# DEFENSE SYSTEMS MANAGEMENT COLLEGE


## PROGRAM MANAGEMENT COURSE

## INDIVIDUAL STUDY PROGRAM

THE NAVY TEST AND EVALUATION PROCESS
IN MAJOR SYSTEMS ACQUISITION

STUDY PROJECT REPORT
PMC 76-2

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DEFENSE SYSTEMS MANAGEMENT COLLEGE

STUDY TITLE:

THE NAVY TEST AND EVALUATION PROCESS IN MAJOR SYSTEMS ACQUISITIO

STUDY PROJECT GOALS:

To identify and examine unique test and evaluation methods, plans and problems associated with a low risk, long ~~fabrication~~ conventional hull ship program (Patrol Frigate) and a high risk, relatively short duration aircraft acquisition program (F-14).


STUDY REPORT ABSTRACT: (T/E)

Test and Evaluation is an integral and continuing part of the weapons system acquisition cycle. In the process of gaining knowledge from research through development and production, some some test and evaluation occurs each step of the way. In the past, it ~~too often~~ has been compromised as attempts were made to meet fixed deployment dates, even though programs slipped in their earlier stages. This study investigates the Navy's ~~test and evaluation~~ process in the procurement ~~life cycle~~ of ships and aircraft, including some ~~of the~~ recent changes in ~~test and evaluation~~ concepts brought about by ~~the~~ recommendations of the Blue Ribbon Defense Panel and DOD Directive 5000.1. The unique problems associated with low risk, long-duration, conventional hull ship acquisition programs are discussed including Land Based Testing, Initial Operational Test and Evaluation and DCP/DSARC alternatives. Similarly, problems associated with high-risk, but relatively short aircraft acquisition programs are also addressed with emphasis on concurrency, prototyping and operational test and evaluation. Incorporation of partial solutions to these problems (as evidenced in the Patrol Frigate and F-14 programs) are ~~cited and~~ examined for applicability to future test and evaluation programs.


SUBJECT DESCRIPTORS: Procurement Management, Test and Evaluation, Fly-Before-Buy.

| NAME, RANK, SERVICE | CLASS | DATE |
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| Thomas H. Hoivik, LCDR, USN | PMC 76-2 | 10 Nov 1976 |

# THE NAVY TEST AND EVALUATION PROCESS IN MAJOR SYSTEMS ACQUISITION

Study Project Report

Individual Study Program

Defense Systems Management College

Program Management Course

Class 76-2

by

Thomas H. Hoivik
LCDR USN

November 1976

Study Project Advisor

LCOL Carroll C. Rands USAF

## EXECUTIVE SUMMARY

Test and Evaluation is an integral and continuing part of the weapons system acquisition cycle. In the process of gaining knowledge from research through development and production, some test and evaluation occurs each step of the way. In the past, it too often has been compromised as attempts were made to meet fixed deployment dates even though programs slipped in their earlier stages. This paper investigates the Navy's test and evaluation process in the procurement life cycle of ships and aircraft, including some of the recent changes in test and evaluation concepts brought about by the recommendations of the Blue Ribbon Defense Panel and DOD Directive 5000.1. The unique problems associated with the extremely long but low risk conventional hull ship acquisition programs are discussed using the Patrol Frigate as an example. Included in the discussion are 1) the Navy's initial reaction to the requirements of DODD 5000.1 and their counterproposal for a unique DCP/DSARC process applicable to conventional hull ships only, 2) the initial Patrol Frigate test and evaluation plan using Land Based Test Sites, and 3) results of DSARC I and II. In contrast to conventional hull ship programs, the aircraft acquisition is one of high risk and uncertainty with a relatively short acquisition cycle. Problems associated with aircraft testing are also addressed with emphasis on concurrency, prototyping, T and E competition,

non-representative hardware, and operational test and evaluation. It is concluded that the systems integration approach to testing may be the best answer to the problems associated with Navy test and evaluation. Little faith is placed on policies that simply shift the test and evaluation power structure or pretend that concurrency can be eliminated. The only realistic hope for decreasing the concurrency of test and evaluation and production is to reduce the length of the Navy test and evaluation process through improved test planning, improved efficiency, and the reduction of redundancy in testing. It appears that coordinated and integrated testing is the most likely approach to result in significant improvement in Navy test and evaluation and bears investigation by other major acquisition programs as to its applicability to their test and evaluation efforts.

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## SECTION I

## INTRODUCTION

Test and Evaluation is an integral and continuing part of the weapons system acquisition cycle. In the process of gaining knowledge from research through development and production, some test and evaluation occurs each step of the way. Evaluation of material prior to approval for service use is a vital function. In the past, it too often has been compromised as attempts were made to meet fixed deployment dates even though programs slipped in their earlier stages. This study investigates the Navy's test and evaluation (T&E) process in the procurement life cycles of ships and aircraft, including some of the problems and recent changes in test and evaluation concepts brought about by the recommendations of the Blue Ribbon Defense Panel and DOD Directive 5000.1.

### A. BACKGROUND

On 1 July 1970, the results of the Blue Ribbon Defense Panel were published. The study encompassed the entire organization, structure and operations of the Department of Defense including significant comments about test and evaluation. This report made a clear distinction between operational test and evaluation (OT&E) and functional, engineering, or developmental testing. Operational testing is done to determine to what extent a given system or material can meet operational requirements. "It must provide advance knowledge as to what their capabilities and limitations will be when they are subjected to the stresses of the environment for which they

were designed (usually combat). Operational testing must take into account the interface with other systems and equipment, tactics, and techniques, organizational arrangements, and the human skills and frailities of the eventual users (2:9)."[1] Developmental testing is done to determine whether design and performance contractual specifications are met. The report pointed out that test data frequently would have been useful for analyses and decision making, however, the needed data sometimes did not exist, were derived from poorly designed tests, or test conditions did not permit comparison of systems. The report concluded that OT&E had not been adequately managed or supervised at OSD level, and that a 'higher-than-Service' level OT&E organization was needed if the potential of OT&E was to be realized.

Mr. Fitzhugh's Blue Ribbon Committee saw great potential in a program of well-managed OT&E and recognized prototyping and preproduction operational testing as better alternatives than weapons systems analysis in the form of reams of paper.

Secretary Packard issued DepSecDef memos pertinent to OT&E in February, April, and August of 1971. The first directed that each of the Services establish an agency which is separate and distinct from the developing command, and which reports the results of its test and evaluation efforts directly to the Chief of the Service (5:1). In addition the memo advised the establishment of a Deputy Director for Test and

[1]This notation will be used throughout the report for sources of quotations and major references. The first number is the source listed in the bibliography. The second number is the page in the reference.

Evaluation (DDT&E) within DDR&E. The April memo presented the requirements for the flow of T&E information in terms of program milestones. The August memo to the Service secretaries re-emphasized that operational test and evaluation will be accomplished prior to the decision to go into full production. The memo also stated "this initial operational test and evaluation will be accomplished with operational personnel in as realistic an operating environment as possible and where practical, will use pilot or early production items(7:1)."

B. DOD DIRECTIVE 5000.1

On 13 July 1971 DOD Directive 5000.1 was published. This directive further clarified the program decision making process and emphasized that anyone involved with RDT&E must acquire an understanding of DSARC concepts. The T&E effort was discussed as follows: "Test and Evaluation shall commence as early as possible. A determination of operational suitability, including logistic support requirements, will be made prior to large-scale production commitments, making use of the most realistic test environment possible and the best representation of the future operational system available. The results of this operational testing will be evaluated and presented to the DSARC at the time of the production decision(4:5)."

As a result of this directive the Secretary of Defense (SecDef) makes the decision which initiates program commitments or increases those commitments. Currently, the SecDef

with assistance from the Defense System Acquisition Review Council (DSARC) makes three key system decisions by choosing among alternatives posed in the Development Concept Paper (DCP). The specification of the three distinct stages in the system acquisition process with DOD level review between stages was designed to minimize concurrency and commitment of full-scale development and production before adequate information was available and analyzed. A flow chart of the DCP/DSARC system as outlined in the directive is presented in figure 1.

Each Service has been finding unique solutions to the organizational requirements, but the common denominators are: 1) A direct link between those reporting test results and their Service Chief; 2) An early involvement in the acquisition process of the command which will use the weapon system. In most cases the Services are making use of the organizations already in existence rather than opening new offices with new responsibilities. For instance Commander Operational Test and Evaluation Force (COMOPTEVFOR) is becoming a more significant factor in Navy testing since its commander has direct access to CNO for OT&E matters.

C. SECNAV INSTRUCTION 5000.1

In response to DOD Directive 5000.1, the Secretary of the Navy issued SECNAVINST 5000.1 for implementing the new provisions. Due to the wide variety of naval weapons, the Instruction allows varying approaches to the conduct of test

DCP/DSARC

DOD 5000.1

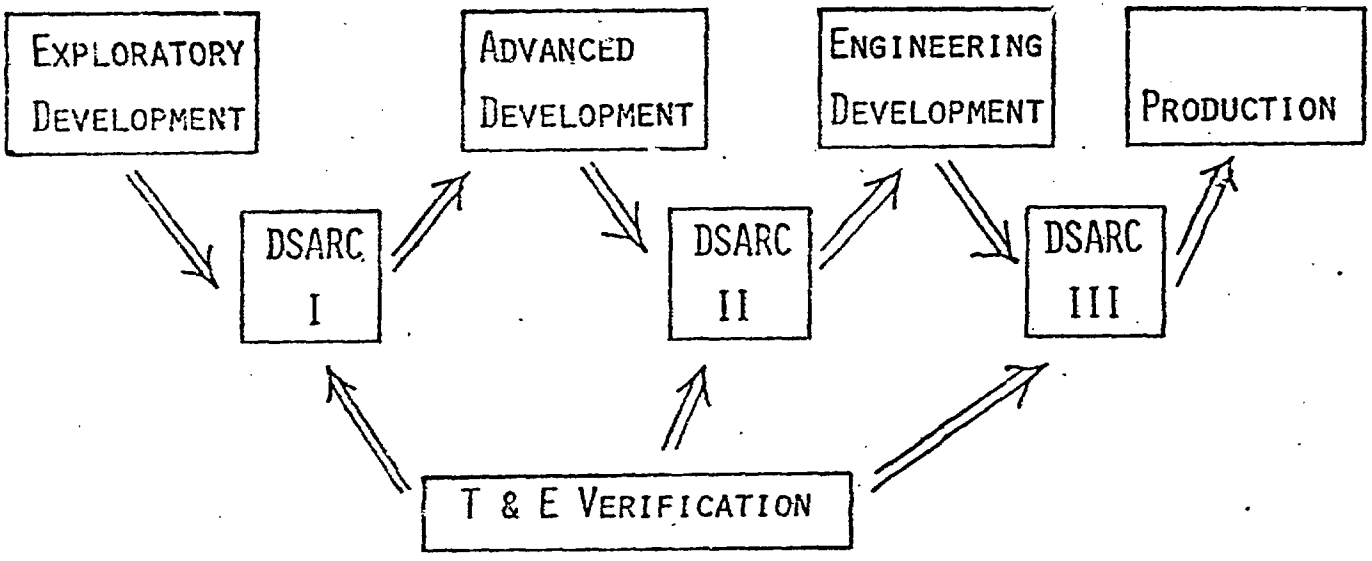



FIGURE 1

and evaluation. However, such effort shall be tailored to the needs and characteristics of each individual acquisition with prime consideration being given to adequate operationally oriented testing. Normally, the following general sequence of events should prevail: 1) laboratory/contractor preliminary test and evaluation of breadboard demonstration hardware during the conceptual effort, 2) contractor/development activity test and evaluation of subsystems and/or full-scale prototype during full scale development, 3) technical test and evaluation conducted by the contractor with Navy participation during pre-production/production, 4) initial operational test and evaluation (IOT&E) by or with the active participation of Navy operational forces prior to the major production decision, 5) Navy OT&E prior to approval for service use and inventory acceptance(16:13).

## SECTION II

## SHIP ACQUISITION

Although the approach to test and evaluation in SECNAVINST 5000.1 appears conceptually good, production of a low risk conventional hull ship might have to be delayed one to two years to allow completion of the operational testing. For example, in the Patrol Frigate (PF) program the delay to the program of waiting until the lead ship was built and operationally tested to start construction of the follow-on ships was initially estimated to be about 15 months. Delays of this duration could drive the already undesirable, but acceptable dip in force levels farther toward an unacceptable force level shortfall. Can delays of this magnitude and other resulting consequences be accepted in major ship acquisitions?

### A. DCP/DSARC CONSIDERATIONS

Several Admirals and Program Managers in OPNAV and SHIPSYSCOM objected to the use of the three step DCP/DSARC procedures for conventional ship construction programs. They felt that the current DCP/DSARC was structured to provide proper management for major Research and Development programs and that the highly controlled and definitive system was, in many ways, inappropriate for the management of a conventional ship acquisition program. They said the rigid application of this procedure to conventional displacement hull ship programs would result in unnecessary expenditure of time by project personnel, increased expense, and delays in delivery of urgently

needed ships to the fleet. It was recommended that the first essential step required to alleviate this problem was to separate non-R&D programs, such as shipbuilding, from the R&D programs that do require the "fine grained" management review and test and evaluation now being proposed for all programs. A flow chart of a proposed modification to the DCP/DSARC process applicable to conventional displacement hull shipbuilding programs is presented in figure 2.

The Chief of Naval Operations (CNO) after studying the problem believed that a streamline of the decision processes used in ship acquisitions was in order. In his memorandum to the Secretary of the Navy on 10 June 1972, the CNO proposed a policy for displacement hull ship programs that included: 1) one DSARC per ship program to be conducted after completion of formulation and ship system design, but prior to contracting for detailed design and production, 2) demonstration of adequate IOT&E performance for sub-systems prior to large scale production, 3) the use of shore based test sites for critical ship system integration demonstration, and 4) elimination of additional DOD formal reviews if all significant milestones are satisfactorily met, including those for IOT&E(3:2).

The Patrol Frigate program appears to be the first test case for gaining approval of the Navy's position regarding DCP/DSARC procedures and ship T&E for conventional displacement hull ship programs. The decisions on the PF T&E will no doubt be used as a precedent in other similar programs.

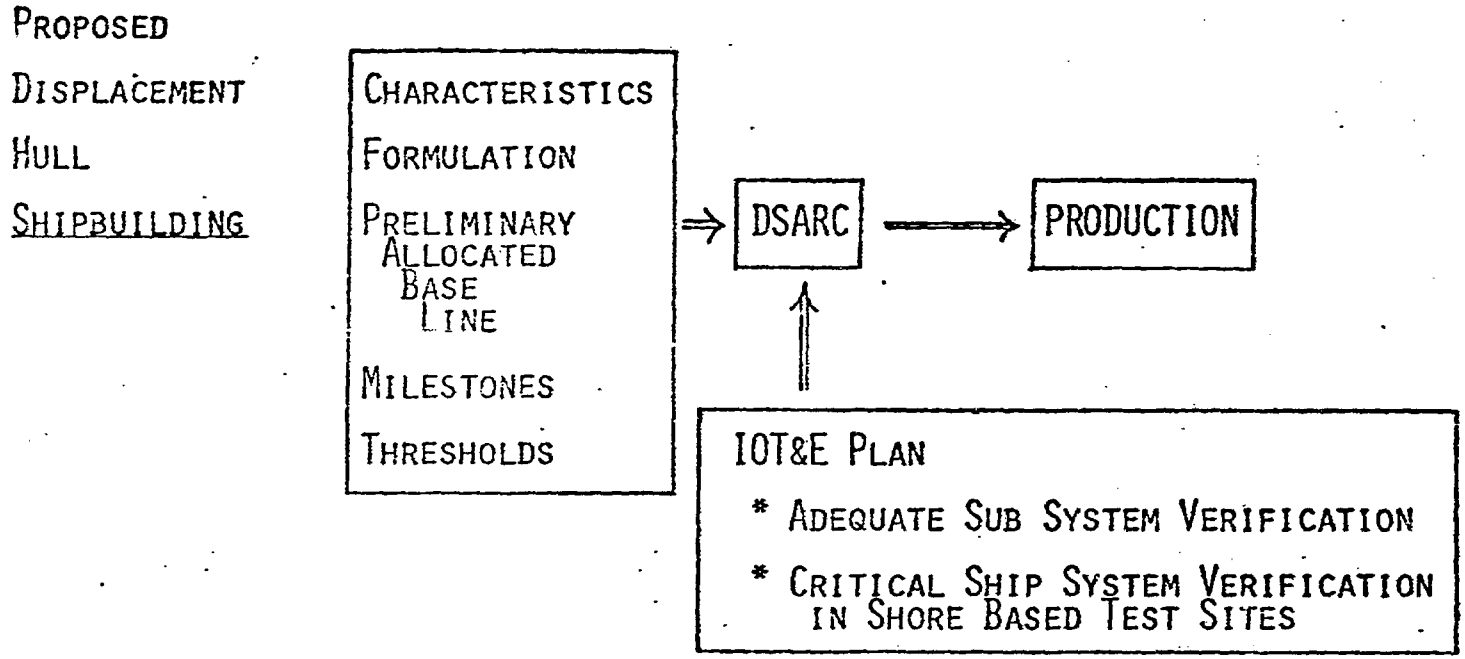

PROPOSED
DISPLACEMENT
HULL
SHIPBUILDING
CHARACTERISTICS
FORMULATION
PRELIMINARY
ALLOCATED
BASE
LINE
MILESTONES
THRESHOLDS
DSARC
PRODUCTION
IOT&E PLAN
* ADEQUATE SUB SYSTEM VERIFICATION
* CRITICAL SHIP SYSTEM VERIFICATION IN SHORE BASED TEST SITES

FIGURE 2

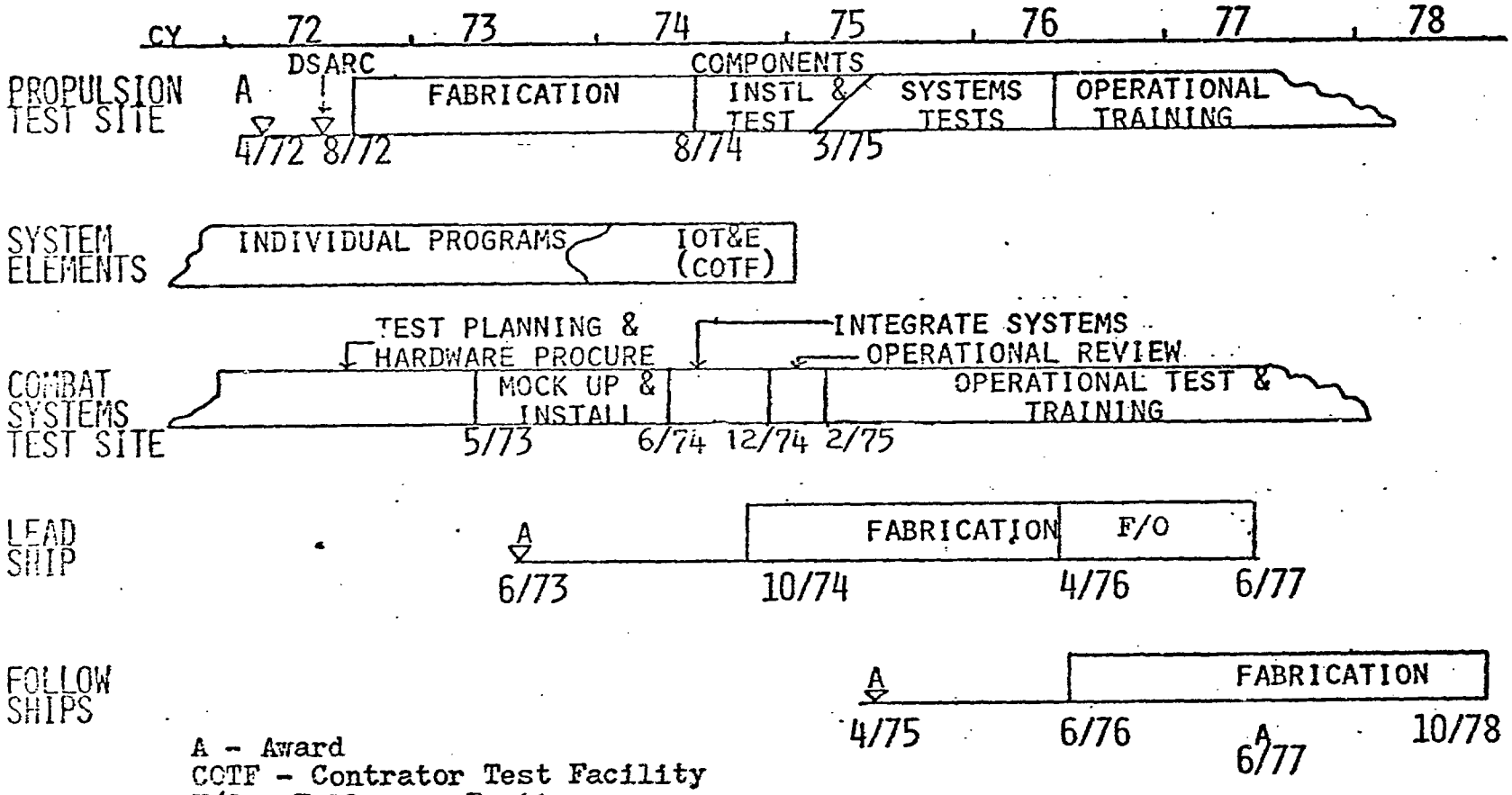
## B. INITIAL PATROL FRIGATE TEST AND EVALUATION PLAN

Supplementing and anticipating the lead ship construction, two individual, full-scale land-based test sites (LBTS) were to be erected for the propulsion and combat systems respectfully. In addition to validating the ship engineering aspects of installation and integration of the critical Patrol Frigate systems, the two land-based test sites have provided the facilities to assist in the configuration management of the Patrol Frigate propulsion and combat prototype systems. In concept throughout the life of the PF program, these sites would be used to evaluate change proposals prior to application to the ships. The sites would be controlled to insure that the LBTSs are a realistic prototype of the PF combat and propulsion system. After the initial validation of system integration, the two land-based test sites would also be used to validate operation, maintenance and support concepts proposed for the PF(14:3-5).

## C. LAND-BASED TESTING

The central relationship of these test sites to the ship acquisition schedule is presented in figure 3. Land-based testing is to be used in concert with IOT&E plans for individual equipments not now in inventory. This should allow achievement of the requisite level of confidence in ship and equipment engineering before a commitment is made to produce either in quantity. The land-based testing and equipment IOT&E schedules provide for proofing of key systems beginning two years before completion of the lead ship. This coincides with the planned

# PF PROGRAM STRUCTURE




A - Award
COTF - Contrator Test Facility
F/O - Follow-on Testing

FIGURE 3

award date for follow-on ship construction contracts.

The Patrol Frigate combat system Land-Based Test Site should be a genuine prototype of the PF combat system. Its creation early in the PF development process should provide the opportunity and the mechanism to validate and document not only the combat system engineering process but also the installation, test and checkout, and operation and maintenance procedures prior to the delivery of the first PF. To achieve these objectives the LBTSs will aggregate three essential functions:

1. A functional Checkout Facility to validate the system engineering and electrical compatibility of the equipment.

2. A Computer Program Checkout Facility to debug the combat system computer programs.

3. A Physical Mockup to validate the design and to be the ultimate recipient of the results of the above efforts. The Physical Mockup will be the combat system prototype.

Throughout the life of the PF program the LBTSs should be used as an integral part of the PF configuration management program. The Ship Acquisition Program Manager (SHAPM) should require that all change proposals be evaluated at the appropriate LBTS before they are considered by his change control board. Once engineering solutions have been validated at the LBTS the configurations will be frozen and controlled. This LBTS approach allows for a DSARC decision on the basis of the initial assessment of the PF's operational capabilities before at-sea trials

and will identify areas where rigorous at-sea evaluation is required.

According to the initial PF test plan it is apparent that the IOT&E would be completed and the results available only after all contracts were finalized and fabrication has begun on about half of the 50 ships in the contract(13:2). It is important to note that when construction begins simultaneously at the three shipyards, the results of IOT&E on the lead ship as a unit are not available and would not become available for two years. Should the members of the DSARC consider themselves obligated to be responsive and letter strict to the requirements of DOD Directive 5000.1 and the desires expressed by Congress in Public Law 92-156 Section 506, covering their desire for appropriate operational test reports, the initial PF test plan would be unacceptable. However, if whole ship IOT&E is to be completed and results published and analyzed before the initial production decision the delay in delivery of each ship could be as much as three and a half years. According to the CNO, the requirements of the Navy make this unacceptable. A middle ground introducing considerably less delay might be more appropriate. In other weapon system acquisition programs, DDT&E has agreed that continuation of production at one source before the major production decision is an appropriate measure to reduce program costs and additionally provide units on which to conduct further OT&E. This precedent indicates the OSD criticism would be directed only toward the beginning of production at the second and third

shipyard in advance of the results of IOT&E from the lead ship.

D. DSARC I RESULTS

On 31 August 1972, the PF Project Manager presented the PF program to the Defense Systems Acquisition Review Council. The following is Deputy Secretary of Defense Rush's response to DSARC I with respect to Test and Evaluation:

> I am pleased to note the strong effort to insure adequate test and evaluation (including IOT&E) prior to major contract for follow ships. However, the planned date for the first major contract for follow ships assumes that no critical deficiencies will be found during such testing. The Navy should continue to give emphasis to the completion of all feasible early T&E (including IOT&E) on the combat subsystems and on the land-based test sites. The DSARC and the DDT&E will evaluate at the time of their review of the Navy's recommendation to proceed with follow ships whether adequate test and evaluation (including IOT&E) has been accomplished with satisfactory results, and if not, whether some delay in contracting is warranted.
> Also, it may be desirable that a period for operational test and evaluation of the lead ship, prior to that ship's full release to normal Fleet usage, be allocated to OPTEVFOR. The purpose of this testing would be to determine the PF's expected operational effectiveness in its expected roles and the need for any early modification to follow ships. Should such modification be required, a later DSARC would have to determine the relative merits of opening existing contracts to change by change order procedures or making modifications after acceptance from the shipbuilder(8:1-2).

E. INITIAL LAND BASED TESTING RESULTS

Although it is too early to predict the final results of the PF T&E program, the ability of the LBTSs to generate initial assessment data of the PFs operational capabilities has been significant. OT&E and development personnel have conducted such thorough and extensive testing at the LBTSs

that as a result of DSARC II, SecDef waived the requirement for a DSARC III. The lead ship FFG-7 was launched on 25 Sept 1976 and expects to be delivered to the Navy in Oct 1977. Fabrication is currently scheduled to begin on the follow-on ships in May 1977. Although the Program Management Office is very optimistic, the real proof of the LBTSs operational assessment value will be readily evident during the at-sea operational test trials scheduled to be conducted in 1978.

## SECTION III

## AIRCRAFT ACQUISITION

In contrast to the low risk, long fabrication program of conventional hull ships, the aircraft acquisition is one of high risk and uncertainty with a relatively short acquisition cycle. In most aircraft or aircraft related weapon systems programs the overall test program is very complex and is subdivided into elements. The manner in which the test program is subdivided depends on the planned test organization, location of facilities, time frame, and other factors.

### A. DEVELOPMENT TESTING

Early testing in the exploratory development stage is designed to investigate, test, or evaluate the soundness of a concept, device or system in a breadboard or rough experimental form, without regard to the eventual overall design or final form. The advanced development stage usually involves a model of the complete system or integral parts of the system for experimentation or testing to demonstrate the technical feasibility of the design and its ability to meet existing performance requirements, and also to secure engineering data for further development. The final advanced development model will approach the required form factor. Serious consideration will be given to military requirements such as reliability, maintainability, human factors, and environmental conditions. In the full scale development stage,

engineering or operational tests under Service conditions are conducted to evaluate performance and military suitability. The prototype aircraft system will closely approximate an initial production design, have the required form, and will meet the standard military requirements such as reliability, maintainability, human factors, extreme environmental conditions, etc.

B. AIRCRAFT TEST PROGRAM REQUIREMENTS

The Navy aircraft test program requirements are presented in figure 4. These tests take place in the full scale development phase of the procurement cycle. The primary purposes of these tests are:

1) To determine that the aircraft can be safely operated by Navy pilots during in-flight trials to limits consistent with the contract design limits;

2) To obtain early basic information regarding the military potential of new models of aircraft and the operability of all their equipment;

3) To permit early decisions regarding attainment of superior characteristics;

4) To obtain quantitative information on safe limits for operation by fleet pilots(11:7).

After the first flight, but prior to initial delivery of the aircraft for trials, Navy test pilots designated by

# NAVY AIRCRAFT TEST PROGRAM REQUIREMENTS

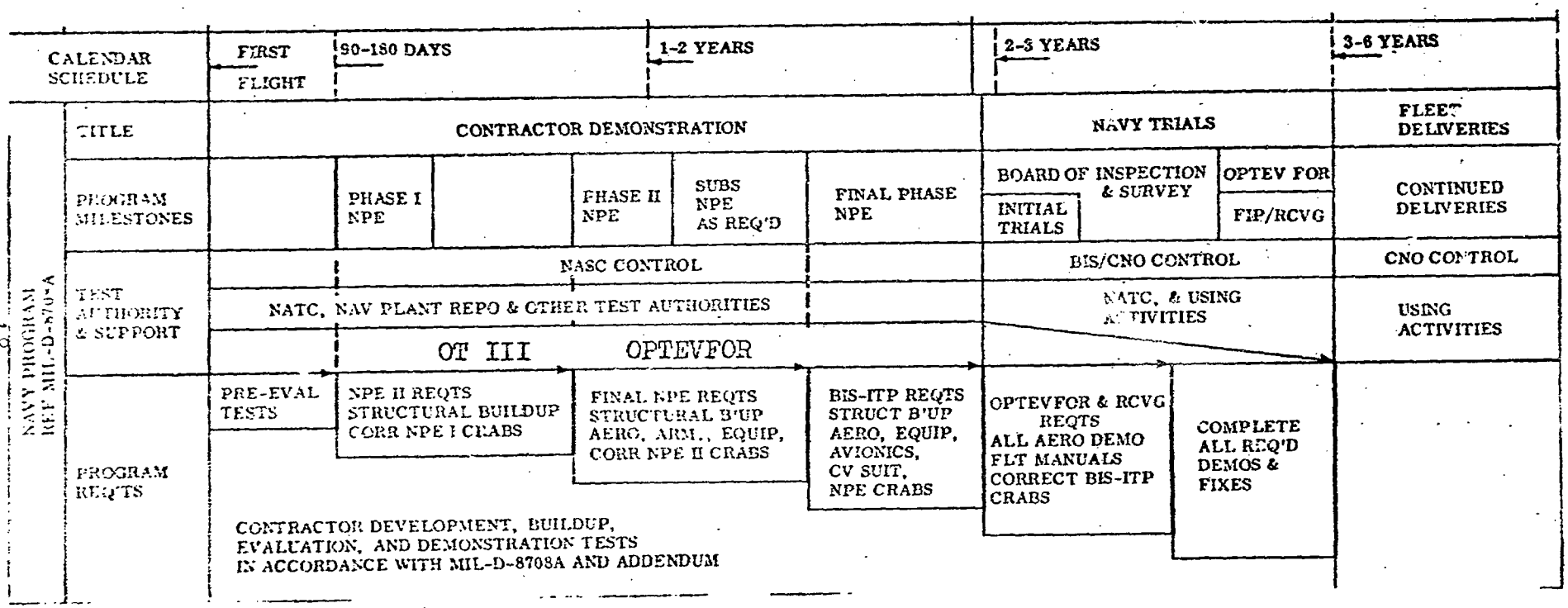



FIGURE 4

the Commander, Naval Air Test Center, Patuxent River, Maryland, conduct normally in five phases, the Navy Preliminary Evaluation (NPE). A phase consists of one or more flights by the Evaluation Team and each phase is terminated by the COMNAVAIR-TESTCEN. Phase I of the NPE is performed immediately subsequent to the contractor's inspection, normally about 90 days after the contractor's first flight of the aircraft. Additional phases, as required, are performed at times appropriately related to the development of the design by the contractor as the allowable flight envelope is increased, or to evaluate changes incorporated in the aircraft to correct deficiencies. The final phase is scheduled just prior to initial delivery of the aircraft for Board of Inspection and Survey (BIS) Trials. The NPE flights are made at the contractor's facility unless otherwise authorized by the COMNAVAIRTESTCEN.

The purposes of the Navy Preliminary Evaluation are as follows:

1) To determine at the earliest possible opportunity the combat potential and gross deficiencies of the aircraft and thereby enable an estimate to be made of the degree to which operational requirements will be met.

2) To highlight the need for and to allow early correction of deficiencies,

3) Evaluate the aircraft weapons system installation including functional and accuracy checks of gun, bomb sight,

rocket rack, etc., and flight tests of fire-control systems and firing runs at a suitable target.

4) Evaluate critical combinations of aircraft weight and C.G. to determine aircraft readiness for BIS Trials(11:10).

Following the NPE the Board of Inspection and Survey Trials are commenced to determine Service suitability and contractor specification conformance with production aircraft. All equipment and installations specified for the aircraft must be installed and operable except for aircraft instrumented for special tests in which weight requirements for instrumentation may require the removal of certain equipment. In these special test aircraft, all applicable armament, electronic equipment, and other items that influence aerodynamic characteristics or the C.G. positions of the aircraft must be installed or simulated appropriately to represent aircraft scheduled for fleet delivery. All discrepencies reported from the NPE's must have been corrected unless otherwise authorized by NAVAIRSYSCOM.

## C. CURRENT PROBLEMS IN AIRCRAFT TEST AND EVALUATION

Some of the significant factors that consistently distort the orderly flow of aircraft test and evaluation are discussed below.

### Concurrency

The Board of Inspection and Survey generally receives the production aircraft right after those designated for

contractor test and demonstration purposes. The next sub-block of aircraft produced go to COMOPTEVFOR's aircraft testing activities (VX-1, VX-4,or VX-5). The next block of aircraft produced are delivered to the fleet (usually to squadrons designated to train the initial group of aircrewmen and maintenance personnel). The point is that within one or two months of BIS's receipt of its aircraft, the aircraft is in the fleet. The lead time OPTEVFOR has is slightly less. This degree of concurrency has two effects. Because the BIS aircraft follow closely on the heels of the contractor's test article, they do not contain the fixes that have turned up in the contractor's testing program. Thus BIS airplanes are not representative of the operational configuration, nor are the OPTEVFOR or early fleet deliveries.

Secondly, because the production line is running while BIS and operational testing are in progress the problems identified in Navy T&E are generally not incorporated in even early deployed aircraft. Safety of flight and other extremely crucial fixes are incorporated by factory teams in early operational squadron aircraft just prior to or after deployment. Hopefully some of these problems were identified in the NPE's, but it must be remembered that these tests are conducted upon aircraft that are even less representative of the operational configuration than the BIS or operational test aircraft.

To preclude a lengthy delay (1 to 2 years) between production of the contractor and Navy test articles, and the

operational aircraft, a considerable degree of concurrency is planned into the program. Then as schedule slides occur in earlier program activities, the concurrency between Navy T&E and production is increased because initial operational dates are rarely changed to accommodate test and evaluation. That is, an unfortunate initial situation tends to worsen during the program. The results of this concurrency are:

1) A large number of Engineering Change Orders (ECO's).

2) Initial dissatisfaction of the fleet with many new aircraft.

3) A large number of different configurations of a particular aircraft in the fleet to be supported.

4) Delays in positioning of spares to support systems modified by ECO's and late production changes.

5) Additional life-cycle costs due to rework or scrapping and reprocurement of existing spares.

6) Degradation of training because of inoperable or faulty weapons systems.

Late Test Data/Results

Since the receipt of Navy T&E test data and results by the procuring activity are generally critical and to late to affect the original program technical decisions, they have the effect of seeming to put the Systems Command personnel "on report". A defensive attitude on the part of the Program Manager and the Systems Command technical branches inevitably results. The cost of solving and implementing the solutions

for these problems is high. Thus the test report tends to embarrass the program team and provide ammunition for program critics both within and without the Navy who have their own axes to grind, instead of being a tool for the acquisition and fielding of the best weapons system. Unfavorable test reports are usually buried or at least not acted upon with whole-hearted vigor and determination. If a test report from another activity can be found that disagrees with the unfavorable test report in any substantial, or occassionally insubstantial manner, it is used to cast doubt on the validity of the unfavorable report. These statements are not intended to besmirch the characters of systems command personnel but to simply point out the natural human reaction to a test report received too late to aid in a decision already made and implemented which says, in effect, that the wrong decision was made.

Non-Representative Hardware

As discussed in the previous section on concurrency, test aircraft and early operational aircraft configurations are in a continual state of flux. The result is that technical (BIS) and operational testing may be conducted on systems that will later undergo substantial changes. Some changes obviously invalidate prior test results; other changes do also but it is not at all obvious in advance. The T&E community is frequently called upon to determine whether to delay

tests awaiting a modification they know will take place or proceed on the tentative assumption that the change will not invalidate the test results. Delaying tests is rarely chosen unless invalidation is apparent. Although systems integration testing of a change is commonly done by the contractor on the computor in the laboratory or on prototypes, it can not be depended upon to reveal second order or higher effects and suffers from the basic lack of complete reality inherent in simulations and the laboratory.

In summary, T&E is conducted on an aircraft that differs markedly from the operational aircraft. Some of these differences are inconsequential but many are not. The worst facet of this situation is not that the test work done may become invalid, but that adequate T&E will not be conducted on the operational configuration aircraft. This situation causes the fleet to be the one who identifies many consequential problems and leads the fleet to feel with some justification that it is building its own aircraft.

Competition Among Navy T&E Activities

One of the major bars to efficient and economical testing is the high degree of competition among and within the testing activities. As the military pie has gotten smaller in real terms, pressures to increase a particular activity's slice to the detriment of another activity have grown much larger. Brochuremanship has become the order of the day. A

perusal of the mission statements of several major aircraft testing activities within the Navy reveals a large amount of overlap. This overlap results as each activity attempts to enlarge its scope and potential budget via its mission statement. This same disease exists within major activities as divisions and branches vie for the T&E budget. The temptation here is for each activity to overestimate its expertise and facilities or plan on developing the necessary expertise and/or facilities after receipt of a task. This procedure is extremely wasteful of resources because it leads to duplication of facilities and expertise and the conduct of testing by activities not particularly well qualified to do so.

While Navy Industrial Funding (NIF) does provide an incentive to efficiency in test work it also feeds the fire of intense and destructive competition. As in the civilian world, the primary goal of any Navy organization is survival, and the means of long-term survival is to expand into other testing activities' areas of competence. A further unfortunate aspect of NIF is that some testing activities are NIF funded, e.g. the Naval Air Test Center (NATC), and the Naval Weapons Evaluation Center (NWEF) and others are not, such as OPTEVFOR, so that testing tends to go where costs are lower without due regard to competence and comparability of actual costs to the Navy.

The result of this intense competition is that competing testing activities find it very difficult to cooperate

fully on a major testing program. What has been said with regard to funding is equally true of test assets, particularly test aircraft.

An attempt to ameliorate this competition is being implemented now. An existing organization, the Naval Air Systems Command T&E Coordinator, has been empowered to designate where aircraft testing will take place and by whom it will be done. Of course, the T&E Coordinator will be faced with end runs to OPNAV and the Program Manager by dissatisfied T&E activities.

D. PROTOTYPING

As a result of Deputy Director of Defense David Packard's ideas, prototyping has gained a great deal of attention. Another name for total system prototyping is "fly before buy". Visions of competitive fly-offs and the like arose. The Air Force has conducted several successful competitive fly-offs including the AX, but total system prototyping is frequently not an economical approach. It is an emotionally attractive technique in that it vastly reduces the degree of risk in major decisions, but the increase in cost, time, and resources is great and may not always be available. However this interest in actual hardware signalled a decrease in dependence on paper studies which existed during Mr. McNamara's tenure in DOD. It is likely that increased sequential component or sub-system proofing at lower levels of development will prove to be the most beneficial aspect of this change rather than the few "fly before buy" or competitive fly-off

systems that have occurred.

E. INITIAL F-14 TEST AND EVALUATION PLAN

A more economical approach to the improvement of T&E was planned in the Navy's F-14 T&E program. A key factor in this approach was the selection of the NASC T&E Coordinator to supervise the generation of integrated test plans, the allocation of test resources, and of the actual testing and witnessing. The testing requirements of the technical testing activities, the Board of Inspection and Survey, and OPTEVFOR were integrated into a single test plan. The majority of the Navy developmental and operational testing took place during the same period and even on the same flights. Maximum use was made of contractor demonstrations witnessed by the Navy testing activities to obviate the retesting of a technical point already demonstrated by the contractor. Witnessing by testing activities was crucially important and allowed the contractor's data to be readily accepted by the testing activities. This approach also helped to eliminate redundancy in testing, i.e. the testing of the same performance parameter by several different activities which has been a consistent and wasteful feature Navy testing in the past.

Obviously, this approach places a great deal of responsibility directly on the shoulders of the T&E Coordinator, and requires his staff to deal knowledgeably with a wide-ranging and complex test plan. The potential for major improvements

in Naval aircraft testing is evident but it depends greatly on the competence and the resources of the T&E Coordinator's staff and the T&E Coordinator's ability to resist strong pressures from various special interest groups in the T&E community (OPTEVFOR, NATC, etc.). The intense competitive pressures previously mentioned still exist and must be resisted by the T&E Coordinator or the potential of this rational approach will flounder in interactivity politics.

## SECTION IV

## CONCLUSIONS

It is readily apparent that significant differences exist in ship and aircraft acquisition cycles. Whereas a conventional hull ship acquisition program is one of low risk and long fabrication, an aircraft acquisition is one of high risk and uncertainty with a relatively short acquisition cycle. Therefore the test and evaluation requirements established by DOD must be tailored to fit each program.

DOD Directive 5000.1 states that a determination of operational suitability will be made prior to large scale production commitments. However, it does not appear that the Navy intends to wait one or two years to start production of a system after the completion of operational test articles. In the PF program, the delay to the program of waiting to start construction of the follow ships until the lead ship was built and operationally tested was estimated to be 15 months. Since this delay was unacceptable, the decision was made to start production on the first half of the ships prior to the completion of the Initial Operational Test and Evaluation. However, the production on the second half would be deferred until IOT&E was complete. It seems unlikely that extended delays to complete IOT&E will ever be accepted in a major system acquisition. The trend since 1972 has been to allow OPTEVFOR an earlier start on their operational evaluation and a better power position with respect to the technical testing community. But, no great

improvements in T&E are expected until the basic human, concurrency, and hardware problems which reduce T&E effectiveness have been changed.

The systems approach to testing may be the best answer to the problems associated with Navy T&E. Little faith is placed on policies that simply shift the T&E power structure (OT&E) or pretend that concurrency can be eliminated (prototyping). The F-14 testing concept appeared to be a step in the right direction, however funding problems developed and a significant portion of the test program was cut out. Since the United States will always be reacting to newly perceived existing or future threats, there will never be enough time to develop major weapons systems without concurrency in the development, test and evaluation, and production phases of the acquisition. Leisurely serial development, test, and production of major weapons systems is an unrealistic procedure to hope or plan for. The only realistic hope for decreasing the concurrency of test and evaluation and production is to reduce the length of the Navy T&E process through improved test planning, improved efficiency, and the reduction of redundancy in testing. It appears that coordinated and integrated testing is the most likely approach to result in significant improvement in Navy T&E and bears investigation by other major acquisition programs for applicability to their T&E efforts.

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