.6 weeks to 12.5 weeks. Further, weekly student inputs can be increased from 40 (30 USN and 10 USMC) students per week to 60 (46 USN and 14 USMC) students per week with no increase in facilities (MILCON) or instructors. This would result in an annual input of 2300 USN and 700 USMC students in AO "A" school. The 12.5 week syllabus involves streamlining to eliminate unnecessary information that would be specialized later in the NAMTRADET syllabus, according to the ultimate duty station of the individual. An example of the present and recommended flow is as shown in Tabs C-1 and C-2.

Conclusions

1. An increase in AO "A" school output, coupled with revised syllabi, would permit the U. S. Navy and U. S. Marine Corps to meet current annual requirements with additional, better qualified personnel. Further it will provide standardized entry level personnel for the ordnance rating system.

2. Additional studies of AQ/AT/AE "A" schools are required to determine if the respective syllabi can be streamlined to eliminate information to be covered by specialized training later in the NAMTRADETS, thereby increasing school capacity and improving quality of graduates to CVA's and squadrons.

Recommendations

1. CNO, BUPERS, and CNATECHTRA examine the first term enlistment training program to emphasize: training vice education, earlier contact with hands-on-hardware training, earlier contact with current fleet equipment and procedures, and increased utility of the first term enlistee.

2. CNATECHTRA examine "A" school syllabi for AO's, AE's, AT's and AQ's, coupled with follow-on specialized training in the NAMTRADETS and the RCVN's with the objective of providing functionally qualified personnel in the numbers required by the Fleets.

3. Examine BUPERS/EPDOPAC detailing procedures to ensure that personnel trained in air-to-air missilery are initially detailed and retained in that job capacity throughout their first enlistment.

4. Institute a 12.5 week streamlined AO "A" syllabus as soon as possible with a concomitant increased student input of 60 per week.

5. Establish shipboard air missile assembly and handling courses at NAMTRADETS Oceana and Miramar. These courses would be phased to include all air launched missiles as they are introduced into the fleet. The initial courses should cover SPARROW and SIDEWINDER, as well as the present air-to-surface missile family.

6. Establish shipboard conventional ordnance handling and assembly courses for AO-3 and below at the present Air-Launched Weapons NAMTRADETS.

7. Establish organizational level missile and bomb handling courses at the existing Weapons System NAMTRADETS. These courses should be specialized to meet squadron needs by type aircraft (F4, F8, A4, A6, A7). These courses should be in addition to the present weapons system maintenance courses.

8. Establish On-the-Job Training in the RCVW's to provide loading team training for each type of Fleet aircraft.

II. PUBLICATIONS/REPORTING

There are several problems in publications and reporting procedures which directly affect CVA operation.

A. Aircraft/MCS Maintenance Publications

Discussion

1. Maintenance publications have not changed appreciably in the past few years and have been generally unsatisfactory. With the advent of more complex weapons systems, the problem of maintaining current publications places an unnecessary burden on maintenance activities.

The operational effectiveness of air-to-air missile systems is being adversely affected by relatively low manpower productivity, especially in the maintenance area. In fact, there is some evidence indicating that the manpower productivity of maintenance personnel has been decreasing over the years at the same time that the complexity and inherent capability of the weapon systems has been increasing. The acuteness of the problem of ineffective manpower productivity will continue to increase unless some drastic changes are made in the very near future.

2. Analysis of aircraft maintenance statistics has revealed that an abnormal amount of time is being spent in information research and troubleshooting, particularly in the unscheduled maintenance area. Handbooks, the present form of data available, have become increasingly cumbersome as the complexity of the associated aircraft and systems increase.

3. One new concept in maintenance information, designed to reduce maintenance manhours, has been developed by the McDonnell Douglas Corporation. The system, called WSMAC (Weapon System Maintenance Action Center) was originally created for the Phantom II aircraft produced in St. Louis, Missouri for the United States Navy and Air Force. Using a microfilm storage system and a retrieval unit built by Eastman Kodak Company and utilizing their commercially proven MIRACODE system, WSMAC provides access to any and all technical data by button selection. Codes, compatible with work unit codes for maintenance accounting, set into the keyboard, allow retrieval in seconds of any request. Operation of the unit is simple and requires no specially trained operator.

4. McDonnell-Douglas reports that the WSMAC system in use at their plant has saved thousands of dollars in aircraft maintenance search time alone.

5. Other approaches to improve manpower productivity are available. Project PIMO (Presentation of Information for Maintenance and Operation) developed by Serendipity Incorporated for the USAF C-141 system is a good example. A proposal to develop maintenance job guides for the AN/AWG-10 Missile Control System for the F-4J aircraft has been submitted to NAVAIRSYSCOMHQ in October 1968 by Serendipity Incorporated, Chatsworth, California.

<u>Conclusion</u>

System maintenance publications are voluminous, difficult to use and understand, difficult to maintain current and consume many man-hours to revise and maintain. Concepts such as WSMAC and PIMO offer potential solutions to these publications problems.

<u>Recommendations</u>

1. Extend contractor support to the VF92 WSMAC evaluation to include the first 90 days of the WESTPAC deployment.

2. NAVAIRSYSCOMHQ assign a high priority to explore all avenues of presenting maintenance information that will result in a dramatic improvement in manpower productivity.

3. NAVAIRSYSCOM use the AN/AWG-10 Missile Control System as a test system to evaluate methods of improving the presentation of information for maintenance and operations. Review the proposal submitted by Serendipity Incorporated to develop maintenance job guides, expanding as necessary to include a coordinated evaluation of WSMAC, PIMO, RAPID, and other proposals/concepts for the presentation of technical information.

B. <u>Missile Publications for Operations and Maintenance</u>

<u>Discussion</u>

1. During September 1968 publication review conferences were conducted to review and correct deficiencies in the technical manuals for both SPARROW and SIDEWINDER. Brief summaries of the conferences are as follows:

<u>SPARROW</u> - Discrepancies between manuals due to duplication of information and different revision dates will be eliminated by consolidation of manuals where possible. Information contained in various OP's and NAVORD publications will be consolidated in NAVAIR manuals. All pertinent technical manuals will be declassified where possible. The contractor will provide an AIM-7 SPARROW missile Technical Manual Guide (TMG) listing all technical manuals. The TMG will be revised every 90 days. Tactical/NATOPS manuals were not reviewed.

SIDEWINDER - ALL SIDEWINDER technical manuals were reviewed and action assigned for correction of deficiencies. Several problems reported consisted of manuals not being revised following initial distribution, specific requirements for Marine Corps operations and All-Up-Round concept not being reflected in the manuals, and data in conflict with official publications being published in unofficial bulletins released by various field activities. Review of Tactical/NATOPS manuals revealed that descriptive data and launch envelopes were not up-to-date in all manuals.

Recommendations

1. NAVAIRSYSCOM assure follow-up and correction of deficiencies reported by NWC letter Serial 4255 of 2 October 1968.

2. NAVAIRSYSCOM review status of Tactical/NATOPS manuals for SPARROW missile and expedite revision.

3. NAVAIRSYSCOM implement revision of technical manuals for SPARROW and SIDEWINDER.

C. Conventional Weapons Loading Manuals and Checklists

Discussion

1. There are numerous inadequacies and conflicts concerning airborne stores loading manuals and conventional weapons release and control checklists.

2. NAVAIRINST 5400.2 issued 27 July 1966 established a program to provide centralized verification of stores/aircraft combinations for operational compatibility at NWEF (Naval Weapons Evaluation Facility), Albuquerque, New Mexico. This instruction applies to all publications intended for general Fleet use that relate to combinations of stores (including nuclear weapons) and aircraft.

3. A review of recent aircraft accidents and incidents involved with the carriage and release of airborne stores has revealed that conflicts and inadequacies exist in current publications concerning airborne stores, their preparation, loading, carriage and release. The lack of proper instructions has resulted in various improvised Fleet procedures, some of which have been improper and unsafe. Additionally, related information was found to be scattered throughout various manuals.

4. NWEF currently prepares loading manuals, conversion manuals, release and control checklists and stores reliability cards for each aircraft/store combination as appropriate.

5. NWEF verifies procedures for loading, unloading, suspension checkout and release of airborne stores.

6. NWEF also prepares corrections to preliminary technical manuals submitted for verification and prepares advance changes to published documents when required.

7. Specific problem areas and recommendations that will enable NWEF to provide adequate, accurate and current publications are contained in the following paragraphs. If these problems are corrected the overall system effect will increase system reliability and safety.

a. Problem:

Acquiring accurate timely data for development of conventional weapons checklists by NWEF.

(1) Discussion:

It is extremely difficult for NWEF to acquire timely accurate source data for developing conventional weapons checklists. This problem is very apparent in the areas of new weapons, weapon improvement, aircraft modifications, SSE, and handling equipment.

(2) Recommendations:

(a) Include NWEF representatives as a part of BIS (Board of Inspection and Survey) Trials and OPEVALS (Operation Evaluations) at NAVMISCEN and NATC Patuxent River and provide administrative and technical support to these representatives in developing or modifying procedures to ensure that accurate checklists are available when new or updated aircraft are introduced into the Fleet. All BIS and OPEVALS should use proposed or existing Naval Weapon Evaluation Checklists to determine their adequacy.

(b) In the development of a new weapon or modification of an aircraft, Cognizant Field Activities/Participating Field Activities (CFA/PFA) and/or prime contractors provide NWEF with a data package containing recommended loading procedures, SSE (Special Support Equipment), and release and control systems checks.

(c) NWEF establish a technical records center containing source data for conventional weapons checklists. CFA/PFA or prime contractor provide updated source data to NWEF on existing systems and programmed systems.

b. Problem:

Difficulty in verifying conventional weapons checklists/manuals.

(1) Discussion:

Since verification normally involves the use of Fleet assets (aircraft, weapons, equipment, facilities and personnel) belonging to the using commands, it is difficult, time consuming, and requires numerous trips on the part of NWEF personnel in the verification of checklists - manuals.

(2) Recommendation:

CNO (Chief of Naval Operations) issue a directive to type commands to provide necessary Fleet configured, operationally ready assets, on a priority basis to NWEF, for checklist verification as required by NWEF.

c. Problem:

Lack of technical support and review of checklists by CFA, PFA, or prime contractor prior to verification.

(1) Discussion:

It is presently difficult and time consuming on the part of NWEF to acquire necessary accurate technical information and inprocess review of proposed checklist/manuals.

(2) Recommendation:

Naval Materiel Command direct NAVAIRSYSCOM and NAVORDSYSCOM (Naval Ordnance Systems Command) to provide timely technical support and inprocess review by CFA, PFA, and prime contractor on all conventional weapons checklists and manuals prior to verification by NWEF.

d. Problem:

Preparation of reproducible checklists and SRCs (Stores Reliability Cards) is time-consuming.

(1) Discussion:

At present tape-type machines using manual inputs are employed. Investigations are underway to determine the feasibility of using computers to store and reproduce data for revisions and changes to checklists and SRCs. Using computers would reduce the time required to produce changes and revisions considerably.

(2) Recommendation:

Fund NWEF for computer services to facilitate increased volume of changes and revisions.

8. NWEF has the responsibility to provide verification of stores/aircraft combination for operational compatibility. NWEF is continuing to develop and improve conventional weapons checklists/manuals. The main problems encountered by NWEF are lack of equipment, technical support, and to retain trained qualified personnel to write and verify checklists. At the present time there are four highly qualified officer personnel scheduled to depart NWEF by March 1968. This will require 6 months to a year to re-establish present expertise. The Ordnance Technical Publications Division is staffed by 8 Naval Officers, 8 enlisted personnel, and 8 civilian personnel with approval for 4 additional civilians who are responsible to write and keep updated over 600 conventional weapons loading manuals/checklists and SRCs. The Facility has a limited amount of assets which would enable checking and verification checklists on-site. This requires NWEF personnel to travel extensively to update existing procedures and develop new checklists/manuals.

Conclusion

NWEF has received limited support from CFAs, test and evaluation facilities, and Fleet units in form of UR's access to equipment, technical support and in-process review. If NWEF is to continue to provide adequate, timely and accurate procedures, steps should be taken to eliminate stated problem areas. One of the most important ways to attain reliability and safety is to provide adequate, workable, accurate and current checklists to operating Fleet units. This can be accomplished by NWEF, if adequate support, personnel, and assets are provided.

Recommendations

Immediate

(1) Direct CFAs, PFAs, and test and evaluation facilities to provide technical support and assets as required by NWEF.

Long Term

(2) Automate reproduction of checklists and SRCs by using computer devices.

(3) Allot a minimum of 600K dollars for a building program to increase existing facilities. Increase existing manning to adequately cover existing requirements as illustrated in TAB E.

D. Missile Malfunction Reporting

Discussion

1. There are presently 9 reports related to missile malfunctions. These reports are:

(a) Accident (Aircraft and Explosive Ordnance)

(b) Incident (Aircraft and Explosive Ordnance)

(c) Ordnance Malfunction (Major and Minor)

(d) Safety UR

(e) Special UR

(f) AAMREP

(g) AAMREP (Captive Flight)

(h) Guided Missile Service Record (GMSR)

(i) Individual Missile Logbook

2. The malfunction of an air-to-air missile requires that operating activity personnel select the appropriate report(s) to fit the situation. The report types, formats and instructions are listed in TAB D.

3. The 3M system has features which report malfunction and usage. Reports 6 through 9, above, tend toward adaptation to the 3M system.

4. The UR reporting system and the Ordnance Malfunction reporting requirements both contain provisions which apply to missile malfunctions not of the explosive ordnance nature.

5. The GMSR (Guided Missile Service Record) contains information which could be readily combined with other information.

6. The classification of the missile logbook complicates complete and accurate recording. No provisions are made to report malfunctions of missile test equipment.

Conclusions

1. The numerous reports, reporting formats and reporting instructions which deal with air-to-air missile malfunctions are both time-consuming and confusing to personnel in operating activities.

2. Technical information reports and malfunction reports should be consolidated to the maximum extent possible.

3. The 3M system offers a possible method to reduce the number of reports and to provide automatic reporting of usage and of some malfunctions.

4. Provisions must be made to include missile test equipment in the reliability reporting system.

Recommendations

1. NAVAIRSYSCOM revise NAVAIRINST 4700.2 to include UR reporting of air-to-air missile and missile test sets rather than Ordnance Malfunction reporting.

2. NAVAIRSYSCOM in conjunction with FMSAEG, FWSGLANT, NAVMISCEN review existing missile technical reports for use, necessity and consolidation.

3. Naval Materiel Command with NAVAIRSYSCOM, NAVORDSYSCOM, NAVSAFECEN, NAVMISCEN, NAVWEPCEN's and other cognizant agencies, review possible 3M inputs which would simplify and standardize ordnance malfunction incident/accident reporting.

E. Updating of Publications

Discussion

Fleet maintenance technicians are constantly faced with the problem of maintaining systems with out-of-date maintenance publications. Publications do not include most recent changes resulting from system modifications.

Conclusion

Fleet maintenance technicians must be provided with up-to-date technical information, either official or unofficial, that is compatible with their particular system's configuration.

Recommendations

1. In those cases where the contractor is unable to provide handbook data to NATSF in sufficient time to be included in manuals concurrent with Fleet delivery of equipment, require the contractor to provide preliminary unofficial data to the appropriate Fleet activities until official manual changes become available.

2. NAVAIRSYSCOMHQ ensure that the information contained in applicable Navy-generated changes and bulletins is forwarded to the responsible contractor for inclusion in the appropriate manuals.

3. In view of the large number of weapon system configurations and the impending configuration freeze, concentrate effort on developing a good set of handbooks for the freeze configuration in a timely manner.

4. Cover intermediate configurations by a series of difference data and deployment documents rather than complete handbook revisions.

III. INSPECTION/SUPPORT

Increased emphasis on inspection and support is required to ensure maximum readiness.

A. Pre-deployment Reviews/Inspections

Discussion

1. Weapon System Pre-deployment Reviews are currently being held for CVA's and squadrons. The effectiveness of these reviews is limited by lack of direction, military team leadership, timeliness, operational priority, standardization, documentation, technical scope, and follow-up. The arrival of an "Expert Team" at an operational activity already heavily burdened with maximum training and limited turnaround time meets with varying degrees of enthusiasm.

2. With strong authority and military team leadership, the technical talent and system knowhow of these "Expert Team" members can provide a tangible increase in system readiness. This should be accomplished in accordance with the following plan:

(a) Direction - The basic directive should be originated at the CNO (Chief of Naval Operations) level directing the type Commanders to follow a CNO approved Inspection Work Sheet Format (TABs F and G) for applicable airborne weapon systems to include associated fire control systems. Inspection formats to be submitted to CNO for approval from missile and fire control system CFA's (Cognizant Field Activities) via project desk at Air Systems Command.

(b) Military Team Leadership - The Type Commander should assign, as team leader, a staff officer, senior or equal in rank to the CVA Weapons Officer or squadron CO being inspected.

(c) Timeliness - Six months prior to deployment date, the inspection formats for each applicable system should be forwarded to the Commanding Officer of the activity to be inspected, the inspection to be conducted 60 to 90 days prior to deployment. This provides guidelines to the activity to be inspected, for assigning personnel to formal schooling and for having test equipment calibrated and handling gear repaired. Sixty to 90 days allows some time to correct deficiencies noted during the inspection.

(d) Operational Priority - The inspection should be afforded highest priority and cooperation of the inspected activity.

(e) Standardization - A CNO approved inspection format to be used for weapon or fire control system.

(f) Documentation - A formal inspection report to be returned to the operating activity inspected by the type command as a follow-up to an on-site debrief.

(g) Technical Representation - The present team members from NAVMISCEN (including local NAVMISCEN NCTS), the CFA, and NASCREPLANT/PAC should be supplemented by NAESU CETS/NETS to cover applicable fire control systems.

(h) Follow-up - The Type Commander should enlist the aid of required support activities to correct any deficiencies noted during the inspection prior to deployment. In addition, a follow-up inspection using the same team and criteria should be conducted for the CVA and Squadrons at sea 60 to 120 days following deployment to determine the effectiveness of follow-up and to investigate additional problems encountered in operations.

Conclusions

Weapon System Pre-deployment Reviews currently being held for CVA's and deploying squadrons are not accomplishing desired results due to a lack of emphasis, direction, and follow-up. A CNO directive is required to assign the responsibility for a more formal review to the Type Command, using technical personnel from support activities.

Recommendations

1. CNO promulgate a directive requiring Type Commanders to conduct an ALMTPI (air-launched missile technical proficiency inspection) for all deploying CVA's and squadrons with recommended inspection formats, similar to TABS F and G.

2. Type Commanders follow-up on ALMTPI's by on-site reviews in each CVA 60-120 days following deployment to the Sixth or Seventh Fleets.

B. Technical Assistance

Discussion

1. There is some confusion among operating activities with regard to procedures for obtaining technical assistance on the air-launched missile system.

2. The NAVMISCEN provides the technical assistance and training on all air-launched weapons to using activities by the assignment of NCTS's (Navy Civilian Technical Specialists) to the operating commands. The NCTS's or technical representatives are under the operational control of the Fleet as advisors and instructors in the operation and maintenance of the air-launched weapon systems. This function for the AERO 1A and AN/AWG-10 is provided by NAESU (Naval Aviation Engineering Service Unit). The procedure for obtaining these services is contained in NAVAIRINST 4350.2 and the coordination of the services is the responsibility of the Engineering Technical Services Officer on the TYCOM Staff. The overall management structure and procedures are not adequately described in existing instructions.

Conclusion

Engineering Technical Services for air-launched weapons are being provided; however, governing instructions do not adequately describe the procedures for the operating activities to acquire and utilize these services.

Recommendation

NAVAIRSYSCOM revise NAVAIRINST 4350.2.

C. Augmented Maintenance Support

Discussion

Weapon system planning, insofar as maintenance personnel, support equipment, maintainability requirements, and other such factors are concerned, has not anticipated the tempo of operations that is now being experienced in SEA. For this reason, the existing organizational maintenance capabilities of on-line CVA's require augmentation. Facilities and personnel are available at NAS Cubi Point, which could be used for this purpose.

Conclusion

Due to the sustained tempo of operations in SEA, and a shortage of trained organizational level maintenance personnel, the proper maintenance of weapons systems aboard on-line CVA's is extremely difficult to achieve.

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The practicability of augmenting NAS Cubi Pt. in order to provide for AMCS "peaking" services for VF squadrons while CVA's are in port at SUBIC Bay should be specifically investigated.

Recommendations

1. Immediate

It is recommended that CNO form a team composed of representatives from Commander, Naval Air Force Pacific; Commander, Naval Air Force Atlantic; the Naval Air Systems Command; Commander, Fleet Air Western Pacific; Naval Air Systems Command Representative Atlantic; Naval Air Systems Command Representative Pacific; and the Naval Missile Center to determine how best to utilize existing facilities and personnel at NAS Cubi Point to augment shipboard weapons system maintenance.

2. Long Term

Weapon system planning and logistics planning documents should incorporate plans for augmenting the logistical and maintenance support of weapon systems in the event of operational employment of the weapon system at levels significantly above initial plans.

IV. MAINTENANCE AND TEST PHILOSOPHY

INTRODUCTION

Maintenance and testing problems requiring design changes are covered in Appendix IV. The problems included in this section, therefore, describe the management and philosophy of maintenance and testing.

A. Shipboard Missile Test Equipment

Discussion

Missile test equipment aboard CVA's is presently calibrated and maintained by the missile shop. Shortage of qualified AQ's/AT's precludes adequate maintenance with resulting false rejects and poor availability of equipment. Adoption of the portable DPM-14 missile test for SPARROW would decrease the maintenance requirements in that the test set can be periodically offloaded to the calibration laboratories as presently done with the other missile test sets.

Conclusion

Provided its performance can be validated by a Tester Correlation Study, adoption of the DPM-14 as the standard shipboard test equipment will alleviate existing maintenance problems with SPARROW test equipment.

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However, this will not change the requirement for qualified electronics personnel.

Recommendation

Staff the CVA Guided Missile Division with sufficient AQ's/AT's properly trained to perform assigned maintenance responsibilities.

B. Air-Launched Missile Maintenance Procedures

Discussion

1. The organizational, intermediate and depot level maintenance procedures for air-launched missiles have never adequately been defined or delineated. There is confusion in Fleet activities concerning maintenance policies and procedures for air-launched missiles.

2. NAVAIRINST 08810.1 defines the maintenance for air-launched missiles. The purpose of this document is to provide guidance and information to using activities in the processing and maintenance of the air-launched missiles. This instruction was last published in 1958. NAVMISCEN was requested to coordinate the revision of this instruction to incorporate the newer weapon systems and update the technical information. This revision was completed in 1964. Since that time, it has been reviewed, revised, modified and rewritten by various command levels and is presently under review by NAVAIRSYSCOM. The vital information contained in this instruction includes missile test frequencies, shelf life for ordnance components and defines the 3 levels of maintenance for each weapon system.

Conclusion

Maintenance procedures for missiles have not been revised since 1958. The operating activities urgently require this information.

Recommendation

NAVAIRSYSCOM assign to a field activity the responsibility of maintaining and publishing NAVAIRINST 08810.1. Direct that the instruction be updated every 12 months and that an annual review conference be held. Enclosures to 08810.1 for new weapon systems should be incorporated prior to Fleet introduction.

C. NAVAIRINST 4700.2

Discussion

Present maintenance levels and procedures for air-launched missiles are not defined for operating activities. NAVAIRINST 4700.2 presently refers to NAVAIRINST 08810.1 for this information. The proposed revision of NAVAIRINST 08810.1 defines maintenance procedures for air-launched missiles.

Recommendation

Include in NAVAIRINST 08810.1 the definition of maintenance policies for air-launched missiles, and expedite revision of this instruction to prescribe three levels of maintenance for air-to-air missiles. Malfunction reporting for air launched missiles should be deleted from 08810.1.

D. Air-Launched Missile Test Philosophy

Discussion

1. The shipboard test philosophy for air-launched missiles is governed by the following factors:

a. Captive flight environment - Air-to-Surface weapons such as WALLEYE and BULLPUP operate successfully as "No-Test" missiles because they are essentially one-shot devices. Air-to-Air missiles are subjected to repetitive captive flight cycles, and the degradation in missile reliability as a function of captive flights must be predictable. The allowable degradation that the user will permit will then establish the upper limit on the captive flights between periodic testing.

b. Depth of Test - The thoroughness of the missile periodic test is determined by the complexity and design of the test set. Generally, the greater the depth or thoroughness to which the missile is tested, the greater the complexity of the test equipment. In the case of the SPARROW the test equipment varies in thoroughness from the 40% check performed by the aircraft SELECT light to the 100% check performed on the NARF production line. All missiles should be provided periodically with an extensive check at a NARF or NAVWEPSTA. For example, if shipboard testing does not include a test of Resistor R1, and Resistor R1 normally accounts for 1% of the total failures, eventually all of the missiles being captive flown will have a failed resistor R1 unless they have been returned periodically to an NAVWEPSTA or NARF for a test which does check that resistor.

c. Inherent design reliability - A fallacy in test philosophy is that testing will increase missile free flight reliability. If the missile reliability is degraded during operations, periodic testing will screen out those failed missiles; however, components fail during missile flight and all components are not tested. Periodic testing will not screen these failures out of the system. The inherent design reliability of a missile cannot be increased by periodic testing.

d. Effect of sub-systems - The reliability of the 20 mm gun has been compared to the reliability of the SPARROW missile. In this comparison, the status of the aircraft radar, the launcher maintenance and the post-launch maneuvering of the aircraft are not excluded from the missile reliability because they are essential sub-systems necessary for missile success; however, missile testing will not affect the degradation to system reliability caused by sub-systems other than the missile.

e. Purpose of shipboard testing - The three reasons for conducting shipboard testing are.

(1) To isolate faults for maintenance and repair.

(2) To provide assurance that the system has remained in a GO status.

(3) To provide an assessment to the pilot of which systems are available prior to commitment.

Air-launched missiles are not maintained or repaired on board ship, therefore only (2) and (3) apply. The desirability of combining the assurance test and the assessment test into one Missile-on-Aircraft-Test (MOAT) is discussed below.

The MOAT would provide maximum user's confidence in the status of the system.

2. Based on the foregoing, the following comments are provided concerning the two air-to-air missiles currently in operation:

a. SIDEWINDER - The AIM-9D is tested on the aircraft prior to each flight by illuminating the seeker with a flashlight and ascertaining that an audio signal is present. A periodic test is conducted using the Mark 409 test set, which is a relatively uncomplicated portable shipboard tester, every 100 hours of activated time, or approximately every 50 captive flights. The loss of audio during the preflight test and in flight provides a limited MOAT. There has been little concern or investigation of the adequacy of SIDEWINDER testing policy because of the missile's free flight reliability demonstrated in training and in combat. This reliability is due to the small effect of the SIDEWINDER sub-systems on overall system reliability, and to the lesser complexity of the SIDEWINDER as compared to the SPARROW.

b. SPARROW - The SPARROW has had test frequencies varying from every 5 to every 30 captive flights. Tests are conducted with the DPM-7, during shorebased operations, the DSM-32 aboard CVA's, and the DPM-14 is used exclusively by the Marines and Air Force. The aircraft SELECT light provides a limited MOAT as a preflight and inflight test. There has been much command attention directed to the SPARROW testing policy and extensive investigation has been conducted by various activities. However, comparison of Navy versus Air Force firings during SPARROW SHOOT and combat firings, and engineering investigations, such as TAB H, do not indicate a significant change in missile free-flight guidance and fuzing reliability due to changes in test frequency or test equipment. The concern directed towards SPARROW test philosophy is due to the design reliability, seriously degraded by the effects of unreliable sub-systems. The combination of these two factors has resulted in an extremely low overall system reliability.

Conclusion

The attention focused on test philosophy for air-launched missiles, particularly the SPARROW, is attributed to the lack of user's confidence in the overall weapon system reliability. In actuality, varying the test frequencies, or changing the test equipment for missile guidance section testing has had little effect on the overall system reliability.

Recommendations

1. Continue shipboard testing of the SPARROW missile to maintain user confidence.

2. Return SPARROW missiles to a NAVWEPSTA for check and reissue after every 30 captive flights. Consider adoption of a policy for shipboard test every 10 captive flights until return for rework after 60 flights, unless rejected earlier.

3. NAVAIRSYSCOM specify that a high reliability be maintained throughout the repetitive captive flight cycle for future air-to-air missiles.

4. NAVAIRSYSCOM establish, as a design goal, that shipboard testing of future air-launched missiles be limited to a Missile-on-Aircraft Test (MOAT).

E. Missile on Aircraft Test (MOAT) for SPARROW

Discussion

1. To maximize the probability of successful launch of the SPARROW missile, it is necessary to check the missile as thoroughly as feasible and as near to the time of launch as is practical. At present the only missile-on-aircraft test is by means of the SELECT light. This test will detect an estimated 40-50% of SPARROW G&C failures.

2. Test of the missile G&C aboard the CVA (attack aircraft carrier) requires that the missile be downloaded periodically from the aircraft, disassembled, tested, reassembled, and reloaded on an aircraft. This process requires many man-hours and increased the incidence of physical damage

to the missile during handlings. In addition, shipboard test equipment is difficult to maintain, requires personnel trained in its maintenance, and requires spares, handbooks, and space aboard the CVA.

3. The IRR (Improved Rearming Rates) program anticipates that air-launched missiles, including the SPARROW, will be received and stowed aboard ship in a fully assembled condition (including rocket motor and warhead) and provides for modification of CVA's to conform to this concept. For reasons of safety, SPARROW missiles cannot be tested aboard the CVA when fully assembled. Test of SPARROW missiles aboard ship under the IRR program would require disassembly, test, and reassembly of the missile. This process would negate much of the purpose of the IRR concept.

4. An alternative to test aboard the CVA would be an expanded test of the missile while on board the aircraft (MOAT). MOAT would provide for a comprehensive missile check-out on the aircraft during pre-launch and flight and would be compatible with the IRR program. The feasibility of an expanded MOAT of future Air-to-Air Missiles should be investigated.

Conclusion

The use of shipboard equipment to test air-launched missiles is undesirable and incompatible with the improved rearming rates program. An alternative to shipboard test equipment is offered by missile on aircraft test.

Recommendation.

NAVAIRSYSCOM particularize and specify the requirement for development of an expanded missile on aircraft test, possibly as part of the Built-in-Test, to allow the aircrew to ascertain the missile status, for future Air-to-Air Missile systems.

V. SAFETY

INTRODUCTION

Operational requirements during combat operations conflict with CVA safety requirements. USS AMERICA MSG 190547Z Jul 1968 details the inconsistencies of procedures contained in OP 4 Vol. 2, OP3347, OP3365 and NAVAIR 01-245FD-75-21.

A. CVA Safety Requirements

Discussion

1. Existing safety procedures require removal of the SPARROW missiles from all aircraft at the completion of the daily flight operations.

The operational requirements in SEA frequently require the carrying of up to 72 missiles during one day of operations. In addition, approximately 30 additional missiles must be maintained as a backup in ready issue status. The safety requirement to download all missiles results in the disassembly and strikedown of these missiles over the capacity of the CVA ready service magazine. The extra handling results in physical damage to the missile and missile components.

2. The air-launched missile systems are highly susceptible to personnel error during aircraft checkout and missile loading due to non-standardization of safety procedures and test equipment. There is little standardization of safety procedures, firing interlock circuitry and stray voltage test receptacles on Navy aircraft. In addition, the HERO (Hazards of Electromagnetic Radiation to Ordnance) testing of SIDEWINDER is incomplete.

<u>Conclusion</u>

Shipboard safety requirements are unrealistic and conflict with operational requirements. A thorough safety review of the F-4 and F-8 SPARROW and SIDEWINDER systems is required.

<u>Recommendations</u>

1. <u>Immediate</u>

a. NAVAIRSYSCOM/NWEF review the procedures contained in TAB I and modify as required to provide an approved procedure which will preclude daily downloading of SPARROW missiles.

b. NAVAIRSYSCOM expedite completion of SIDEWINDER HERO testing.

c. NAVAIRSYSCOM institute a review of ordnance safety with particular emphasis on shipboard procedures during periods of extensive operational commitment.

d. CNO activate an air-to-air Missile Safety Study Group to conduct a thorough safety study of the F-4 and F-8 aircraft weapons systems as described in TAB J.

2. <u>Long-Term</u>

a. Standardize nomenclatures and functions of aircraft installed weapon control equipment, firing circuitry and safety interlocks.

b. Standardize stray voltage tests, receptacles and equipment for all weapon systems.

c. Establish a monitoring agency to assure that directives do not overlap or conflict and are validated before promulgation.

VI. LOGISTICS

INTRODUCTION

Of the two problems contained in this section, one item is submitted to improve logistics; however, the other item is submitted due to the lack of logistical support.

A. SPARROW COMPONENTS

Discussion

1. Wings - Wings currently are identified by part number only, making rapid identification difficult and increasing the possibility of inadvertent mixing of wings (e.g., 7E and 7D wings installed on 7D missile). ALMC 15 has not been incorporated in all wings. ALMC 15 requires epoxying of the lead weights into the wings to prevent their loosening and deforming during captive flight.

2. Fins - Fins are not properly identified on their containers. A plastic or cowhide mallet is required to remove fins from the missile; however, a fin is frequently used as a hammer rather than using a mallet. This practice results in damage to numerous fins.

3. Phase "C" Antenna - The Phase "C" (rear) Antenna is subject to moisture intrusion, dirt (inside) and physical damage. Many antennas are removed by striking the polyrod antenna. No test of these antennas is conducted, either aboard ship or at NAVWEPSTA, although a gross functional test of the antenna is performed by the aircraft (SELECT Light). Dirt, damage, etc., do not present a significant problem and do not appear to significantly degrade reliability during one deployment, provided that the antennas are offloaded at the end of deployment and returned to NAVWEPSTA for inspection, cleaning, and re-issue. In many cases, these antennas are not returned to a NAVWEPSTA and their condition deteriorates considerably with time and usage. Problems caused by moisture getting into the antenna should be eliminated with incorporation of ECP 47.

4. Umbilical Inserts, Launcher Ejector Footpads and Lower Motor Fire Connectors - These components form the interface between the aircraft (launcher) and the AIM-7 missiles. Umbilical inserts and lower motor-fire connectors should be periodically cleaned, inspected and checked for electrical continuity to insure their proper operation. Launcher station checks prior to missile loading should be performed with the actual umbilical insert and lower motor-fire connector which will be installed with the missile. Aviation Armament Bulletin No. 361 requires

that lower motor-fire connectors be replaced whenever the missile is removed from the launcher, either by launching or offloading. Launcher ejector footpads are required to dampen the shock applied to the missile during ejection. These footpads are not always available, nor are they always used when available.

Conclusion

SPARROW components such as wings, fins, antennas, etc., are degraded from handling damage or shipboard environment. This degradation can be minimized by assuring that the components are offloaded to a NAVWEPSTA for cleaning and inspection following each deployment, and by assuring that the CVA has sufficient spares onboard prior to deployment.

Recommendations

1. Direct all CVA's when offloading missile G&C's to a NAVWEPSTA from deployment to offload all missile components including wings, fins, umbilical inserts and lower motor-fire connectors.

2. Direct appropriate NAVWEPSTA's to assist the CVA's in offloading missiles and components.

3. Establish realistic allowances for all missile components including umbilical inserts, lower motor-fire connectors and footpads, and charge NAVWEPSTA with the responsibility of delivering these components to the CVA's along with initial loadout of missiles, and with the responsibility of insuring that these components have been cleaned, inspected and checked as appropriate.

4. Provide identifying markings on all SPARROW wings and fins and their containers.

B. F-8/AIM-9C SIDEWINDER

Discussion

1. The F-8/AIM-9C SIDEWINDER system, for the most part, is not in a combat ready status. This problem exists throughout the Fleet.

2. NASC has initiated a program to remanufacture 395 F-8 aircraft of all models. The remanufacturing changes extend the service life and significantly improve the weapons systems and load-carrying capability of the F-8 aircraft.

3. The remanufacturing program was initiated because of the F-8's "all decks" capabilities and continued mission effectiveness coupled with programmed utilization of the 27C class attack carriers. Initially, only F-8E squadrons were equipped with the AIM-9C missile. This was a total of 8 squadrons. Presently, plans show a total of 14 F-8H and F-8J squadrons with full AIM-9C capabilities being formed. This has resulted in a shortage of the required special test and support equipment.

4. At present, no formal maintenance or operational training is being offered at the NAMTRADET's or RCVW's. Official publications are lacking in technical detail, updating, maintenance instruction, tactics and operation envelopes. F-8H's (modified F-8D's) now being received have had the AIM-9C system (less the deviated pursuit computer CP-742) since original manufacture in 1959 and 1960. This system, to date, has never been used, checked out, or maintained.

5. The PP2315/A launcher power supply required by AIM-9C has proven a high cost item and has a high failure rate. There is no repair or maintenance capability for failed units.

6. The new SEAM (SIDEWINDER EXPANDED ACQUISITION MODE) system, developed for use in the F-8H and F-8J aircraft, increases the lock-on capability of the AIM-9D missile by scanning and slaving its seeker. This offsets a portion of the need for the AIM-9C system. Presently, there are 1164 AIM-9C guidance and control sections in Fleet inventory. All other components of the missile are interchangeable with the AIM-9D. In general, it is the opinion of knowledgeable Fleet personnel that AIM-9C capability should be removed from inventory.

Conclusion

The F-8/AIM-9C SIDEWINDER system is not in a combat ready status throughout the Fleet due to the absence of maintenance training, current technical manuals, shortage of SSE and general lack of interest. While generally considered a "dead" program to which further funding will not be provided, the capability and the readiness requirement have not been eliminated from F-8 squadrons. A decision is required.

Recommendations

1. Remove the AIM-9C SIDEWINDER capability from the F-8 aircraft and use existing components (other than guidance and control section) to increase AIM-9D assets.

2. An alternate recommendation is to take immediate action to update the AIM-9C system by providing the following items at an estimated cost of 2000K dollars.

a. Establish NAMTRADET operational and maintenance training courses. Time requirement approximately 80 hours.

b. Establish RCVW OJT course for maintenance, loading, landing, and system checkout. Time requirement approximately 40 hours.

c. Establish formal NAMTRADET MK-401 GCG test set operational and maintenance course. Time requirement approximately 40 hours.

d. Staff CVA and air station missile shops with AT or AQ personnel for maintenance and operation of MK-401 test set. Two men per shop required.

e. Procure additional special test and support equipment for new and existing F-8E, F-8H, F-8J squadrons. Equipment required:

(1) Test set, computer, deviated pursuit, AN/APM-207.

(2) Test set, missile tuning amplifier, CV-21-206103-1.

(3) Test set, missile gate delay, AN/APM-215.

(4) Test set, electrical synchronizer, TS-1394.

(5) Special test set, cross pointer, NWC China Lake supplied.

f. Update, rewrite and write new publications covering maintenance, tactics, NATOPS handling, loading, etc.

g. Establish formal AIM-9C pilot training in the RCVW to include training firings against suitable drone targets such as specially-augmented AQM-37 and BQM-34 target drones.

h. Allow operational squadrons expenditures of at least one AIM-9C missile against suitable targets.

i. Develop and procure suitable telemetering equipment for use on training firings.

VII. SUPPORT EQUIPMENT

INTRODUCTION

There are numerous problems in the design, updating and support of AMCS and missile support equipments.

A. SPARROW Shipboard Handling and Loading Equipment

Discussion

No shipboard loading equipment is available for the SPARROW missile. Missiles are presently loaded by hand. The existing AERO 16B skid and its replacement, the AERO 21A weapons skid, are both adequate for shipboard missile handling, but the missile must be manually lifted from the skid and loaded onto the aircraft. NASC has procured 150 AERO 67A loaders for a planned engineering evaluation. NAVMISCEN at the request of NASCREPAC has developed a shipboard loader consisting of an AERO 21AX loading adapter installed on an AERO 21A weapons skid that will transport and load all weapons under 2000 pounds on all operational aircraft in a shipboard environment. The AERO 21AX loading mechanism is similar to the AERO 52B mechanism which has been proven successful in shore based application.

Conclusion

There is no adequate shipboard handling and loading equipment for the SPARROW missile. Two possibilities consisting of the AERO 67A and AERO 21AX are planned for evaluation.

Recommendations

1. NAVAIRSYSCOM expedite engineering evaluation of the AERO 21AX loading adapter and the AERO 67A loader.

2. NAVAIRSYSCOM provision the selected loader for all CVA's with SPARROW capability.

B. SPARROW Ground Handling Equipment

Discussion

Existing missile ground handling equipment at MCAS and NAS represents many locally fabricated or modified equipments which subject missiles to handling damage and create safety hazards. NAVMISCEN has developed a suitable shore based transporter/loader adequate for the SPARROW, SHRIKE, and BULLPUP A designated the AERO 52B. Four units have been evaluated by the Marines under operational conditions at DaNang and have been recommended for all MCAS's. NAVAIRSYSCOM has funded NAVMISCEN for procurement of 30 additional units and delivery will commence 1 December 1968. The AERO 52B is also considered adequate for transporting and loading at the NAS.

Conclusion

There is no standard SPARROW missile ground handling equipment for shore based activities. The AERO 52B has been evaluated and accepted by the USMC and is equally suited for Navy shore based activities.

Recommendations

1. Type Commanders submit requirements to NAVAIRSYSCOM for shore based SPARROW transporter/loader.

2. NAVAIRSYSCOM procure the AERO 52B as the standard SPARROW shore based transporter/loader.

C. Calibration and Repair of Missile Test Sets

Discussion

Missile Test Sets on CVA's require calibration and repair in order to ensure proper operation.

Recommendation

COMNAVAIRPAC/LANT ensure that an O&R field team visits each CVA and repair and calibrate Missile Test Sets within 30 days prior to deployment.

D. AWM-15/AWA-6 Rework

Discussion

The AWM-15 Test Set, Missile Control System and the AWA-6 Cooling-Pumping Group have not been regularly inducted into rework facilities. The majority of this equipment was procured between 1958 and 1961. Procedures are in existence for inducting the AWM-15 into rework; however, very few have actually been reworked. There is no provision for inducting the AWA-6 into rework.

Conclusion

Provisions for rework of AWM-15 and AWA-6 carts have been made but require implementation.

Recommendations

1. NAVAIRSYSCOMREPAC/LANT establish a rework program for the AWA-6.

2. NAVAIRSYSCOMREPAC/LANT schedule both the AWA-6 and AWM-15 through rework immediately.

3. NAVAIRSYSCOM ensure that funds are available to provide adequate spares for these rework programs.

4. NAVAIRSYSCOM solicit Raytheon for a proposal to replace the spiral ring air hoses on both the AWM-15 and AWA-6 with an inflatable air hose.

5. NAVAIRSYSCOMREPAC/LANT screen all F-4J/AWG-10 GSE for rework requirements.

E. Support Equipment for F-4J Umbilical Checks

Discussion

1. The test equipment supplied to check missile functions at the umbilical of the F-4J aircraft is not satisfactory. At present six TS 2515A/AWM-22's must be connected to the aircraft, one to each station, in order to perform these tests. At present users are not performing these required checks for the following reasons:

a. The TS 2515A/AWM-22 has not worked as advertised. Incorporation of Westinghouse Electric Corporation ECP's S16, S39, S40, S1R1 and S51 (all approved), together with use of 1.5 series Built-in Test Tapes and latest procedures, will eliminate these deficiencies. An additional ECP (SM99) is required for compatibility with AIM-7E-2.

b. It is often impractical to connect all six testers to the aircraft because the aircraft wing stations are configured with bomb racks or without missile pylons. Fleet activities are not willing to configure the aircraft just for test.

2. An existing MSTS (Missile Station Test Set) has been in use for some time to perform similar checks on the F-4B. This test set is capable of checking a single station at a time. Several modifications to the MSTS are required to make it compatible with the AIM-7E-2 missile. The NAVMISCEN, at NASC direction, has identified the necessary modifications and submitted them to NARF North Island for production of a prototype modified MSTS. If the prototype is satisfactory, it is planned that 200 modified MSTS's will be built.

Conclusion

The test equipment supplied to check missile functions at the umbilical of the F-4J aircraft is not satisfactory for daily use. Test equipment used for similar checks of the F-4B would be satisfactory provided it is modified for compatibility with AIM-7E-2.

Recommendations

1. NAVAIRSYSCOM expedite issuance of SEC's to cover the following ECP's, S16, S39, S40, S1R1, and S51, into all TS 2515A/AWM-22's.

2. Expedite approval and incorporation of ECP SM99.

3. NAVAIRSYSCOM provide funding for production, documentation and support of 200 modified MSTS's and modification of existing MSTS's.

4. NAVMISCEN deliver procedures for use of modified MSTS's to McDonnell Douglas Corporation for incorporation into handbooks.

5. With availability of the modified MSTS's, the following check-out policy is recommended for the F-4J:

a. Use the modified MSTS's for daily and preflight checks.

b. Use the TS 2512A/AWM-22, which performs a more thorough check, for periodic (calendar) checks of the missile functions at the umbilical.

F. CW Illumination Test Equipment for the AN/AWG-10

Discussion

1. The RFNA (Radio Frequency Noise Analyzer) is not presently used for performing organizational level CW illuminator checks of the AN/AWG-10. The RFNA requires updating for these tests; calibration and operational procedures need updating, and insufficient numbers of RFNA's have been allocated. The most critical problem with the RFNA is that it is too large for organizational level use aboard a CVA.

2. Westinghouse Electric Corporation is currently investigating two approaches to a "suitcase" size RFNA, which would be of more satisfactory size for shipboard use. One approach would package the existing RFNA without the spectrum analyzer into a "suitcase" tester and would use the Doppler Spectrum Analyzer in the AN/AWG-10 as a replacement for the spectrum analyzer. The other approach would utilize existing AN/AWG-10 circuitry with the exception of an external Stable Local Oscillator which would be packaged into a "suitcase" size tester.

Conclusion

No satisfactory short term solution to the problem of CW illumination test equipment is apparent.

Recommendation

NAVAIRSYSCOM assign a high priority to the rapid development and procurement of a satisfactory suitcase-type tester to perform noise checks on the CW illuminator of the AN/AWG-10 at the Organizational Maintenance Activity level.

G. F-4/AERO 7A Ejection Launcher Dynamic Testing (Pit Testing)

Discussion

1. F-4/AERO 7A ejection launcher dynamic testing is a method of dynamically testing the AERO 7A launchers and SPARROW firing circuits of the F-4B/J aircraft. Dynamic testing was devised as a means of detecting malfunctions in the AERO 7A launcher, which would otherwise go undetected by the prescribed "E" level check, thereby reducing the number of SPARROW misfire incidents. Since the original test was devised, the pit testing program has grown into a tool for checking firing circuit parameters as well as the launcher and is probably used more at present for this secondary purpose than for the original. Dynamic testing is performed by actually ejecting an instrumented missile from the aircraft into an arresting device and recording the firing circuit parameters. The recording is then examined for out-of-tolerance indications, for loss of signal, and for sequence and timing of the signals.

2. Pit testing was made a required check for all F-4 squadrons at NAS Miramar by COMFAIR Miramar in August of 1965 and has produced significant results as reported by FMSAEG's Technical Memorandum E5-680 of August 1967. The report shows that those squadrons which did not pit test have a misfire rate of 14.9%, whereas those squadrons which did pit test have a misfire rate of 4.9%. These figures indicate that pit testing does achieve the desired result, i.e., reducing the misfire rate. In addition to the above, there are intangible benefits such as squadron personnel becoming more familiar with the weapon system, loading crew training, enforced launcher maintenance, etc. All of these contribute to a successful launch.

3. Pit testing has been recognized as a valuable tool by both COMNAVAIRLANT and COMNAVAIRPAC. However, there has been no formal funding, manpower, or logistic support for the pit facilities. This situation imposes the responsibility on the COMFAIR's and NAS's, who must use operating funds and available personnel for this purpose. Logistic support (spare parts and consumable supplies) must also be provided by open purchase, since the facilities are not provisioned by SPCC.

4. There are no publications which provide complete operating and maintenance instructions.

5. A missile change which would initiate motor fire through the umbilical instead of through the motor fire connector has been proposed. This change should have little or no impact on the pit testing program since the emphasis is on the firing circuits more than on the launcher.

6. An advanced instrumentation package is being developed by the NAVMISCEN to supplement or replace existing instrumentation. This new equipment is expected to be comparable in performance to the existing equipment at less cost.

Conclusion

The F-4/AERO 7A ejection launcher dynamic test (pit test) is not adequately supported by funding, manpower, or logistics. In addition, there are no publications which give complete operating and maintenance instructions. Existing installations are not adequate to support Fleet requirements.

Recommendations

1. Immediate

a. COMNAVAIRLANT/PAC establish/implement manpower requirements.

b. NAVMISCEN test and evaluate the advanced instrumentation package now in prototype stage at the NAVMISCEN (funds already provided).

c. NAVMISCEN prepare Aviation Armament Bulletin promulgating test procedures.

d. NAVAIRSYSCOM expedite ECP 940.

2. Short Range

a. NAVAIRSYSCOM (AIR-4107/5108) give formal recognition to the pit testing program and provide funds to support the existing instrumentation packages. Estimated cost: $36,000 (three facilities).

b. NAVAIRSYSCOM (AIR-4107/5108) task the NAVMISCEN to develop a data package for the pit instrumentation. Estimated cost: $20,000.

c. NAVMISCEN standardize existing instrumentation packages to one configuration. Estimated cost: $5,000.

d. NAVMISCEN prepare and distribute interim handbooks until final handbooks can be obtained. Estimated cost: $10,000.

e. SPCC convene provisioning conference using preceding data package.

f. COMNAVAIRLANT/PAC determine requirements and funding for additional pit testing facilities.

g. Aircraft Handbooks be revised to include testing procedure.

VIII. POLICY

INTRODUCTION

A review of air-to-air missile system design, reliability and support areas has revealed three important problems relating to Navy policy. The majority of the problems discussed in the CVA section of this report have become problems because of Navy policy, or lack of policy, in the following three areas.

A. Air-to-Air Missile System Reviews

Discussion

A lack of communication exists between support activities and the Fleet pertaining to the support and operation of the air-to-air weapons systems. Program reviews such as the A-4 and A-7 weapons system reviews have proven to be beneficial in the discussion and most importantly, the solution of system problems. NAVAIR 4103 presently sponsors a semi-annual Fleet support symposium; however, the limited representation of NAVAIR and lack of representation of CNO precludes management decisions.

Conclusion

Periodic review of air-to-air weapons programs is required with representation from CNO and NAVAIR decision making management.

Recommendation

CNO select a review team composed of a member and alternate from the support and Fleet activities engaged in the operation and maintenance of the air-to-air weapons systems, the review to be accomplished as a minimum on a semi-annual basis. The first order of business of this team to be monitoring the progress of the recommendations of this report.

B. Fleet Maintainability and Reliability Problems

Discussion

1. The majority of problems that occur during Fleet operation of air-to-air missile systems are in the area of maintainability and reliability. During the Cuban crisis (November 1962) the excessive flight times

imposed on the missiles revealed sway brace damage problems and moisture intrusion problems. Before funding and approval to correct these problems were obtained, the Cuban crisis was over and funds and interest were again focused on performance improvements. After 3 years of SEA operation, the sway brace damage problem has been corrected but the moisture intrusion problem still does not have an approved solution. The priority of performance over maintainability and reliability was evident throughout the writing of the AIM-7F specifications.

TAB K is a general discussion of maintainability and reliability trends in air-launched weapons and control systems which are in use or planned by the Navy, and the impact of these trends on future systems.

Conclusion

A higher priority should be assigned to the investigation and correction of Fleet maintainability and reliability problems.

Recommendations

Immediate

1. Review and re-emphasize maintainability and reliability in the AIM-7F specifications.

2. Write a MIL-Standard for maintainability to govern missiles and missile support equipment.

3. Provide a reliability and maintainability incentive to the contractor similar to value engineering incentives.

4. CNO/NAVAIRSYSCOM assign a higher priority (including funding) to the early resolution of Fleet maintenance and reliability problems.

C. F-4 Employment Policy

Discussion

Insufficient emphasis and priority is placed on maintaining the aircraft weapons control system in a completely operational ready status.

Conclusion

Historically, the philosophy of placing priority on conventional weapons (iron bombs) employment of the F-4 aircraft at the expense of properly maintaining the missile control systems has materially contributed to overall poor missile system performance.

Recommendation

CNO (Chief of Naval Operations) support a policy of increased emphasis on the air-to-air capability of the F-4 aircraft.

NAMTRADET TRAINING EQUIPMENT REQUIREMENTS

1. SPARROW Requirements

a. AERO 7A launcher cleaning stand.

b. Training films.

c. Cutaway missile sections and components showing internal arrangement.

d. 5 MK-38 training motors complete with inert MK-265 ignitor and S&A mech. and ignitor cable - MK-52 motor with MK-274 ignitor (inert).

e. 5 MK-4 inert warheads with inert MK-38 booster and MK-5 S&A.

f. 5 G&C sections, AIM-7E preferably; these need not be R.F.I. but do need an actual set of wing hubs, tunnel covers, and head and rear antenna connections.

g. 5 NAVMISCEN/AIM-7/13J6 test adapters are needed to perform no voltage checks on G&C prior to warhead connection. This equipment must be made available to NAMTRADET's at NAS Miramar, NAS North Island, NAS Alameda, NAS Norfolk, and NAS Jacksonville.

2. SIDEWINDER Requirements

a. CVA-CVS Conv. Ord. Tra. Det. (Norfolk, Jacksonville, Alameda, North Island

AIM-9B

1 ea Mk-17 Mod 5 dummy motor
1 ea NPU (non-propulsive unit)
1 set wing rolleron assembly (canted hinge)
1 set wing rolleron assembly (straight hinge)
1 ea dummy MK-303 influence fuze
1 ea live MK-303 influence fuze (slotted thread)
1 ea Mk-304 contact fuze (dummy booster)
1 ea dummy warhead
1 ea MK-1 Mod 9-14 G&C section
1 ea dummy MK-1 G&C section

b. AIM-9C, D

2 ea MK-36 Mod 5 dummy rocket motor
2 sets MK-1 Mod 0 wing rolleron assembly

2 ea MK-48 dummy warhead
2 ea dummy MK-15 or -24 TDD's
1 ea cutaway MK-15 Mod 1, 2, or 3 TDD
1 ea cutaway MK-24 Mod 1 TDD
1 ea dummy MK-18 GCG
1 ea live MK-18 Mod 2 GCG
1 ea dummy MK-12 GCG
1 ea live MK-12 Mod 2 GCG
2 sets MK-18 canard fin assembly
2 sets MK-12 canard fin assembly

c. Support Equipment

1 ea missile assembly stand
1 set AIM-9B assembly tools
2 sets AIM-9C, D assembly tools
1 ea MK-409 GCG test set (AIM-9D)
1 ea MK-401 GCG test set (AIM-9C)(North Island and Alameda only)
3 ea AIM-9B, C, and D missile dome covers
3 ea AIM-9B, D fuze covers
1 ea AERO 12B bomb skid
Air and Electrical sources as required for the support of test sets
1 ea AERO 30A-2 vibration isolator
1 ea AERO 8C-1 missile holder
1 ea AERO 39-A bottle storage rack

d. F-4B/F-4J NAMTRADET's 1013, 1014 (Miramar, Oceana, Key West, Cherry Point, El Toro

1 ea AN/ASM-20B guided missile test set
1 ea cutaway LAU-7/A with PP2581/A power supply missile launcher
1 ea Type III AIM-9D missile
1 ea Type III AIM-9B missile

e. F-8H/F-8J NAMTRADET 1098 (Miramar)

1 ea AN/ASM-20B guided missile test set
1 ea cutaway LAU-7/A with PP2315/A power supply missile launcher
1 ea Type III AIM-9B, C, D
1 ea F-8 aircraft mock-up/radar attached

f. A-4/A-6/A-7 NAMTRADET's (Lemoore, Cecil Field, Whidbey Island, Oceana)

1 ea AN/ASM-20B guided missile test set
1 ea cutaway LAU-7/A with PP2581/A launcher

1 ea Type III AIM-9B, D
1 ea AERO 1A adapter
1 ea ADU-299E adapter

g. All aircraft NAMTRADET's should have complete AIM-9D/LAU-7/A repair tools and equipment as spelled out in LAU-7/A manual.

3. <u>APG-59 Training Aid Requirements</u>

It is suggested that the following items be prepared in the form of visual aid charts approximately 3 x 4 feet:

A. Antenna
  (1) Positioning characteristics
    (a) Geographical
    (b) Space
    (c) Drift
    (d) Antenna
    (e) Interceptor

  (2) Patterns
    (a) Cosecant squared
    (b) Nutated
    (c) Pencil beam
    (d) Band Leader
    (e) Hi Map

B. Transmitter
  (1) Modes of operation
    (a) Pulsed doppler
    (b) CW
    (c) Pulse
      a. Monopulse
      b. Chirp

  (2) Radio Frequency

  (3) Radio Frequency Oscillator

C. Indicators
  (1) Dust
    (a) Grid Layouts
    (b) Operating Characteristics

D. (2) "A" Gun
- (a) Symbols presented
- (b) Time sharing logic

(3) "B" Gun
- (a) Symbols presented
- (b) Time sharing logic
- (c) Deflection signals

(4) Displays
- (a) Search
  - a. Pulse
  - b. Pulse doppler
- (b) Track
- (c) Sectored PPI
- (d) Pulsed doppler
  - a. Pause-to-range
  - b. Auto-Acquisition

E. Selector Test Programmer

(1) Move tape functions
- (a) Tape transport
- (b) Tape threading

(2) Testing Function
- (a) Light sensitive transistors
- (b) Test selection logic
- (c) Fibre Optics effects

F. Missile Tie-Ins

(1) CW guidance

(2) Head Aim and Lead Angle Error

(3) Altitude Commands
- (a) Altitude - 1
- (b) Altitude - 2
- (c) SWAB (Switch After Boost)

(4) Roll Command

(5) Launch Characteristics
- (1) Launch envelopes
  - (a) AIM-7
  - (b) AIM-9
- (2) Launch Zones
  - (a) Head-On (Collision)
  - (b) Tail (Pure Pursuit)
  - (c) Beam (Lead Pursuit/Lead Pursuit to Lead Collision)

4. The following items are also being submitted for consideration:

   A. Training film, animated type, depicting pulse doppler as utilized by the AWG-10, operating modes and related displays, missile functions produced by the radar, and launch conditions in several different environments.

   B. An aircraft mock-up complete with gyro stabilization, servo systems, and functioning antenna. When the gyro is operating, the platform can be maneuvered to demonstrate the effects of antenna stabilization in search and track.

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INDOCTRINATION COURSE
FOR
PROSPECTIVE MISSILE/ORDNANCE OFFICERS

OUTLINE OF TRAINING — 2 WEEKS

A. SPARROW 12 hours

1. Block diagram theory
   Basic data flow of missile circuitry
2. Major components and nomenclature
3. Major differences between AIM-7D, 7E, 7E-2, and 7F missiles
   Discussion of the major changes to the AIM-7D to make the AIM-7E, 7E-2, and 7F
4. Shipboard handling and storage
5. AMCS AERO 1A/AWG-10 data flow to the missile
   Basic data flow which will show the over-all tie-in of major system components which comprise the missile control system
6. Present and future ALMC's
   Discussion of changes to missile components and identification
7. Assembly and disassembly of missile components
   Discussion of procedures for mating and unmating of G&C's, W/H and motors
8. Shipment of missile components
   Discussion of storage procedures, handling of containers and security of same

B. TEST EQUIPMENT (DSM-32/DPM-14) 16 hours

1. Block diagram theory
   Basic data flow between major circuits of test sets
2. Maintenance procedures and problems
   Discussion of maintenance procedures and standard problems on test sets
3. Present and future SEC's
   Discussion of reasons for incorporation of SEC's and future SEC's to be incorporated
4. Calibration and repair of test sets
   Discussion of pertinent and alternate test equipment used in repairing and calibrating test sets
5. Missile test procedures
   Perform a few familiarization tests on SPARROW III missiles

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C. SIDEWINDER 8-10 hours

1. Block diagram theory
   Basic data flow of missile circuitry
2. Major components and nomenclature
3. Major differences between AIM-9B, 9C, and 9D
   Discussion of major changes of the AIM-9B to make the AIM-9C and AIM-9D
4. Shipboard handling and storage
5. AMCS AERO 1A/AWG-10 data flow to the missile
   Basic data flow which will show the tie-in of major system components which comprise the missile control system
6. Present and future ALMC's
   Discussion of changes to missile components and identification of such
7. Assembly and disassembly of missile components
   Discussion of procedures for mating and unmating of G&C's, W/H and motors
8. Shipment of missile components
   Discussion of storage procedures, handling of containers and security of same

D. F-4B WEAPONS SYSTEM 8 hours (Squadron Ordnance Officers)

1. F-4B/J firing circuits for SPARROW and SIDEWINDER
   Brief discussion of operation of circuit from pickle-push to missile launch
2. F-8 firing circuits for SIDEWINDER
   Brief discussion of operation of circuits from pickle-push to missile launch
3. Missile firing sequence
   Discussion of firing order for certain block aircraft
4. Procedures for loading mixed loads
   Discussion of procedures of loading AIM-9B, C, or D with AIM-7D and E's or AIM-7D's or AIM-7E's
5. Weapons system tests
   Discussion of use of E and F level and MSTS tests on system
6. AMCS AERO 1A and MCS AWG-10 differences
   Discussion of differences in missile firing procedures
7. Launcher rack maintenance
   Discussion of frequency and methods in performance of rack maintenance

E. PIT TESTING THE F-4B/J 4-6 hours (Squadron Ordnance Officers)

1. Definition
   Discussion of the reason and procedures for pit testing

2. Pit test read-outs
   Discussion of specification and procedures for reading monitored results
3. Pit test performance
   Perform an actual pit test of an aircraft

F. SERVICEABILITY (Missile Officers)

1. Discussion of Fleet missile problems
2. Discussion on BULLPUP, SHRIKE, WALLEYE and Standard Arm missiles
   Discussion of nomenclature, storage and handling, assembly and disassembly of missile components

G. TAWS/PEP BRANCH 4 hours (Missile Officers)

Briefing on F-4 weapons system problems and corrections of same

H. PUBLICATIONS AND CHANGES 4 hours (Missile Officers)

Receive and discuss a listing of pertinent publications and changes to SPARROW and SIDEWINDER missiles, which is followed by a discussion on the DOD code book

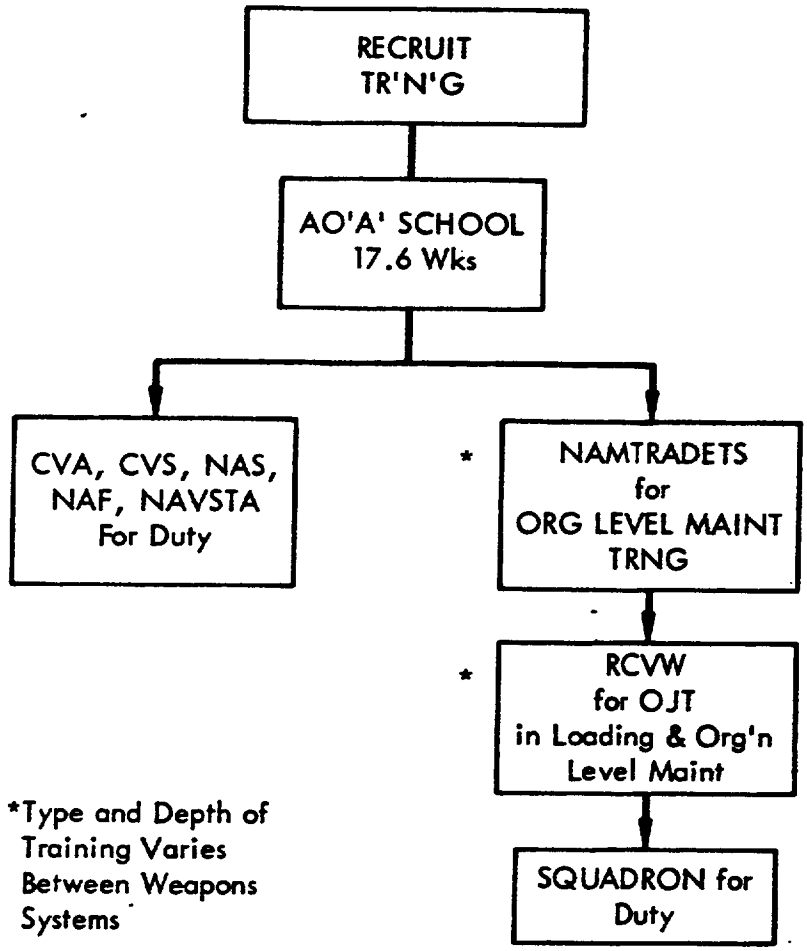
I. SPARROW LOGBOOK AND REPORTS 3 hours (Missile Officers)

Discussion of procedures in the use and disposition of missile test, firing and logbooks

J. TELEMETRY 3 hours (Missile Officers)

Discuss the modification to, installation of and the information available from the XN-6 TM pack

PRESENT AO TRAINING FLOW



TAB III-C

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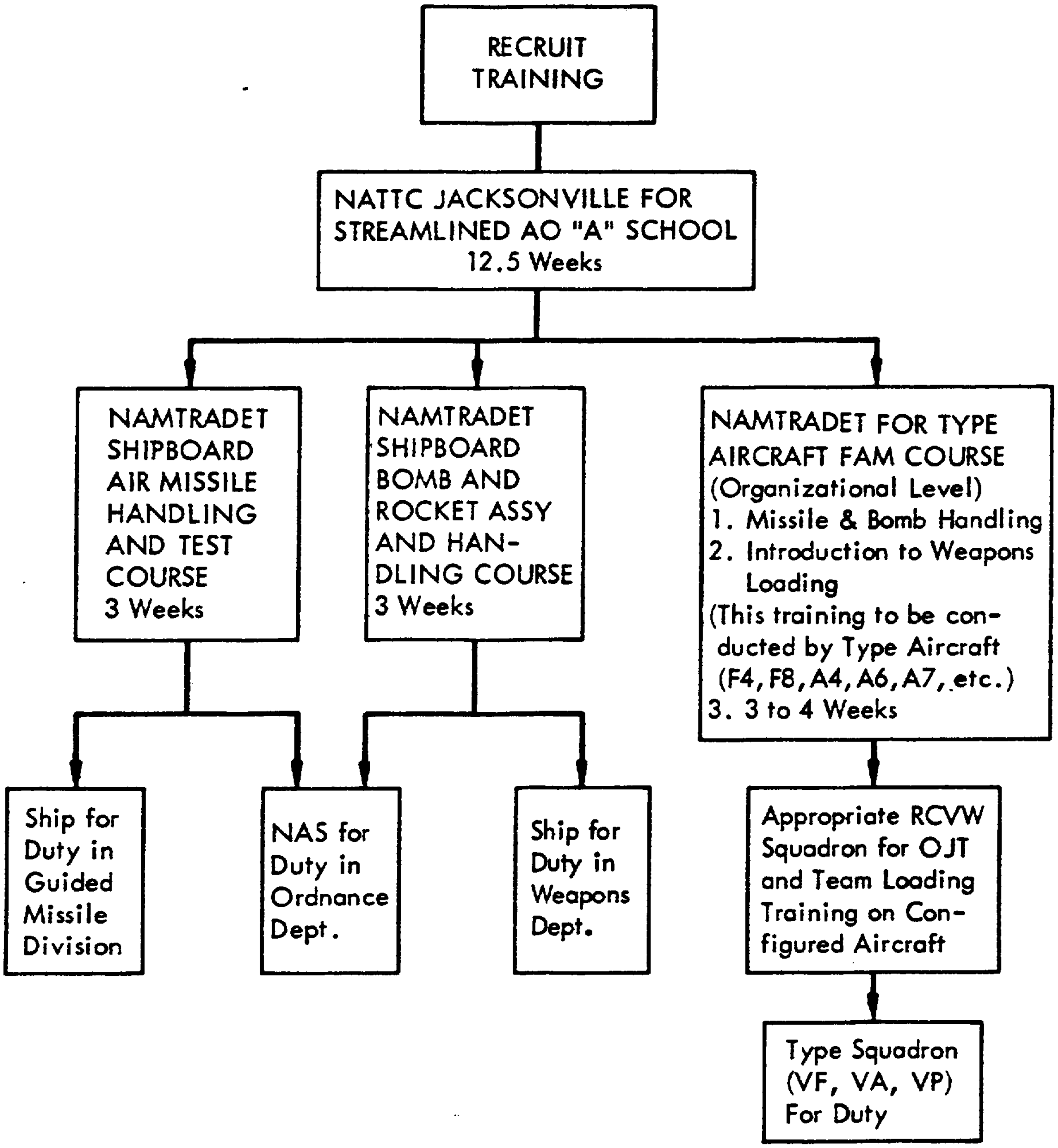
RECOMMENDED AO TRAINING FLOW



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MISSILE MALFUNCTION REPORTS AND REFERENCES

The various reports that may be caused by an air-to-air missile malfunction are found in the table below.

Type of Report	Form of Report	Instruction for Use
Accident — Explosive	Message Format	NAVORD Inst. 8025.1
Accident — Aircraft	Message Format	OPNAV Inst. 3750.6
Incident — Explosive	Message Format	NAVORD Inst. 8025.1
Incident — Aircraft	Message Format	NAVAIR Inst. 4700.2 (Combined Safety U.R.)
	Message Format	OPNAV Inst. 3750.6
Ordnance Malfunction — Major	Message Format	NAVORD Inst. 8025.1
Ordnance Malfunction — Minor	Message Format	NAVORD Inst. 8025.1
	NAVAIR Form 13070/5	NAVAIR Inst. 4700.2 (Combined Safety U.R.)
Safety Unsatisfactory Material/Condition Report (Safety U.R.)	Message Format	(Combined Safety U.R.)
	NAVAIR Form 13070/5	NAVAIR Inst. 4700.2
Special Unsatisfactory Material/Condition Report (Special U.R.)	NAVAIR Form 13070/5	NAVAIR Inst. 4700.2
Air-to-Air Missile Weapon System Flight Report (AAMREP)	NAVWEPS Form 8811/4 Type 1	BUWEPS Inst. 8810.2
	NAVWEPS Form 8811/5 Type II	BUWEPS Inst. 8810.2
Air-to-Air Missile Weapon System Flight Report Captive Flights only (AAMREP-Captive flight)	11ND-FMSAEG 8811/5 Type I	FMSAEG Tech Inst. E-5-68-1 Ch 1
	11ND-FMSAEG 8811/4 Type II	FMSAEG Tech Inst. E-5-68-1 Ch 1
Guided Missile Service Record (GMSR)	NAVWEPS Form 8800/2	FMSAEG Tech Inst. E-5-68-1 Ch 1
Logbook		

NAVAL WEAPONS EVALUATION FACILITY

Proposed manning chart for Ordnance Technical Publications Department

Existing

8	Naval Officers
8	Naval Enlisted
8	Civil Service
4	Civil Service (approved for hire)
28	Total

Proposed manning requirement breakdown

Military

1	Commander
4	Lieutenant Commanders
13	Lieutenants
14	Chief Petty Officers
32	Total

TOTAL MANNING

35 Civilians
32 Military

67

Civilian

1	GS-13	Engineer
4	GS-12	Engineers or Engineering Technicians
1	GS-9/11	Engineer or Engineering Technician
13	GS-9	Engineer or Engrg Techs
8	GS-7	3 Computer Programmers 5 Illustrators
1	GS-4	Secretary
7	GS-3	Clerk/Stenographers
35	Total	

Cost

Present Budget	$324,000
Proposed Additional	400,000
Total annual cost	$724,000
Cost for Increased Facilities	$600,000

This increase in facilities is needed to provide additional working spaces, and alleviate existing crowded conditions.

TAB III-E

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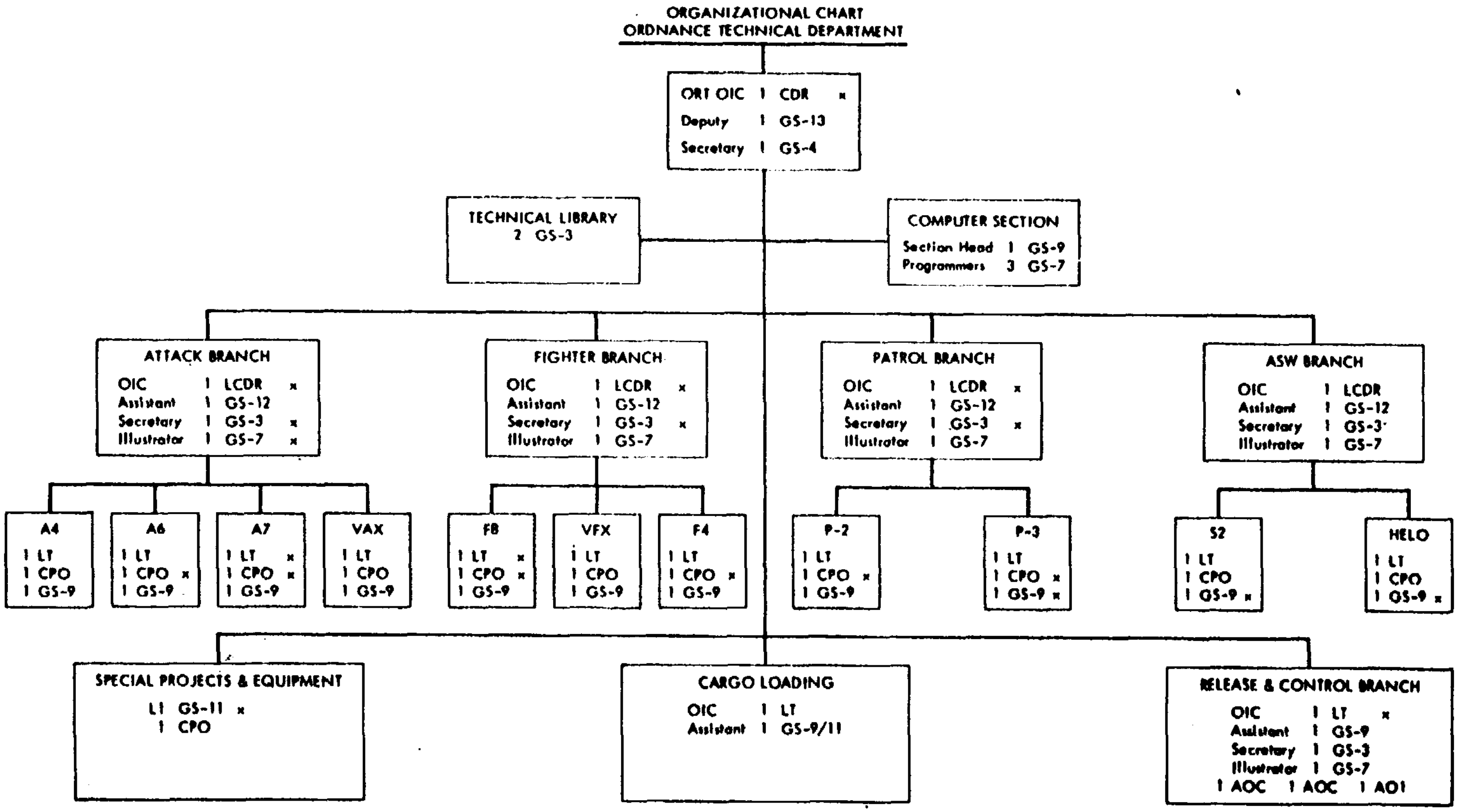

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*DEPLOYING CVA SPARROW WEAPON SYSTEM INSPECTION WORK SHEET

1. To conduct an orderly and complete pre-deployment SPARROW Weapon System Inspection, the following format will be followed. When the attached work sheets are completed, they will be returned to the inspection team leader.

2. The enclosed work sheets are intended as a guide for a qualified SPARROW representative with field experience.

3. Formal schooling as used here is defined as one of the following:

   a. An accredited service school.

   b. An accredited commercial company school.

   c. A course of instruction consisting of a minimum of 40 classroom hours given by a NAVMISCEN NCTS SPARROW Field Representative.

   d. A course of instruction consisting of a minimum of 40 classroom hours given by a NAESU CETS/NETS Fire Control Representative.

   e. A course of instruction consisting of a minimum of 40 classroom hours given by a 2nd Class Petty Officer, or above, who has attended or instructed one of the above.

4. The SPARROW weapon system, testing, handling, assembly, storage and safety, minus the fire control system, are the responsibility of Ships Missile Division.

*SPARROW Missile Representative Inspection Work Sheet excluding the fire control system.

UNCLASSIFIED [redacted]

I. PUBLICATIONS

a. Are required publications on hand and updated with latest revisions? ____________________

List missing pubs by number from required list below:

____

____

____

____

b. Are required publications available in the missile shop or office? ____________________

c. Are SPARROW missile testing, assembly and handling crews aware of publications and have easy access to them? ____________________

d. Is a mandatory reading list for SPARROW crews maintained and current, including the publications listed below? ____________________

REQUIRED SPARROW PUBLICATIONS

____

____

____

____

____

____

____

____

____

____

____

____

UNCLASSIFIED [redacted]

II. TRAINING

a. The minimum acceptable number of SPARROW orientated missile shop crews is two (2); each crew's nucleus content shall meet a minimum standard training requirement as defined below:

1. Crew leader of PO1 or PO2 in rate, and a graduate of formal schooling, both operator and maintenance, on assigned test AN/DSM-32 or AN/DPM-9 and, either formal schooling or one previous deployment as SPARROW crew member on handling and assembly.

2. Two (2) crew members having formal schooling or one (1) previous WESTPAC deployment as SPARROW crew member on handling and assembly. ____________

3. One (1) Petty Officer in crew with previous experience in underway replenishment. ____________

b. Does an on-the-job training (OJT) program exist? ____________

c. Verify crew competence by observing the following:

1. Is assembly accomplished in an efficient manner? ____________
2. Are authorized check sheets followed? ____________
3. Is proper handling procedures and equipment used in transport from magazine to flight deck? ____________
4. Are SAFETY precautions observed at all times? ____________
5. Is missile testing accomplished in an efficient manner? ____________
6. Are authorized testing procedures followed? ____________
7. Does test instructor have adequate knowledge of test equipment operation and maintenance? ____________

III. HANDLING EQUIPMENT

AERO-16B Skid allowance____________on hand____________

AERO-42A Adapter allowance____________on hand____________

AERO-49A Adpater allowance____________on hand____________

UNCLASSIFIED [redacted]

IV. TEST EQUIPMENT

AN/DSM-32

a. Condition (general) ____________________

b. In calibration ____________________

c. Test area (general) ____________________

AN/DPM-9

a. Condition (general) ____________________

b. In calibration ____________________

c. Test area (general) ____________________

Squid Circuit Tester

a. Condition (general) ____________________

b. In calibration ____________________

Is standard test equipment, such as meters, readily available for missile shop use? ____________________

V. STORAGE AREAS AND MISSILE SHOP SPACES

a. Safety equipment ____________________

b. Compatibility ____________________

c. Housekeeping ____________________

d. Comments and/or recommendations ____________________

____

____

VI. SUMMARY OF SPARROW OVERALL COMBAT READINESS

(Make recommendation for improvement) ____________________

____

____

____

____

____

____

UNCLASSIFIED [redacted]

*DEPLOYING VF SQUADRON SPARROW WEAPON SYSTEM INSPECTION WORK SHEET

1. To conduct an orderly and complete pre-deployment SPARROW Weapon System Inspection, the following format will be followed. When the attached work sheets are completed, they will be returned to the inspection team leader.

2. The enclosed work sheets are intended as a guide for a qualified SPARROW representative with field experience.

3. Formal schooling as used here is defined as one of the following:

a. An accredited service school.

b. An accredited commercial company school.

c. A course of instruction consisting of a minimum of 40 classroom hours given by a NAVMISCEN NCTS SPARROW Field Representative.

d. A course of instruction consisting of a minimum of 40 classroom hours given by a NAESU CETS/NETS Fire Control Representative.

e. A course of instruction consisting of a minimum of 40 classroom hours given by a 2nd Class Petty Officer, or above, who has attended or instructed one of the above.

4. The SPARROW weapon system handling, assembly, loading, no voltage checks, and SAFETY are the responsibility of the squadron ordnance shop.

*SPARROW Missile Representative Inspection Work Sheet excluding the fire control system.

UNCLASSIFIE[redacted]

I. PUBLICATIONS

a. Are required publications on hand and updated with the latest revisions? ____________
List missing pubs by number from required list below:

____

____

b. Are required publications available in the squadron missile shop or office? ____________

c. Are SPARROW Ordnance crews aware of publications and have they easy access to them? ____________

d. Is a mandatory reading list for SPARROW crews, including the publications listed below, maintained and current? ____________

REQUIRED SPARROW PUBLICATIONS

SPARROW Safety Manual	OP3365	1 May 1966	______
Maintenance Instruction Manual F-4 Aircraft Armament System	NAVAIR 01-245FDB-2-7	Jun 1968	______
Conventional Weapons Loading Checklist F-4 Aircraft Guided Missile Combined AIM-7, AIM-9	NAVWEPS 01-245FDB-75-3		______

II. TRAINING

a. The minimum acceptable number of SPARROW orientated ordnance shop crews is two (2); each crew nucleus content shall meet a minimum standard training requirement as defined below:

1. Crew leader of PO1 or PO2 in rate and a graduate of formal schooling of F-4 Armament Systems and missile handling and assembly. ____________

2. Two (2) crew members having formal schooling or one (1) previous WESTPAC deployment as a SPARROW crew member.

b. Does an on-the-job training program exist? ____________

UNCLASSIFIED[redacted]

c. Verify crew competence by observing the following:

1. Is proper transport and loading equipment used including adapters? ____________

2. Are authorized assembly and loading procedures followed in an efficient manner? ____________

3. Are SAFE practices observed including cockpit switch settings, launcher SAFETY pin installation, and rocket motor SAFETY pin installation? ____________

4. Are "No Voltage" checks properly performed? ____________

5. Is proper installation of Mark 9 Ejector Cartridges verified?

____

6. Is an authorized arming sequence followed (dry run acceptable)?

____

7. Does crew have a working knowledge of F-4 Aircraft Armament System including ability to "fault isolate" malfunctions? ____________

III. AIRCRAFT STATUS

a. Select three (3) aircraft at random and check the following:

1. Are all SPARROW required changes and modifications installed? ____________

2. General condition of launchers? ____________

3. Pit checks of aircraft updated? ____________

4. Is a launcher cleaning stand available for squadron use? ____________

____

IV. TEST EQUIPMENT

a. Rocket Launcher Firing Circuit Tester P/N 53A53D1 with SEC 813A incorporated? ____________

1. Condition (general) ____________

b. Is standard test equipment such as meters readily available for ordnance shop use? ____________

V. ORDNANCE SHOP SPACES

a. Sound Attenuators available? ______________________

b. Compatibility ______________________

c. Housekeeping ______________________

d. Test equipment stowage ______________________

e. Comments and/or recommendations ______________________

____

VI. SUMMARY OF OVERALL SPARROW COMBAT READINESS (Make recommendations for improvement.) ______________________

SPARROW MISSILE DEGRADATION DURING SERVICE LIFE

INTRODUCTION

During the past several years, the NAVMISCEN has collected extensive Fleet data pertaining to the operational experience of the SPARROW missile. The purpose of this report is to summarize this data which describes the service life of the missile and the degradation in availability and reliability that occurs during Fleet operations. The primary objective of this investigation was to aid in the development of operating procedures that will optimize the effectiveness of the SPARROW weapon system in combat operations; a secondary objective was to provide information useful in the design of new systems.

BACKGROUND

a. CVA SPARROW Operating Procedures: At present, each CVA is equipped with two DSM-32 missile test sets for conducting shipboard testing of the missile G&C. Under current procedures the missiles are subjected to an AT (acceptance test) and a PT (periodic test) following a specific number of captive flights. All missiles tested NO-GO are given an additional RAF (retest after failure) and if still indicating NO-GO, the seeker and control sections are interchanged between missiles and an RAR (retest after remate) is conducted. During captive flights, missiles not evidencing a select light are subjected to an RAF.

The CVA maintains approximately 75 missiles assembled with warhead and motor in ready service storage with the remainder stored by section in deep stowage. Missiles testing NO-GO are removed to deep stowage and are offloaded to an NWS. This procedure is depicted in Figure 1.

b. During the past four years, there have been minor changes in shipboard operating procedures, primarily in changing the test frequency by increasing the number of allowable captive flights between periodic tests. At the beginning of extensive SPARROW operations in SEA, the allowable number of captive flights between periodic tests was 10 to 15, depending upon the severity of landing. Following preliminary investigations into missile availability, the NAVMISCEN recommended an increase of flights from 10 to 30.

During the past two years, all CVA's in WESTPAC have been using the 30-flight criteria. To verify the feasibility of eliminating shipboard testing, the USS FRANKLIN D. ROOSEVELT was deployed to WESTPAC under a no-shipboard trial in 1967. The data used as a basis for this report represents a cross section of missile experience obtained from CVA's operating under the above variations in test frequencies, including shore based operations.

DISCUSSION

a. Missile Degradation During Fleet Operations: The SPARROW missile, during Fleet operations, is subjected to the following environmental conditions:

1. Captive Flight - During captive flight, the missile is electrically energized during the major portion of the flight. It is subjected to vibration, physical damage, and moisture intrusion; this phase is defined to include the loading and unloading of the missile onto the aircraft.

2. Testing - Testing is defined as the entire process of unloading, strikedown, application of energy during testing, reassembly, and loading back on the aircraft.

3. Handling - Handling includes all missile assembly, disassembly, movement to and from storage to support operations.

4. Stowage - Stowage is primarily inert stowage by section in the magazine where the environment consists of shipboard vibration and moisture intrusion.

From examination of the shipboard environment, it is concluded that the primary reasons for missile failures during captive flight and testing are energized time and physical degradation. The primary cause for failure during handling is attributed to physical damage. It is concluded in the next section that there is no significant missile degradation due to shipboard stowage.

b. Data Sources: The importance of the sources of missile experience data cannot be overemphasized. The first complete and accurate information describing missile experience was obtained from the USS RANGER, following a WESTPAC deployment in 1966. Representatives of the NAVMISCEN visited the RANGER and concluded that the data was valid, was recorded conscientiously, and originated from a missile shop that operated in an outstanding manner. The data contained the results of 7,225 captive flights and 2,851 missile tests. The USS RANGER followed the operating procedures shown in Figure 1, and had an average test frequency of seven captive flights per missile test. The RANGER off-load was processed by NWS Concord and the DSM-32 shipboard test results were verified by the DPM-7 testing during NWS processing. The records were changed to reflect the DPM-7 test results. From the RANGER data, much information was obtained such as the acceptance rate of the missile load-out, the reject rate of the acceptance testing, the percentage of missiles rejected by the select light, the false reject rate of the select light, the false reject rate of shipboard testing and the percentage of failures incorrectly indicated by the select light.

The RANGER data was used as the basis for much of this report and was verified by the data obtained from the other following sources:

1. USS FRANKLIN D. ROOSEVELT - Extensive data was obtained from a deployment operating on a no-test plan with procedures shown in Figure 2. The missile load-out was processed by a team from NARF Norfolk, and at the completion of the deployment the identical team processed the off-load. All missiles that failed during the deployment, as evidenced by loss of the select light, were shipped to QEL Concord for evaluation.

2. USS CORAL SEA - Data was obtained from two separate deployments of the USS CORAL SEA. During one deployment the test frequency was 10 to 15 flights per test, and during the other deployment was approximately 30 flights per test.

3. USS KITTY HAWK - The data obtained from the USS KITTY HAWK was recorded while operating on a test frequency of 10 to 15 captive flights per test.

4. VMFA-531 - Data obtained from VMFA-531 describes a shore based environment operating under a no missile test procedure utilizing the aircraft select light to determine missile status. The missile population consisted of new production AIM-7E's. A large sample of the missiles were shipped to the NAVMISCEN for evaluation following the reported deployment.

In addition to the above, spot checks of other CVA's have been performed during the past several years whenever data has been available.

c. <u>Results</u>:

1. Missile Degradation Due to Captive Flight - Missile degradation due to captive flight alone is shown on Figure 3. The curve represents the probability of survival versus the number of captive flights. The curve closely follows an exponential distribution indicating a constant failure rate (λ) as would be expected for an electronic device not significantly affected by aging or use. The curve represents the USS RANGER experience verified by all of the other data sources.

2. Missile Degradation Due to Captive Flight and Missile Test - The failure rate (λ) due to missile testing was calculated to be .0348 missiles per test. Using this failure rate, a series of curves was plotted on Figure 4 representing the combined effect of missile testing and captive flight. The curves were verified from the data sources that were operating under the indicated test frequency.

3. Missile Degradation Due to Physical Damage - Missile degradation due to all forms of physical damage is shown in Figure 5 as the probability of survival versus loadings and unloadings. This information is not considered further and is only provided for information. The curve was plotted from data obtained during the USS FRANKLIN D. ROOSEVELT deployment and would vary widely between CVA's depending upon the care and attention of the operating activities in sway brace adjustment and missile handling.

4. Missile Degradation Due to Stowage - Inputs from NWS personnel have indicated that AE off-loadings of SPARROW missiles that had been at sea for extended periods of time indicated a very low rate during NWS processing. The only factual information to substantiate these inputs was obtained following the FRANKLIN D. ROOSEVELT no-test deployment. A sample of 48 AIM-7E's processed at the completion had zero flight time and was only subjected to shipboard storage. The reject rate of this sample was approximately 4 percent, which compares favorably with the reject rate of new production missiles. It was therefore concluded that the shipboard stowage had a negligible effect on missile degradation.

d. Missile Reliability: All of the previous discussion has been in terms of missile availability or probability of survival versus captive flights. The important question to be answered is the effect of test frequency on missile free flight guidance reliability. If the missile is tested prior to each captive flight, we would be assured of maximum missile reliability. During PMT firings at the NAVMISCEN, this is exactly the case. All firings are preceded by a missile test with expert technicians using the DPM-7 test set. A select light is maintained during captive flight and the launch is performed under controlled conditions by an experienced SPARROW pilot. The average reliability maintained over the years for successful guidance is approximately 71 percent. This number is then assumed to be the maximum inherent reliability that could be attained. If the missile is flown on additional captive flights without testing, then certainly there would be a decrease in reliability versus captive flights with the curve starting at the maximum reliability of 71 percent. The curve is a compilation of all of the preceding data and represents undetected missile failures occurring during captive flight while a select light is maintained. From observations of Figure 6, the probability of the missile successfully guiding on a target following 30 captive flights is approximately 55 percent.

To determine the change in reliability due to test frequency, the average missile reliability for missiles tested every 10 captive flights was compared to the average missile reliability for testing every 30 captive flights; there is a theoretical decrease of 4 percent in reliability by extending the test frequency to 30 flights. The term theoretical is used because the decrease in reliability does not consider errors, false reject rate, and missile degradation caused by testing.

CONCLUSIONS

a. Missile Degradation During Fleet Operations: It is concluded that the SPARROW missile, in Fleet operations, degrades at a constant failure rate due to captive flight and testing. A compilation of all of the data indicates no significant change in failure rate during the past several years. The missile degradation due to physical damage is variable depending upon the using activity and indicates an increasing failure rate with increasing missile loadings. The degradation due to inert storage in a shipboard environment is negligible. There is no measurable difference in the missile failure rate between shore based and CVA operations.

b. Missile Reliability: The theoretical decrease in missile reliability of 4 percent, caused by extending the test frequency from 10 to 30 flights, does not consider any other aspects of the system, such as the accuracy of the test equipment.

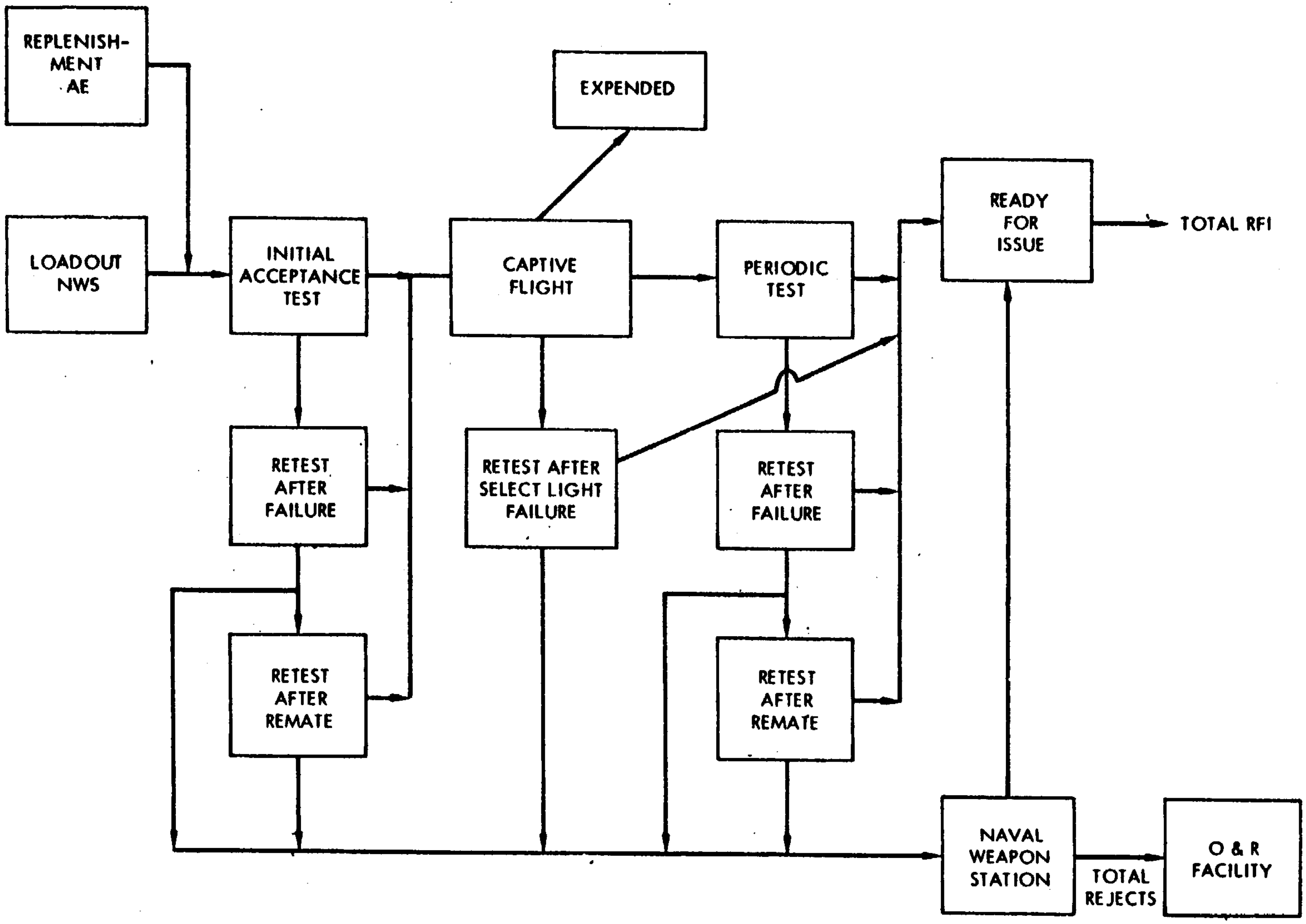

Figure 1. SPARROW Logistics

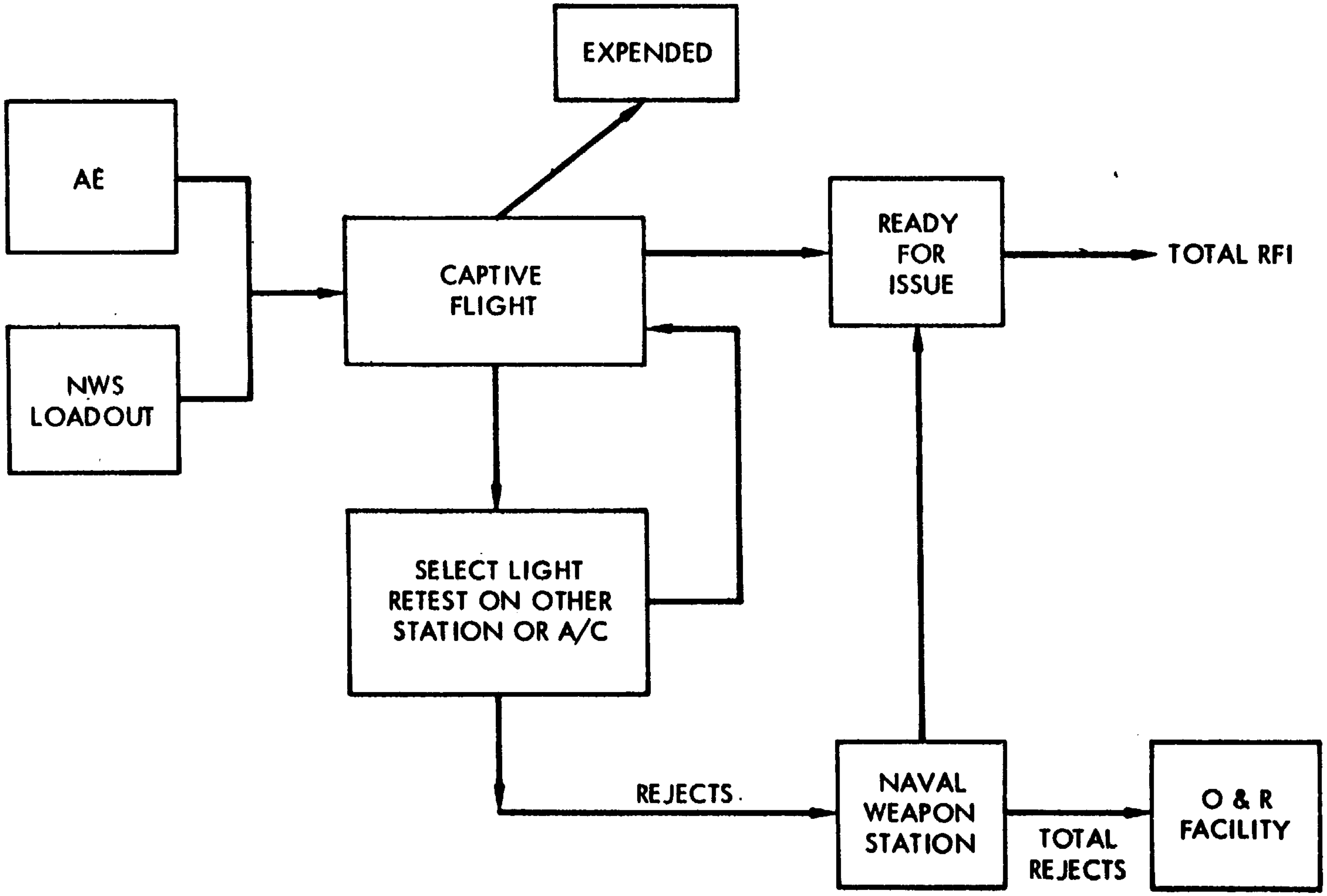

Figure 2. FDR Logistics

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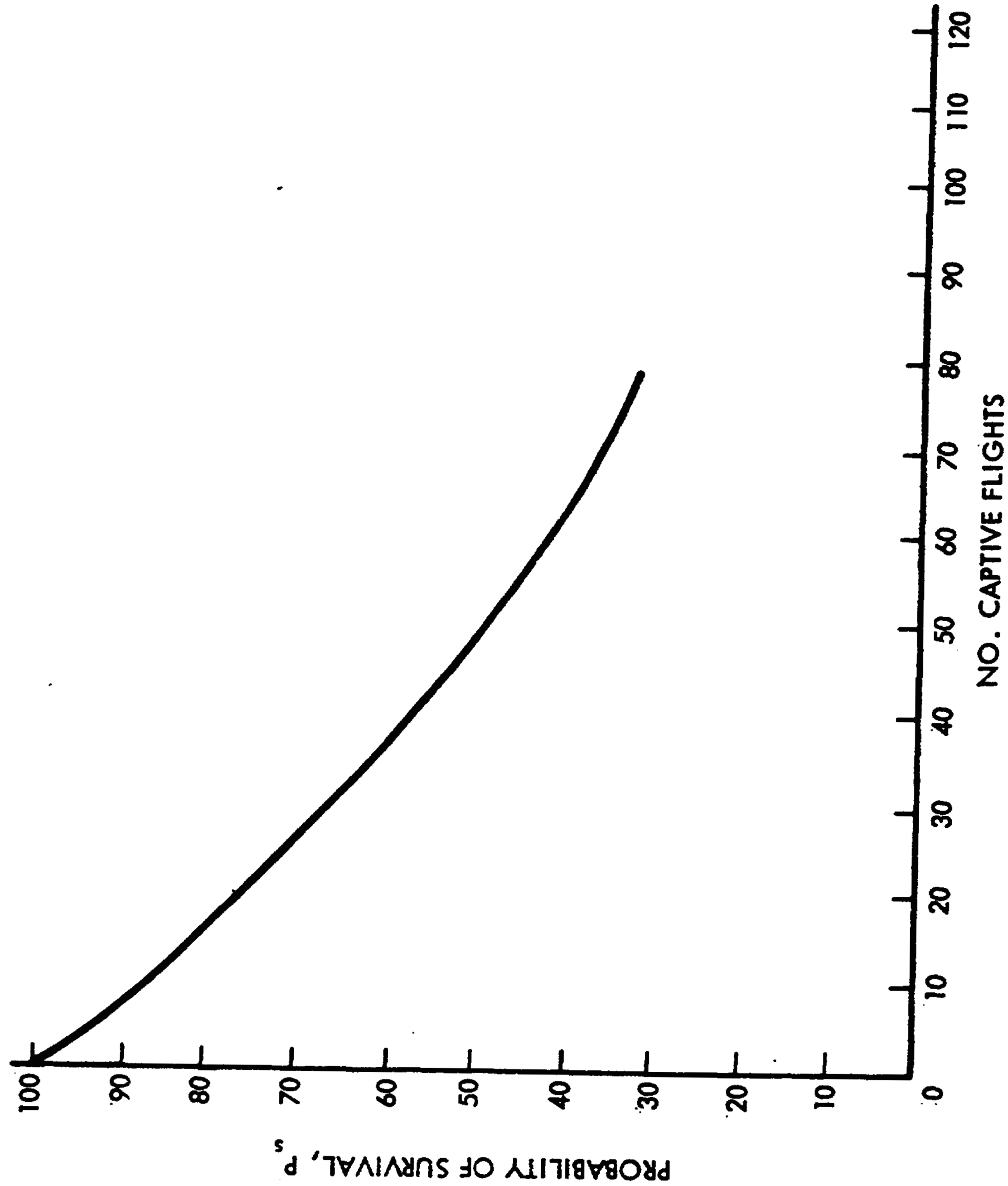

Figure 3. Missile Degradation due to Captive Flight

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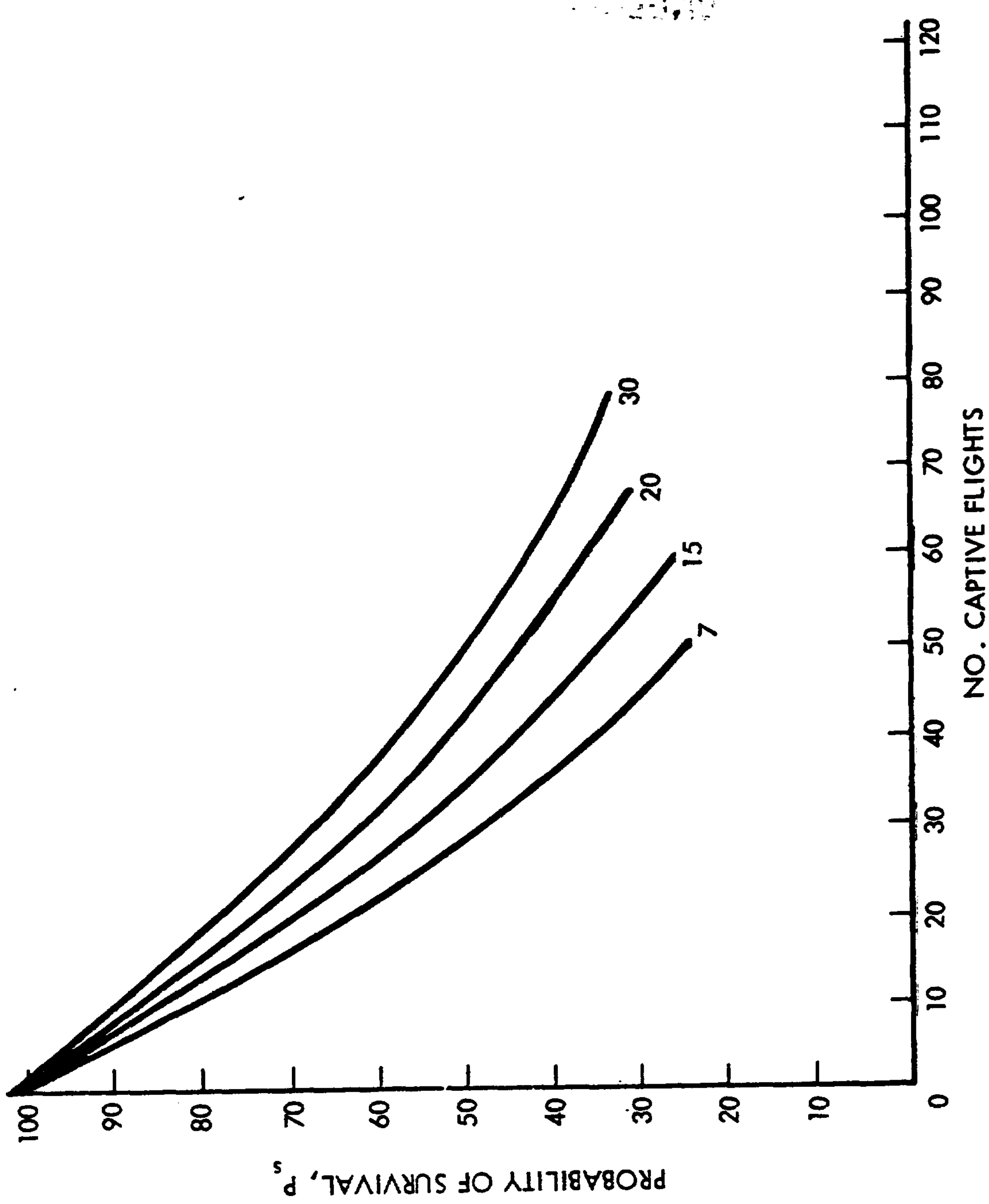

Figure 4. Missile Degradation due to Test and Captive Flight

TAB III-H

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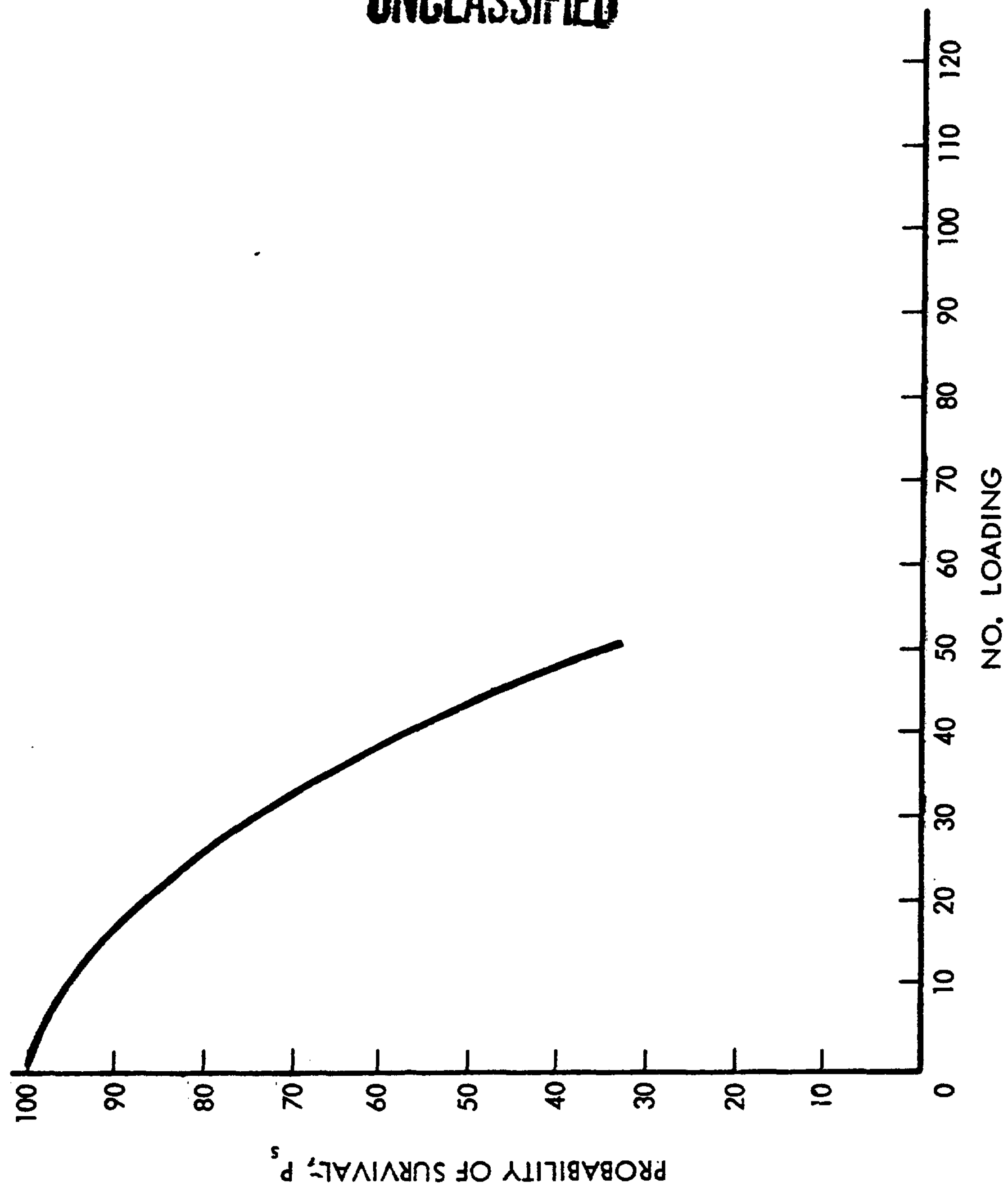

Figure 5. Missile Degradation due to Physical Damage

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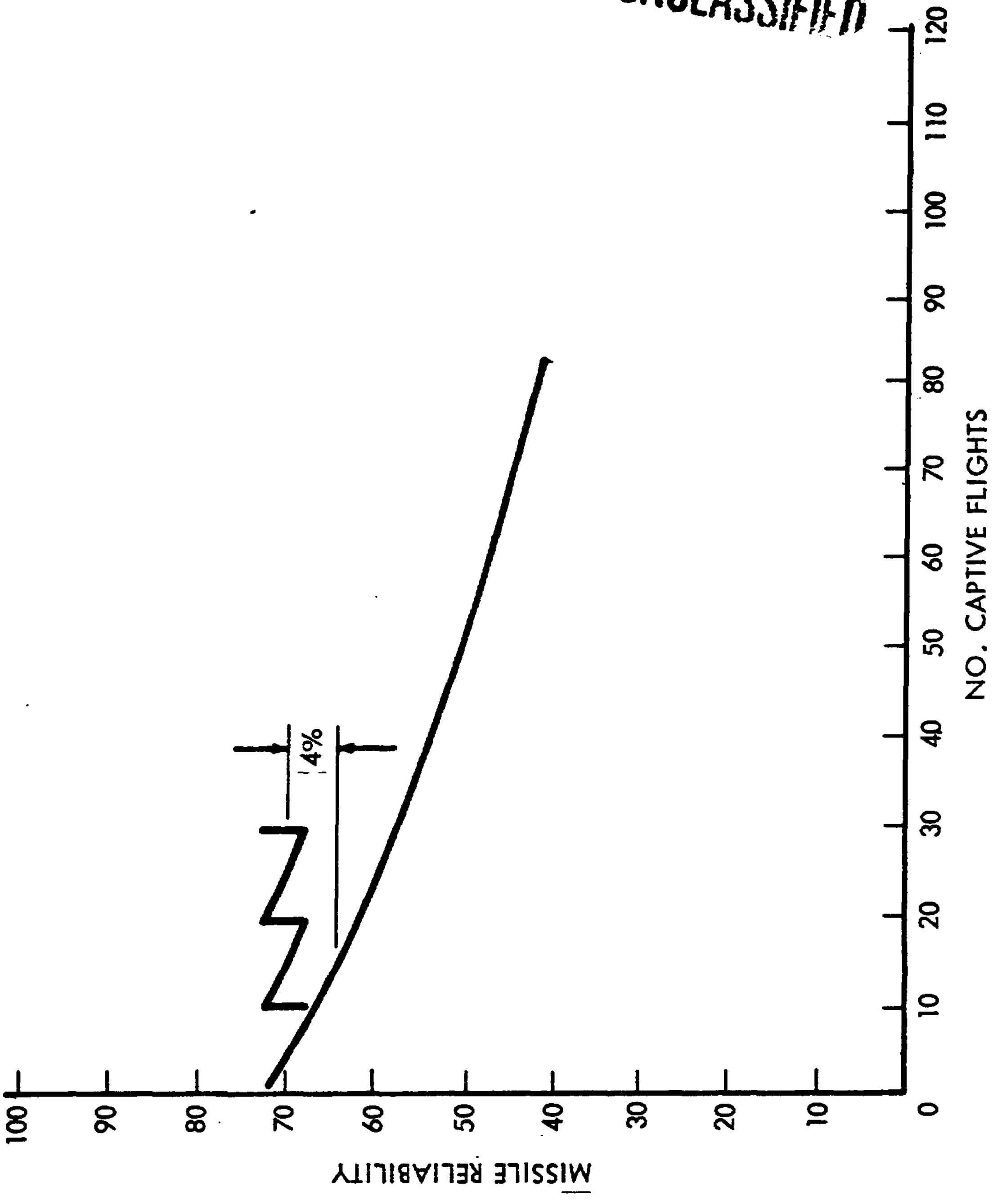

Figure 6. Missile Reliability versus Captive Flight

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SPARROW SHIPBOARD PROCEDURE

The following is proposed as the allowable procedure to permit SPARROW missiles to remain on aircraft overnight aboard ship. Compliance with this procedure would not create a safety hazard and would eliminate extensive missile handling and loading.

1. Aircraft

   a. Electrical/Avionics maintenance will NOT be performed.

   b. Master Armament switch to OFF.

   c. Missile Power switch to OFF.

   d. Selective Missile Jettison switch to OFF.

   e. Missile Control Safe/Arm switch to SAFE.

   f. Generator Control switches to OFF.

   g. Missile Control Interlock IN.

   h. Armament Safety Override switch OUT.

2. Missile/Launcher

   a. Motor Safe/Arm switch to SAFE and red pennant attached.

   b. Launcher safety pin installed.

AIR-TO-AIR GUIDED MISSILE SAFETY STUDY

A weapons system, in addition to its primary purpose, must provide protection to personnel, equipment, and property, and must prevent such inadvertent events as launch, release, arming, or detonation. Two basic methods are available for providing the required safety - features designed into the system and administrative control over the system. Design is the more desirable method of achieving the required safety; however, effective human engineering can reduce a safety problem considerably.

Much of the needed safety can be designed into the system, but where design safety is not possible, reliance must be placed on administrative control and strict adherence to operational procedures. The system must be safe; however, it must also be useful. In conducting an analysis or evaluation, maximum safety consistent with operational requirements must be recognized and taken into account. Hazards should be identified and eliminated when possible, or controlled if they cannot be eliminated.

The scope for this safety study shall include the weapon, delivery vehicle, fire control system, ancillary equipment, and documents. Appropriate Navy safety manuals, Navy safety standards, and weapons manuals will be used as guidelines to determine if safety requirements have been met.

When a study group determines that safety requirements are inadequate or cannot be compiled with, procedures should be recommended to provide administrative safety in lieu of the desired safety requirements. Administrative safety procedures will be used as interim requirements until official action has been taken.

Composition of Study Group

The Air-to-Air Guided Missile Study Group shall be organized with one member from each of the following organizations:

- NWEF, Chairman
- CNO
- NAVAIRSYSCOM
- CAW's/CVA's
- COMNAVAIRLANT
- COMNAVAIRPAC
- NAVAIRSYSCOMREPLANT
- NAVAIRSYSCOMREPAC
- OPTEVFOR
- Marine Corps
- NWS's
- NWL Dahlgren
- NAVMISCEN
- NWC China Lake
- NAVAVNSAFCEN
- NATC
- NAMTG
- NAVORDSYSCOM
- Contractors

The designated representative from each command is expected to be cognizant of his command's position, policies, plans, and responsibilities relative to the weapon systems and to be the voice for that command in these areas. Study Group members are encouraged to bring advisors to provide technical information for consideration by the Group.

The NWEF project engineer is responsible for coordinating the plans and the preparations prior to the study and for the timely dissemination of the Group findings upon completion of the study.

Conduct of the Safety Study

General requirements shall be prepared and a planning letter sent to all interested activities stating the general purpose, scope, and intent. Items for review in addition to those outlined in the letter shall be requested.

An analysis of troublesome safety problems encountered, unsatisfactory reports, ordnance incident reports, failure reports, and Board of Inspection and Survey Trials, will be performed by the Study Group to obtain an over-all view of a weapon system's operational history. Presentations from various ships and stations shall be obtained to determine areas of design, documentation, personnel, or operations that pertain to safety and are of a constructive nature, in addition to undesirable or unsatisfactory conditions.

Demonstrations in handling, storage, maintenance, and launch/firing preparation of a weapon or system shall be required by the Study Group when necessary. Evaluation, for possible safety influence, shall be made of technical manuals, procedures, and practices in their actual environment.

The Study Group shall relate a system's operational history to weaknesses observed during the safety study to determine if design improvements are required to maintain an adequate margin of safety.

Study Group Evaluation Guides

The listings which follow are minimum features which should be observed for evaluation of a system's safety. Additional items may become necessary, depending on the system being considered.

1. Publications
2. Handling Equipment
3. Test Equipment
4. Operational Safety Procedures
5. HERO

6. Shipboard Safety Procedures
7. Stray Voltage Tests
8. Firing Circuit Tests
9. Loading Procedures
10. Built-in Safety Features
11. Personnel Training
12. Igniter/Pyrotechnic Characteristics
13. Storage

Maintainability and Reliability Trends of Air-launched Weapons and Weapon Control Systems

INTRODUCTION

The purpose of this paper is to provide information on the current maintenance and reliability trends of Navy air-launched weapons and weapon control systems and some estimates on how microelectronics could affect these trends.

Addressed herein are current and planned weapons systems, especially SIDEWINDER, SPARROW, BULLPUP, WALLEYE, SHRIKE, PHOENIX, and CONDOR, and primarily the two existing weapon control systems in the F-4 aircraft, namely the AERO 1A and AN/AWG-10. Data are not tied to a specific weapon system and trends are presented instead of specific values.

To determine the impact of microelectronics on current trends, the following factors are considered as advantages of microelectronics:

Increased reliability

Decreased size, weight, and cost.

MAINTENANCE

The general trend in Navy weapon systems today is an increasing awareness of maintainability. When combat aircraft face problems in an aircraft carrier because of the increasing requirements for avionics maintenance spaces, the subject of maintainability obtains command attention. A program called "Improved Rearming Rates" has as one of its objectives to handle all air-launched weapons as "all-up-rounds". For the past several years much work has been done in container design and logistic planning, and by 1970 the weapons will be shipped and handled as complete rounds with a minimum of maintenance requirements.

There are three levels of maintenance - organizational, intermediate, and depot. In the logistics cycle of weapons the levels of maintenance are:

	Past	Present	Future
Ship	Test	1/2 Test	None
NWS	Repair	Test	Test
NAVAIREWORKFAC	Overhaul	Repair	Repair

The NWS in addition to testing the G&C includes physical inspection of all components. The NAVAIREWORKFAC overhaul consists of refurbishing mechanical portions, adjusting the weapon to production specifications, and replacement of failed components.

The weapon control systems are also maintained at three levels:

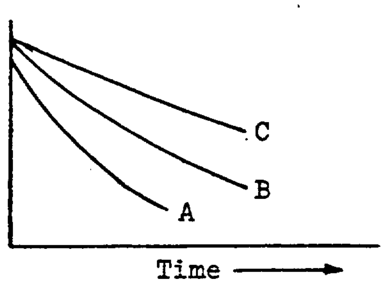
	Past	Present	Future
Squadron	Repair/Replace/Harmonize	Replace	Replace
Ship	Repair	Repair/Replace	Replace/Repair
NAVAIREWORKFAC	Overhaul	Overhaul	Overhaul

The trend here is clearly toward replacement only in the field, with very little actual repair. This trend will be increased by increasing use of microcircuitry, for obvious reasons, but a need for repairing connectors, wiring bundles, and the like will remain. In addition to these three formal levels of maintenance there is really a fourth consisting of an in-flight test of the system, using on-board or built-in test equipment for which the trend is toward highly automated, rapid verification of the performance of the weapon control system. These tests, together with operator complaints and periodic ground tests, are used to determine when maintenance is necessary.

TESTING

The first element of maintenance to be considered is testing. The only purpose of weapon testing at the organizational and IMA level is to verify status, since repair is not accomplished at these levels. The following is typical of the trend in weapon testing:

P_s
Probability of Survival



A-Periodic Testing

B-No Test

C-No Test with limited on-aircraft test

The curves are extracted from a comprehensive study completed on weapon availability. It was concluded to fly X number of flights with the missile without periodic testing and send the weapons to an NWS for testing.

None of the attributes of microelectronics would affect this trend toward less testing. Increased reliability, if attained, would accelerate the trend to eliminate testing, if anything.

While missiles are receiving fewer tests, the weapon control systems are being tested more frequently and in more detail. These tests are normally required to perform two functions - determine the operational status of the weapon system (performance verification or confidence testing) and, in the event of a failure in the weapon system, to locate or assist in locating the fault.

The performance verification function normally provides for a detailed periodic ground test of the status of the weapon system and for a rapid and less detailed in-flight status check. The in-flight check, in the event of a failure, or degraded performance, should provide enough information to permit the selection of an alternate mode of usage for the weapon system while the aircraft is on the way to the target. This in-flight status requirement makes some sort of built-in test a necessity. Microcircuitry appears well adapted to built-in test requirements.

BITE (built-in test equipment) is also used to assist in the "fault isolation" function of the maintenance task. While, in fighter or interceptor aircraft, the replacement of faulty black boxes must be done on the ground, the fault isolation can be done while the aircraft is airborne, using BITE. However, if the BITE is programmed to play the percentages and locate the most frequently expected, predictable failures it is of little use unless it is also programmed to solve the difficult trouble-shooting problems. As an example, one complex airborne fire control system which has been in the Navy inventory for several years has long been considered a maintenance problem. The average time spent trouble-shooting this system exceeds 30 minutes per symptom. This average would be higher were it not for the fact that trouble-shooting attempts for non-critical faults are often stopped if the source of the trouble cannot be found in a few hours. Nevertheless, 50 percent of the trouble-shooting actions are completed in less than 10 minutes, and a great many take no time whatsoever since the failure can be located immediately based on the nature of the symptom and the technician's experience. Were an automatic fault isolating aid to be applied to this system, it would have to correctly locate considerably more than the 50 percent of the faults which are now found in 10 minutes in order for it to be worthwhile from the standpoint of time savings. As more and more functions are packaged into a single replaceable module, or unit, the old-fashioned method of trouble-shooting by trial and error may prove to be as efficient as more technologically advanced methods.

REPAIR

The other elements of maintenance to be discussed are repair and overhaul, which for weapons are essentially the same process. All weapons that are rejected during the operational cycle are processed to a NAVAIREWORKFAC from an NWS for repair. As stated, some mechanical portions are refurbished and all failed components are replaced. To date there is no evidence to indicate that any of the systems have entered the wearout portion of their life, and several systems studied demonstrate a constant failure rate. With minor exceptions, there are no limited duty components that are replaced periodically. All work is accomplished by civilians in a production facility. It is difficult to see how microelectronics would affect the repair cycle. One system presently under evaluation is probably indicative of the trend. This particular system is of solid state design. The decrease in size and weight over its cordwood predecessor allowed a larger motor to be utilized, and much of the remaining available space was utilized for additional circuitry to increase weapon capability. The microelectronics components in this system are potted throwaway units, and due to the state-of-the-art in qualification testing, the components are not qualified, meaning they are single source components. The trend therefore is that the weight and space savings provided through improved techniques is utilized to increase weapon capability rather than maintainability.

The trend to throwaway modules naturally greatly reduces the amount of actual repair which must be done in the intermediate maintenance shop aboard ship. Here, as at the squadron level, the time and manpower consuming effort is devoted to trouble-shooting rather than repair. Because of this, the requirements for avionics maintenance spaces aboard an attack carrier are greatly expanding due to the ever-increasing amounts of specialized test and trouble-shooting equipment being procured. To reverse this trend, much effort is being devoted to the development of systems such as VAST (Versatile Avionic Ship Test System) which will provide testing, fault isolation, and checkout of a great variety of avionics equipments, systems, universal Line Replaceable Units, and modules, through use of a centralized test facility. It is presently the policy of the Navy that all new system developments and acquisitions shall have appropriate sensors and test points incorporated so as to be compatible with these centralized automated test systems (reference NAVMATINST 3960.4 of 31 July 1967). This requirement must be considered in the design of any new system and in the design of microcircuits themselves.

RELIABILITY

The reliability of Navy weapon systems has not changed significantly during the past four to six years. The emphasis has been on increasing performance and capability. As component reliability increases, the addition of functions to the weapon keeps the overall reliability essentially the same. On one air-to-air system the Navy is presently evaluating the fourth generation of the original weapon. The performance envelope and increased capabilities have been greatly extended; however, the single-shot kill probability of the overall system will show little change. The maintenance requirements have changed, but the change has been independent of design and is attributed to changing policy in the Navy. A new air-to-surface weapon recently introduced can be compared to a system that has been operational for seven years. Due to breakthroughs in technology, the accuracy of the new system is significantly greater; however, the two systems are comparable in reliability despite incorporation of state-of-the-art design and manufacturing techniques.

As with the missile, the emphasis in weapon control systems over the last number of years has been on increased performance and capability and on providing several alternative modes in which the system can be used. This ability to select any of several modes, based on the operational status of the weapon control system at that time, has increased the reliability of the overall system; however, the total number of maintenance actions required to keep the system at or near a 100 percent "up" status has not significantly changed, so that maintenance and logistics problems have not been appreciably eased by this increased reliability. If this trend toward added complexity continues, it can be expected that the much-heralded reliability of microelectronics will have little overall effect on the Navy's maintenance and logistics burden.

FAILURE MODES

Having treated maintenance and reliability of current weapon systems, the effect of microelectronics on reliability, will be addressed by a brief look at the types of failures experienced in operational use.

Between the air-to-surface and the air-to-air systems, two separate environments are experienced. An air-to-air weapon is flown on an aircraft as an integral part of the system to be available on short notice at some time on some flight. Captive flight cycles of 50-100 flights of several hours duration would not be unusual, while an air-to-surface weapon is loaded on an aircraft for a planned, specific target at a specific point in the flight. Seldom are air-to-surface weapons flown more than one captive flight. Considering the two different requirements, the types of failures being experienced can be predicted:

a. <u>Air-to-Air</u> - Moisture, corrosion, physical wear, and damaged connectors are the primary problems. After significant improvements in electronic design, a $20K missile requires the installation of $.22 of tape about 20 feet long to keep the accumulated moisture out prior to flight.

b. Air-to-Surface - The majority of weapon system failures of air-to-surface weapons can be attributed to the aircraft, which is subjected to the moisture problems of the air-to-air weapon. The one major problem of the weapon itself would probably be quality control.

In general, the problems could be summarized by stating that they are not component failures but problems that probably plagued Edison - connections, interconnecting wires, aging wire bundles, all complicated by moisture and corrosion. During the recent introduction of a new aircraft incorporating very sophisticated systems, an entire squadron was temporarily out of action due to rain's shorting out the electrical system caused by one connector in the aircraft wing.

CONCLUSIONS

It is concluded that maintenance concepts, and not design, govern the maintenance requirements.

Improved techniques such as microelectronics could provide greater choice of maintenance concepts; however, to date the advantages of microelectronics have been utilized to increase performance and capability with little application to maintenance or reliability.

The trends discussed indicate that maintenance at the organizational level is decreasing, but not as a result of changes in technology.

Deficiencies in avionic systems still consist of the age-old problems of interconnecting circuitry and quality control.

It is concluded that overall weapon reliability is remaining essentially constant even though component reliability has significantly increased due to improvements in technology.

Fire control system reliability could be described as increased because of the redundancy provided by additional modes available; however, Mean Time Between Maintenance Actions stays essentially the same for old and new systems.

In closing, the final conclusion is that microelectronics and other improvements in electronic design can undoubtedly increase system maintenance and reliability. The inherent reliability of microelectronic circuits together with redundancy permitted by the decreased size and weight could significantly decrease the maintenance burden on the Navy; however, there is no evidence at this time that this is occurring.

Funding Estimates

1. All of the recommendations of Task Team Three are considered adequately covered within fiscal planning for current programs with the exception of the following:

a. Items for which funding estimates are possible:

Paragraph	Subject	Costs (x 1000) Initial	Costs (x 1000) Recurring
I. C.	Training Equip. for NAMTRADETS	60	6
II. A.	Aircraft/AMCS Maint. Pubs.	500	-
II. C.	Loading Manuals/Check Lists	100	10
III. C.	Augmented Maint. Support	300	300
V. A.	Safety Review	200	-
VI. A.	AIM7/AIM-9C Logistics	2,500	100
VII. A.	AIM-7 Handling Equip. (Ships)	10	10
VII. B.	AIM-7 Handling Equip. (Shore)	60	6
VII. F.	RFNA for AWG-10	4,136	100
VII. G.	F 4/AERO-7A Pit Checks	235	50
	TOTALS	8,101	582

*Includes $2,000K for AIM-9C if retained in inventory.

b. Items for which further investigation is required:

I. G.	Programmed Instruction
VII. E.	Missile System Test Sets