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AIR COMMAND AND STAFF COLLEGE

STUDENT REPORT

SSTS: THE IMPORTANCE OF EARLY TEST AND EVALUATION ORGANIZATIONAL PARTICIPATION

MAJOR WILLIAM T. SMITH 88-2440

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The early involvement of all participating organizations in the Test and Evaluation (T&E) process is important to the success of the weapon system development program. The identification of critical technological and test needs, particularly with respect to space systems, of both the weapon system and the ground test facility require early organizational participation. This study substantiates the need to involve all participating organizations early in the T&E process. It concludes that the guidance provided by the Department of Defense and the Air Force is clear and comprehensive. Test and Evaluation Master Plans and Test Planning Working Groups must be continually emphasized and utilized. With respect to test facilities, requirements must be identified early. Finally, the Space Surveillance and Tracking System (SSTS) development program provides an excellent example of how early participation by T&E experts contributed to the early identification of critical system and test facility components.

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PREFACE

Within the Department of Defense (DoD), the adequacy of test procedures in the acquisition of a new weapon system has been a central issue to Congress and weapon users. As a result, there has been an increased emphasis on testing by the DoD, especially the early involvement of Operational Test and Evaluation participants. While this is helpful, it is not enough. It is this author's opinion and the subject of this study that the early involvement of all participating organizations in the Test and Evaluation (T&E) process is important to the success of the weapon system development program. These organizations should include but not be limited to those involved in technology development, development testing as well as operational testing. In the T&E process, it is important to understand the technology and test requirements of both the weapon system and the ground test support facility that will be used to evaluate the weapon system. The identification of critical technological and test needs require early organizational participation. This is particularly true when the T&E process involves the development and acquisition of a space system where the substantial cost, the high degree of technology involved and the environment require most of the testing to be performed on the ground. This study will substantiate the need to involve all participating organizations early in the T&E process by reviewing the guidance provided by DoD and the Air Force regarding T&E and presenting an example where the early involvement by T&E experts allowed an important space program, Space Surveillance and Tracking System (SSTS), time to develop critical system and ground test facility components concurrently.

The author would like to express his appreciation to his project advisor, Major Donald E. Frye Jr., of the Air Command and Staff College for his many ideas on the subject and his excellent editorial assistance. In addition, the author is greatly indebted to his wife whose patience and understanding has allowed this project to be completed.

ABOUT THE AUTHOR

Born on [redacted] Major William T. Smith received his Bachelor of Science in Aeronautical Engineering from the State University of New York at Buffalo in 1972. He enlisted in the Air Force in 1972 and after completing basic training at Lackland AFB, Texas and technical schooling at Keesler AFB, Mississippi, was assigned to the 5th Mobile Communications Group at Robins AFB, Georgia, as a Telecommunications Systems Specialist. In 1974, he attended and was a Distinguished Graduate of the Air Force Officer Training School. After commissioning, Major Smith was assigned to the Foreign Technology Division at Wright Patterson AFB, Ohio. There as an Advanced Missile Systems Engineer, he was responsible for forecasting, identifying, and analyzing future foreign ballistic missile systems. While at Wright Patterson AFB, he received Master of Science degrees in Aeronautical Engineering and Management Science from the University of Dayton in 1976 and 1977 respectively. In 1978, Major Smith graduated from the Air Force Test Pilot School as a Flight Test Engineer. From there he was assigned to the 4950th Test Wing at Wright Patterson AFB, Ohio. In that assignment, he served as Test Director for the Air Force team performing acceptance testing on the C-130E Simulator. In 1980, Major Smith attended Purdue University working on a PhD in Aeronautical Engineering. At present, all but his dissertation is complete. In 1984, he was assigned to Arnold Engineering Development Center (AEDC) in Tennessee. His initial position was Project Manager then Chief, Aeromechanics Branch in the Directorate of Technology, responsible for planning, coordinating and directing AEDC's aeromechanics technology programs. His final position at AEDC was Chief, Reentry Systems Division where he was responsible for directing reentry materials tests for the Air Force and Navy and the testing of missile projectiles for the Army. Major Smith is currently a student at Air Command and Staff College. He is married to [redacted] and has two daughters [redacted]

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REPORT NUMBER 88-2440

AUTHOR(S) MAJOR WILLIAM T. SMITH, USAF

TITLE 88T8: THE IMPORTANCE OF EARLY TEST AND EVALUATION ORGANIZATIONAL PARTICIPATION

I. Purpose: To substantiate the need to involve all participating organizations early in the Test and Evaluation (T&E) process.

II. Problem: It is the belief of Congress and users that more and more Department of Defense (DoD) weapon systems are making it into production without adequate testing. As a result, the early involvement of Operational Test and Evaluation participants in the Test and Evaluation (T&E) process has been emphasized. While this is helpful, it is not sufficient. The early involvement of all participating organizations in the T&E process is important to the success of the weapon system development program and needs to be emphasized.

III. Discussion: In the T&E process, it is not enough just to understand the technology and test requirements of the weapon system itself. It is also necessary to understand the technology and test requirements of the ground test support facility which

will be used to evaluate the weapon system. It is necessary to ensure the test facility will be ready when the weapon system is ready to test. The identification of these technological and test needs require early organizational participation. This is particularly true when the T&E program involves the development and acquisition of a space system. The space environment requires that the system works the first time it is used in space. The substantial cost of space hardware and the high degree of technology involved prohibit the use of the customary incremental buildup approach to testing. The space hardware must be carefully and completely tested on the ground to protect the large investment in that item. This study focuses on the guidance provided by DoD and the Air Force regarding T&E. It also presents the Space Surveillance and Tracking System (SSTS) development effort to illustrate the importance of involving all participating organizations early in the program.

IV. Conclusions: Acquisition, together with the T&E process, is well structured. The guidance provided by DoD and Air Force is clear and comprehensive. It stresses the need for early T&E and the importance of the Test Planning Working Group (TPWG) and Test and Evaluation Master Plan (TEMP). In addition, since adequate test facilities can take as long to develop and acquire as the system itself, test facility requirements must be identified early in the development program. The early involvement by T&E experts identified the need for infrared (IR) scene generation to properly test the focal plane array in the SSTS development program. As a result, the technology for an IR scene generator will have sufficient time to develop so that an adequate test facility will be available when the system is ready to test.

V. Recommendations: Increased emphasis should be given to combining Development Test and Evaluation (DT&E) and Operational Test and Evaluation (OT&E) as early as possible and wherever possible, without compromising the individual test objectives in the T&E process. In addition, Program Office Managers should actively consult with test facility experts. This may require a change in attitude of both parties regarding program obligation and test facility proliferation. Finally, other programs should follow the SSTS program example in their emphasis on TPWG, TEMP and early organizational participation.

Chapter One

INTRODUCTION

> Weapon system testing stresses quantity - not quality; often conducted under nonrealistic conditions; are often "success oriented"; are not really independent; problems have not only been around for a long time but are getting worse. (18:9)

> Each year the number of success-oriented unrealistic tests increase.... Most unfortunately...our combat forces are not getting the systems that they need to carry out their mission. Mr. Chairman, if there was only one system in the Department of Defense that was not properly tested it would be one too many. (18:38)

The first quote is a congressional staff opinion while the second is the view of Lt. Gen. James Hollingsworth, US Army (retired). Both views were expressed at a 1986 Armed Services Subcommittee hearing on the Department of Defense Test Procedures where the central issue was the adequacy of test procedures in the acquisition process. It was the belief of Congress and the users of these weapon systems that more and more systems were making it into production without adequate testing. (18:1) These views have resulted in an increased emphasis on testing by the Department of Defense, especially the early involvement of Operational Test and Evaluation (OT&E) participants. (17:247) However, based on over ten years experience in testing, this is not enough. It is this author's opinion that the early involvement of all participating organizations in the Test and Evaluation (T&E) process is important to the success of the weapon system development program. These organizations should include, but not be limited to, those involved in technology development, development testing as well as operational testing. In the T&E process, it is not enough just to understand the technology and test requirements of the weapon system itself. It is also necessary to understand the technology and test requirements of the ground test support facility which will be used to evaluate the weapon system. It is necessary to ensure the test facility will be ready when the weapon system is ready to test. The identification of these technological and test needs require early organizational participation. This is particularly true

when the T&E program involves the development and acquisition of a space system. The purpose of this study is to substantiate the need to involve all participating organizations early in the T&E process.

Test and evaluation programs follow guidelines defined in DoD Directive 5000.3 which states that "Test and evaluation shall begin as early as possible in the system acquisition process...." (12:2) While T&E does begin early, the complete test program objectives may not be accomplished effectively; leading to insufficient OT&E results which could cause the program to be canceled. One example of such a program was the Army's Division Air Defense (DIVAD) system which was canceled in 1985 due to problems based on OT&E results. (1:13)

Department of Defense test programs are designated as Development Test and Evaluation (DT&E) and Operational Test and Evaluation (OT&E). The primary objective of DT&E is to demonstrate that the system engineering design and development is complete. Air Force DT&E is usually managed by Air Force Systems Command (AFSC). In contrast, the OT&E objective is to evaluate the system's operational effectiveness, reliability and suitability. (8:3) These tests are usually managed by the Air Force Operational Test & Evaluation Center (AFOTEC). Both organizations have different missions and compete for limited DoD resources. The early involvement of all participating organizations, particularly those associated with OT&E, may be limited since OT&E traditionally follows DT&E. Combining DT&E and OT&E is permitted by DoD directives but is not encouraged. Therefore, by the time DT&E is accomplished, it is possible that only limited resources are available or test requirements are not identified in sufficient time to allow adequate OT&E testing. For special acquisition programs, such as space systems, combining OT&E with DT&E must be emphasized so that DT&E can contribute to the accomplishment of the OT&E objectives. (5:15)

The space environment requires that the system works the first time it is used in space. The substantial cost of space hardware and the high degree of technology involved prohibit the use of the customary incremental buildup approach to testing. The space hardware must be carefully and completely tested on the ground to protect the large investment in that item. (1:6) The interdependence of technology and test efforts in a space program must be identified and maintained. The interrelationships in program development were highlighted by Lt. Gen. James A. Abrahamson, Director, Strategic Defense Initiative Organization, in a Senate hearing. He stated:

> Development of a space based sensor is dependent, in part, on an integrated sensor, which is in turn dependent on focal plane technology, which is built on technology supporting new development of arrays,

> submodules, and modules. Multiply this by nearly a hundred fold and one begins to get an idea of the complex interrelationships that intertwine throughout the program. (21:80)

In addition, we have, to date, demonstrated only a limited on-orbit repair capability; therefore, these systems must also be highly reliable once they are deployed. This reliability must be verified before deployment. T&E takes on even more dramatic importance because of the criticality of reliability. One aspect of ground testing space systems involves simulation testing.

Surveillance systems will rely on realistic simulation tests to verify attainment of technical performance specifications and effectiveness before they are deployed. (5:15) Lt. Gen. Abrahamson pointed out in the 1986 hearings before the House of Representatives Subcommittee on Appropriations for Research, Development, Test and Evaluation:

> It is hard to overestimate the importance of the generation of realistic threat models, the estimation of the vulnerability of targets to the numerous kill mechanism options being exploited, and the development of strategies, tactics and technology to ensure system survivability to mission completion. These analyses and estimates will provide the boundaries for measuring success. (14:570)

Mr. Charles K. Watt, Acting Director, Defense Test and Evaluation, stated during a House Armed Services hearing that the capabilities of supporting ground test facilities are vital to the development of all weapon systems. (16:308) The projected size of satellites and the complexity of the mission and the simulation environment in which the satellite must be tested may preclude a full up operational test of the complete system until future test capabilities are developed. (5:15) These test capabilities may require significant technological development lead time. The technology and test requirements must be identified and studied early in the acquisition process. Adequate funding for testing programs is very important. The competition for funds is always keen, and early involvement by as many participating organizations as possible could increase advocacy for the funding of test programs.

It is this author's position that space systems are uniquely suited to illustrate the importance of involving all participating organizations early in the development program. In this study, one space system in particular, the Space Surveillance and Tracking System (SSTS), will be highlighted to illustrate that early organizational involvement is important in the development process.

The SSTS is a very complex satellite surveillance system that will be used in our Strategic Defense Initiative (SDI) program. It's primary mission is to provide midcourse surveillance--acquire, discriminate, track and perform kill assessment--of post boost vehicles (PBV), reentry vehicles (RV), decoys and interceptors. (3:3-1;23:--) One of the most critical technologies in the system is the development of the focal plane arrays (FPA). (6:4) The focal plane array consists of the sensors on the satellite that will be used for detection and tracking. It is expected to track tens of thousands of objects during the midcourse phase of ballistic missile flight. (16:356) In addition, because of the need for greater precision tracking, the sensors will require higher sensitivities and therefore a very large number of these detector arrays will be needed. (16:214) It is planned in the early 1990s to perform space-based surveillance experiments to demonstrate survivable means of detecting and tracking boosters at very high altitudes in space and to determine our ability to track large numbers of objects. (16:356) The ground testing of the operational effectiveness of these focal plane arrays will range from static radiometric calibration to performance testing against dynamic scenes. (5:19) This requirement will in turn require adequate test capabilities. Technological experts at Arnold Engineering Development Center stated: "The capability to generate high fidelity scenes is essential for all levels of sensor testing....Thus one of the most stressing and urgent of the technology areas ...is the IR [infrared] scene generation." (5:41) Realistic representations of the threats and environments in which the space system will operate must be tested before the system is deployed. This will require early operational testing in the acquisition process. (17:241) Further discussion of the SSTS is presented in chapter three.

As stated earlier, an understanding of the technology and test requirements for both the weapon system and its ground test facility should provide the T&E community an increased awareness of the importance of involving all participating organizations early in the development program. This understanding of technology and test needs requiring early organizational involvement will be accomplished by first briefly reviewing the acquisition process and guidance provided by DoD and the Air Force. It will show that this guidance is quite clear and comprehensive regarding T&E. Second, the T&E process, composed of DT&E and OT&E, will be discussed with the emphasis on combining DT&E and OT&E early in the process, especially for space systems. The importance of the Test and Evaluation Master Plan (TEMP) and the Test Planning Working Group (TPWG) to the overall T&E process will also be presented. Third, the necessity for early identification of adequate ground test facility support will be presented. It will be suggested that a possible change in attitude of the program office and testing organizations may be needed in order to have an active dialogue

between the two. Finally, using the SSTS as an example, it will be shown that the early involvement by T&E experts has allowed this critical and complex program time to develop the focal plane array and scene generator concurrently; thus, the test facility will be ready when the system is ready to test.

Several assumptions and limitations have been made to limit the scope of this study. First, the study will be limited to the technology aspects of the focal plane array and scene generation as they apply to the SSTS. The specific SSTS technology costs will not be included. Second, the study will be restricted to the unclassified aspects of SSTS. Finally it is assumed that the technology and test programs are allowed to progress in a peacetime environment (i.e. no "crash" system development programs).

The study consists of three additional chapters. Chapter two deals with the general acquisition process and specific DoD and Air Force policies for test and evaluation. The objective of T&E and its management will be addressed along with the importance of the TEMP and TPWG. Test facilities will also be discussed. Chapter three will highlight the SSTS and discuss the technological and test requirements of the focal plane array and the scene generator. In addition, the early participation by T&E experts will be presented. Chapter four will conclude the study with the author's conclusions and recommendations.

Chapter Two

TEST & EVALUATION (T&E) IN THE ACQUISITION PROCESS

ACQUISITION OF MAJOR DEFENSE SYSTEMS

Before addressing the Space Surveillance and Tracking System (SSTS) specifically, one must understand how the Department of Defense and the Air Force in particular expect systems to be developed and acquired. This chapter will deal with the general acquisition process and specific DoD and Air Force policies regarding test and evaluation. The Test and Evaluation (T&E) process will be discussed along with the importance of the Test and Evaluation Master Plan (TEMP) and the Test Planning Working Group (TPWG). A discussion on test facilities with respect to the T&E process will also be presented.

Regarding major system acquisitions, DoD Directive 5000.1 states:

> It is the policy of the Department of Defense to ensure that DoD acquisition of major defense systems is carried out efficiently and effectively to achieve the operational objectives of the U.S. Armed Forces in support of national policies and objectives.... (10:1)

To ensure that major systems are acquired in the most efficient and effective manner, an acquisition strategy is developed at the inception of each major program. This strategy is used to establish the objectives, resources, management assumptions, and program structure (i.e. development phases, decision milestones, test and evaluation periods, planned concurrence, and production releases). (10:2)

The program structure is divided into distinct phases of the acquisition process. These phases include: concept exploration, demonstration and validation, full-scale development, and production and deployment. According to DoD Directive 5000.1, each phase is "tailored to fit each program to minimize acquisition time and cost, consistent with the need and

degree of technical risk involved." (10:4) A general program structure--acquisition process--is depicted in Figure 1. along with T&E involvement.

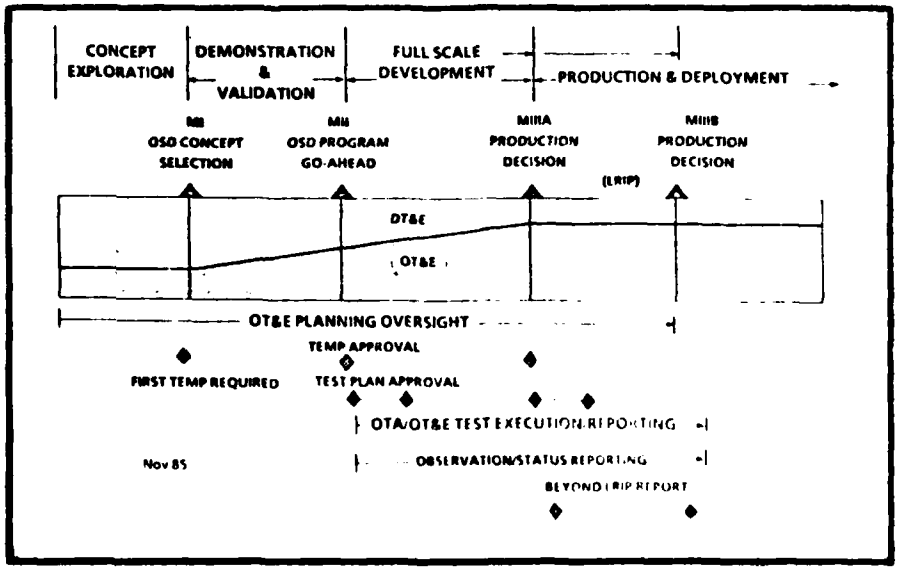

Figure 1. Acquisition Process and T&E Involvement (17:249)

Prior to the concept and exploration phase, a mission need determination is accomplished in the the Planning, Programming, and Budgeting System (PPBS) process. The need is based on the Justification for Major System New Starts (JMSNS) submitted with the Program Objective Memorandum (POM). The Secretary of Defense provides guidance for the program in the Program Decision Memorandum (PDM). The PDM permits a major system new start and allows the Military Services to enter the concept exploration phase of the acquisition process. (10:4;11:4)

In order to enter subsequent phases, the program must pass specific milestone decision points. "The first Secretary of Defense major milestone decision is the concept selection and entry into the demonstration and validation phase." (10:4) The Milestone I decision point is used to summarize the results of the concept exploration phase and includes the identification of the concepts that will be further pursued in the next phase. The Test and Evaluation Master Plan (TEMP) is required at Milestone I. TEMPs will be described in more detail later in this chapter. "The second Secretary of Defense major decision is program go-ahead and approval to proceed with full-scale development." (10:5) The purpose of the Milestone II decision is to review current system performance, revalidate the threat

for which the system is required, and review the overall cost, schedule, and testing program. These reviews are performed in an effort to reduce the risk and uncertainty in a program before major resources are committed to full-scale development. (10:5;11:4-5) "The production decision at Milestone III is delegated to the DoD Components, provided the thresholds established at Milestone II are met." (10:5) It is clear that a well structured process for system acquisition has been established by the Department of Defense.

T&E AND TEMP

The T&E effort takes place throughout the acquisition process. As DoD Directive 5000.3 states:

> The primary purpose of all T&E is to make a direct contribution to the timely development, production, and fielding of systems that meet the user's requirements and are operationally effective and suitable. (12:2)

Test and evaluation starts at the earliest possible time in the acquisition process to reduce risks and to estimate the system's capability to meet all technical and operational requirements. The testing should provide the quantitative data, while minimizing the need for subjective evaluations of the system's performance. (12:4-5) Development Test and Evaluation (DT&E) and Operational Test and Evaluation (OT&E) make up the T&E effort.

DT&E is conducted throughout the acquisition process. Its primary purpose is to ensure that the engineering design and development of a system is complete and that it meets or exceeds the technical performance specifications. (12:4) "The T&E encompasses the use of models, simulations, and testbeds, as well as prototypes of full-scale engineering development models of the system." (12:4) OT&E is also conducted throughout the acquisition process with the primary purpose of "ensuring that only operationally effective and suitable systems are delivered to the operating forces." (12:5) These tests are performed under realistic conditions that simulate, as closely as possible, the actual threat environment. Additionally, the components that are tested must be representative of the product to be delivered by the contractor. (8:7) OT&E is traditionally separate and usually follows DT&E. However, combining DT&E and OT&E is permitted. DoD Directive 5000.3 states: "Combined DT&E and OT&E...may be used when cost and time benefits are significant and are clearly identified, provided that test objectives are not compromised." (12:8) The needs of both the developing agency performing the DT&E, and those of the operational test agency performing the OT&E, must be satisfied.

DoD Directive 5000.3 also points out that T&E of special programs, such as space, where the procurement of a few items over an extended period represent a substantial resource investment, the operational test agency "shall monitor and participate in relevant laboratory and controlled testing, and use these test results, as appropriate, to provide an assessment of system effectiveness and suitability." (12:8) "If separate testing would cause significant delays or increases in system acquisition cost or in resources, development and operational testing will be combined." (8:7) The guidance again appears quite clear that consideration of combining DT&E and OT&E must be accomplished early in the T&E process, especially regarding space systems.

One of the most important documents in the T&E process is the Test and Evaluation Master Plan (TEMP). The TEMP is used to specify development and operational events. A TEMP is required on all Air Force programs directed by a Program Management Directive (PMD). (8:5) Air Force Regulation 80-14 states: "The TEMP will integrate critical issues, test objectives, evaluation criteria, system characteristics, responsibilities, resources, and schedules for T&E." (8:5) Approved TEMPs are required before the start of any system testing and are updated at least annually. (8:6) The TEMP is such an important document in T&E that the Under Secretary of Defense, Research and Engineering (USDR&E), Dr. James P. Wade Jr., emphasized during a 1985 House Armed Services hearing, the continuing need for quality improvements in the preparation of TEMPs to ensure the completion of essential tests on T&E programs. (16:153) He has asked the Services to continue to improve the timeliness and quality of the TEMPs "particularly in quantifying system parameters to be verified by testing." (16:153) The early identification of test resource requirements and possible shortfalls and contingency plans to overcome the shortfalls are now a mandatory part of the TEMP. (16:153) The next year, Mr. John E. Krings, Director of Operational Test and Evaluation (DOT&E), at another House Armed Services hearing, expressed his views on the importance of the TEMP when he stated that DOT&E would use "its authority under the law to approve and disapprove TEMPs and OT [Operational Test] plans to assure that OT concerns and requirements are incorporated early in the life of a new program." (17:241) The TEMP is considered a living document, its currentness is so essential that the Secretary of Defense will direct, in the revised DoD Directive 5000.3, that "...no program may proceed to a Defense System Acquisition Review Council (DSARC) or Service SARC review unless it has an up-to-date TEMP approved by DOT&E and USDR&E." (17:243-244) In chapter three we will see that for the SSTS the technology and test needs were well documented in the TEMP.

MANAGEMENT OF DT&E AND OT&E

Many organizations can become involved in the T&E process; however, who manages the DT&E and OT&E and how do other organizations participate? Air Force Regulation 80-14 states: "The implementing command is responsible for DT&E management." (8:6) The implementing command for Air Force acquisitions is the Air Force Systems Command (AFSC). Among the most important responsibilities of the implementing command is that they plan, manage, and conduct the DT&E; they integrate the OT&E requirements into the acquisition process; they establish and chair the Test Planning Working Group (TPWG); and they prepare and coordinate the TEMP. (8:14)

Management of the Air Force OT&E program is the responsibility of the Air Force Operational Test and Evaluation Center (AFOTEC). (8:6) However, HQ USAF can designate AFOTEC or the operating command as the OT&E command. (8:11) Among the most important responsibilities of the OT&E command are that they accomplish the HQ USAF directed OT&E and are actively involved in DT&E to obtain information applicable to OT&E objectives. In addition, they serve as a member of the TPWG when AFOTEC is designated the OT&E command. (8:11-12)

The TPWG includes representatives from each organization involved in the test program. The members could include: program office, test agencies, various commands (operating, participating etc.), and contractors. It is formed and chaired by the implementing command. Its purpose is to provide a forum to actively discuss T&E-related subjects. As stated in Air Force Regulation 80-14: "It helps to set test objectives and evaluation baselines, and defines organizational responsibilities and relationships." (8:5) It is "...formed in time to allow for early and thorough test planning and coordinating with proper agencies....assists in updating the TEMP and ...monitors test progress." (8:5) The TPWG provides a unique opportunity for all participating organizations to get involved early in the development program. As we shall see in chapter three, the program office for the SSTS made excellent use of the TPWG.

MAJOR RANGE AND TEST FACILITY BASE (MRTFB)

Test organizations providing the T&E support facilities make up the Major Range and Test Facility Base (MRTFB). DoD Directive 3200.11 states: "The MRTFB is a national asset which shall be sized, operated and maintained primarily for DoD test and evaluation support missions...." (9:1) The capabilities of these ranges and facilities are based on a combination of user requirements and the mission of the individual MRTFBs. (9:2)

New test facilities must go through a thorough process that includes planning and technology, design, construction, activation and operation. This process could take as long as a major system program acquisition and, therefore, must be started as soon as the need is identified. (24:--) The Focal Plane Array Facility used for testing the SSTS, described in chapter three, is estimated to take six years to develop at an approximate cost of 65 million dollars. (4:B-157) Acquisition of a near term operational SSTS is expected to take approximately eight years. (3:4-1) The Honorable Dr. Thomas E. Cooper, Assistant Secretary of the Air Force Research, Development and Logistics, recognized that in order to support the development and production of weapon systems and the increased emphasis by Congress on testing, a substantial investment is required to modernize and improve these facilities. (15:161) Unfortunately, an organizational bias may inhibit cooperation between system program offices and test organizations. A recent Air Command and Staff College research study has suggested that "organizational relationships and procedural responsibilities create a built-in bias which thwarts efforts to obtain needed test range resources for operational testing." (2:--) According to Air Force Regulation 80-1, military construction costs must be included in the system development costs for construction that is directly related to the system. (7:2) As a result, many system program offices are very reluctant to involve the test range community for fear that this activity may carry with it the obligation to fund proposed test facilities. (2:3) This reluctance can contribute to a situation where a program office fails to take full advantage of available experts in the field of testing and test techniques. A change in attitude for both the program office and test organization is required. The program office must remember that the involvement of test expertise very early in the development program does not carry with it any obligation to advocate for or fund test facility proposals unless it is mutually agreed that the program requires such a facility. The test organization must remember that every new system does not require a new test facility.

SUMMARY

The acquisition process is well structured and is tailored for each program to minimize acquisition time and cost while reducing the technical and operational risks. The goal is to deliver a system to the user that will enable him to accomplish his mission. The guidance set forth by the DoD and Air Force is quite clear and comprehensive for the acquisition process as well as the T&E process. Test and evaluation must begin at the earliest possible time in the acquisition process. T&E is made up of DT&E and OT&E, each having their own objectives. For space systems, combining DT&E and OT&E must be considered early

in the T&E process. TEMPs and TPWGs are very important in the T&E process. Both need to be continually emphasized and utilized. With respect to test facilities, adequate test facility support can take as long to develop and acquire as the system itself; therefore, the test facility requirements must be identified early. Finally, program offices and test organizations need to adjust their attitude toward program obligation and proliferation of new test facilities so that there can be an active exchange of ideas and information between both organizations.

Chapter Three

SPACE SURVEILLANCE AND TRACKING SYSTEM (SSTS)

GENERAL

In chapter two we reviewed the guidance provided by the Department of Defense and the Air Force regarding testing and the acquisition process. In this chapter we will address one space system in particular, the Space Surveillance and Tracking System (SSTS). The technology and test requirements of the focal plane array and scene generator will be discussed. In addition, the early participation by T&E experts will be presented.

General Abrahamson, Director of the Strategic Defense Initiative Organization, in a Senate hearing on the Strategic Defense Initiative (SDI) program made this statement about the SSTS supporting the defensive weapons in SDI:

> One of the **key** sensors is a space surveillance and tracking system [SSTS] located in medium-earth orbit that is capable of doing surveillance against all objects that come into space as well as doing surveillance of rockets against the harder Earth. [boldface added] (22:107)

The R&D program for this system is expected to cost approximately 1.3 billion dollars between 1985 and 1989. (19:15) Since the SSTS is one of the key sensors in the SDI program and represents a substantial investment, it is imperative that the system operate effectively. Successful T&E becomes increasingly more important. Early organizational participation in the development program can contribute to this success. The SSTS is a very complex satellite surveillance system whose primary mission is to provide midcourse surveillance for SDI. (3:3-1) Before SDI, this system was known as the Space-Based Surveillance System which was intended to provide support to the antisatellite (ASAT) programs in the space defense role. (20:109) When SDI was initiated in 1983, the midcourse surveillance role was added and became its primary role. To accomplish this role, HQ Space Division stated in the "SSTS

System Test Requirements" briefing that the SSTS is expected to "acquire and track PBVs [post boost vehicles], RVs [reentry vehicles], decoys and interceptors; discriminate RVs from decoys; designate targets and update interceptors; perform kill assessments; handover information to BM [battle management] and terminal defense; and survive and endure." (23:--) In the space defense role, according to Dr. Cooper, the SSTS was to "provide full earth orbit coverage, reduce dependence on overseas basing of sensors, and provide timely, operationally responsive coverage of objects and events in space." (16:1075) The initial operational time periods were divided into the near (1994-2000), mid (2000-2005), and far (2005+) term with corresponding increases in the operational performance of the SSTS as the system evolves. (3:4-1)

FOCAL PLANE ARRAYS (FPA)

One of the most critical technologies identified in the TEMP for the SSTS is the development of the focal plane arrays (FPA). (6:4;23:--) The focal plane array consists of the sensors on the satellite that will be used for detection and tracking. Since the satellite is expected to track tens of thousands of objects during midcourse, a very large number of sensors are anticipated. As stated in the TEMP: "Test facilities to perform integrated 150,000 element FPA and processor testing will be needed." (6:18) In addition to the development of a large number of these detectors in a cost effective manner, other technology issues are involved, such as, radiometric performance and hardening, producibility/stability, and analog preprocessing. (23:--) Various approaches to deal with these issues have been identified under a focal plane technology program. (23:--;13:34) The testing on the FPA has been summarized in the TEMP and in part states:

> FPA testing evolves from individual detector testing to selected FPA modules and finally a complete FPA...and the total of 120,000 detectors....These tests are most likely performed at the contractors facilities. The next level of integration will be a complete FPA with optics in the telescope test....New or modified facilities, instrumentation, and perhaps new testing and measuring techniques will be applied. Testing of the complete telescope will include, optical performance and alignment, thermal, and mechanical characteristics. After completion of these tests the FPA will be installed to make up the complete telescope for radiometric testing....To perform the radiometric performance tests the facility at AEDC [Arnold Engineering Development Center] will [be] enlarged to accept the one meter class aperture telescope.... (6:16)

SCENE GENERATION

The TEMP also identified test limitations for the FPA due to limitations in the state-of-the-art in infrared scene generation. (6:13) The TEMP states: "The major operational issues associated with the SSTS system concern the ability to detect and track targets and then report the appropriate messages to the service weapon systems at the proper time." (6:11) The SSTS is expected to track a large number of targets in space under strategic defense. Since this operation can not be fully tested in space, some of this OT&E will be ground tested. Mission scenarios involving a large number of targets under varying conditions will be tested in ground simulators. (6:11) An AEDC Space Plan providing guidance in the development of T&E improvements for space systems stated:

> The capability to generate high fidelity scenes is essential for all levels of sensor testing from focal plane to full sensor system. Thus, one of the most stressing and urgent of the technology areas which must be addressed is that of IR scene generation. (5:41)

Scene generators must provide realistic radiance patterns to the sensors. These patterns must simulate the real world radiance patterns "...with a fidelity such that the sensor...is unable to detect the difference." (4:5.1-51) The scenes must be dynamic; simulating the motion due to the movement of the line of sight, background objects and the targets themselves. AEDC, in their "Space Facility Conceptual Design" study, stated: "Scene generator technology development must begin with the infrared source plane. No demonstrated capability was found for this critical component." (4:5.3-53) It was estimated by AEDC that it would take four years to develop the appropriate scene generator at a cost of approximately 20 million dollars. (4:B-143) The identification of the need for scene generation technology and its development can be attributed to the early participation by experts.

EARLY PARTICIPATION BY T&E EXPERTS

The Air Force Space Division is responsible for the development of SSTS. The SSTS Program Office is responsible for managing the DT&E while AFOTEC will most likely manage OT&E. The Space Technology Center is responsible for the focal plane development. (24:--;6:4) HQ Space Division invited all agencies, including test facility experts, to the TPWG meetings. The T&E experts at the TPWG meetings concluded that there was no existing capability to test integrated mosaic focal plane assemblies with complex IR scenes and realistic space backgrounds. In addition, it was determined that current

infrared test facilities were limited in size. (24:--) The identification of these inadequate test capabilities resulted in early studies to address this deficiency. (4:--;5:--) Had not all the agencies participated in the TPWG, this deficiency may have been overlooked. The possible consequence of overlooking this deficiency in the T&E process would have been the risk of placing a critical surveillance system asset in orbit without adequate ground testing. (24:--)

SUMMARY

The SSTS program has clearly followed the guidance set forth in the DoD directives and Air Force regulations discussed in chapter two. They made excellent use the the TEMP and TPWG. It should be noted that although no OT&E manager was designated, the TPWG and TEMP completely outlined the OT&E effort and recognized the limitation in infrared scene generation. The combining of DT&E and OT&E will be performed where possible. The program office was not reluctant to involve the testing agencies early in the development program to help establish the test requirements. Finally, and most importantly, they involved all participating organizations early in the development program.

Chapter Four

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

This study has briefly reviewed the acquisition process and the guidance provided by DoD Directives and Air Force Regulations regarding the T&E process. The importance of the Test Planning Working Group (TPWG) and Test and Evaluation Master Plan (TEMP) was highlighted. The adequacy of ground test facility support was also discussed. Finally, the SSTS was presented as an example of early organizational participation. These areas were presented to provide the T&E community an understanding that technology and test requirements for **both** the weapon system and its ground test support facility require the early involvement of **all** participating organizations in the development program. Specific conclusions are as follows:

1. Acquisition, together with the T&E process, is well structured. The guidance provided by DoD and Air Force is clear and comprehensive. It stresses the need for early T&E and the importance of the TPWG and TEMP.

2. Adequate test facilities can take as long to develop and acquire as the system itself; therefore, the test facility requirements must be identified as soon as possible in the development program.

3. Space systems are very expensive to acquire; they involve high technology; and have very complex missions to perform. They are special in the T&E community because they must work the very first time they are deployed in space. This means that most of the space hardware must be carefully and completely tested on the ground. If the current ground test capabilities are inadequate to properly test the system, then future test capabilities must be identified, studied and developed. This requires the early involvement of testing experts. In the case of the SSTS, the early organizational participation identified the need for infrared (IR) scene generation to properly test the focal plane array. As a result, the technology for an IR scene generator will have sufficient time to develop so that an adequate test facility will be available when the system is ready to test.

RECOMMENDATIONS

1. Increased emphasis should be given to combining DT&E and OT&E as early as possible and wherever possible, without compromising the individual test objectives in the T&E process.

2. Program Office Managers should actively consult with test facility experts. This may require a change in attitude of both parties regarding program obligation and test facility proliferation.

3. Other programs should follow the SSTS program example in their emphasis on TPWG, TEMP and early organizational participation.

CLOSING REMARKS

The need to adequately test every system that is being acquired cannot be overemphasized. The time to find out if the weapon system performs effectively, reliably, and suitably is not in the heat of the battle. We, in the T&E community, have an obligation to develop and provide to our users the most efficient and effective weapon system we can. This means we must do everything possible to test the weapon system as soon as possible in the most realistic environment. This means a team effort where all the players are involved and can contribute to the program from the start--early organizational participation. Finally, we must all remember the words of General Hollingsworth presented at the beginning of this study, "...if there was only one system in the Department of Defense that was not properly tested it would be one too many." (18:38)

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