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THESIS

INTEGRATING TEST AND EVALUATION INTO THE ACQUISITION PROCESS FOR NAVAL AVIATION

by

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September 2009

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13. ABSTRACT (maximum 200 words)

Test and evaluation is incorporated throughout both the systems engineering and Department of Defense system acquisition processes. It is the mechanism for accomplishing verification in the systems engineering process and characterizing technical risk of achieving a proper final design solution. Test and evaluation is a critical and continuous activity throughout the Department of Defense systems acquisition process to ensure that cost, schedule, and performance requirements are satisfied with acceptable levels of risk.

Guidance for integration of test and evaluation into the systems acquisition process for Naval Aviation flows from Federal law, to the Department of Defense, to the Department of Navy, to the Naval Air Systems Command for implementation through Naval Air Systems Command policy and guidance.

This thesis analyzes this test and evaluation related guidance along with interview results from senior acquisition professionals to identify areas of weakness that exist regarding integrating test and evaluation into the systems acquisition process for Naval Aviation. This thesis makes ten specific recommendations to improve test and evaluation policy and guidance, training, and tool development.

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INTEGRATING TEST AND EVALUATION INTO THE ACQUISITION PROCESS FOR NAVAL AVIATION

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LIST OF ACRONYMS AND ABBREVIATIONS

AFI	Air Force Instruction
AFPD	Air Force Policy Directive
AoA	Analysis of Alternatives
APEO	Assistant Program Executive Officer
AR	Army Regulation
ASR	Alternative Systems Review
ASN(RD&A)	Assistant Secretary of the Navy (Research, Development, and Acquisition)
CDD	Capabilities Development Document
CDR	Critical Design Review
CJCSI	Chairman of the Joint Chiefs of Staff Instruction
CJCSM	Chairman of the Joint Chiefs of Staff Manual
COMOPTEVFOR	Commander Operational Test and Evaluation Force
COMOPTEVFORINST	Commander Operational Test and Evaluation Force Instruction
CPD	Capabilities Production Document
CT	Contractor Testing
DA PAM	Department of the Army Pamphlet
DAU	Defense Acquisition University
DT	Developmental Test
DT&E	Developmental Test and Evaluation
DAG	Defense Acquisition Guide

DoD	Department of Defense
DoDI	Department of Defense Instruction
DoN	Department of Navy
DOT&E	Director Operational Test and Evaluation
FAR	Federal Acquisition Regulations
FRR	Flight Readiness Review
FOT&E	Follow-on Operational Test and Evaluation
ICD	Initial Capabilities Document
IOT&E	Initial Operational Test and Evaluation
IT	Integrated Test
ITR	Initial Technical Review
ITT	Integrated Test Team
IT&E	Integrated Test and Evaluation
JCIDS	Joint Capabilities Integration and Development System
LFT&E	Live Fire Test and Evaluation
LRIP	Low-Rate Initial Production
M&S	Modeling and Simulation
NAVAIR	Naval Air Systems Command
NAVAIRINST	Naval Air Systems Command Instruction
NDI	Non-Developmental Items
NSERC	Naval Systems Engineering Resource Center
OA	Operational Assessment
OSD	Office of the Secretary of Defense
OT	Operational Test

OTA	Operational Test Agency
OT&E	Operational Test and Evaluation
OTD	Operational Test Director
OTRR	Operational Test Readiness Review
PDR	Preliminary Design Review
PEO	Program Executive Officer
PM	Program Manager
PRR	Production Readiness Review
QOT&E	Qualification Operational Test and Evaluation
QT&E	Qualification Test and Evaluation
RDT&E	Research, Development, Test and Evaluation
RFP	Request for Proposals
SECNAVINST	Secretary of the Navy Instruction
SETR	Systems Engineering Technical Review
SIL	Systems Integration Lab
SFR	System Functional Review
SME	Subject Matter Expert
SRR	System Requirements Review
SVR	System Verification Review
T&E	Test and Evaluation
T&E ESR	Test and Evaluation Executive Strategy Review
T&E WIPT	Test and Evaluation Working Integrated Product Team
TDS	Technology Development Strategy
TEMP	Test and Evaluation Master Plan

TES	Test and Evaluation Strategy
TRR	Test Readiness Review
TRMC	Test Resource Management Center
USD(AT&L)	Under Secretary of Defense (Acquisition, Technology & Logistics)
USNTPS	United States Naval Test Pilot School
V&V	Verification and Validation
WSEP	Weapon System Evaluation Program

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I. INTRODUCTION

A. BACKGROUND

Naval Air Systems Command (NAVAIR) is the primary acquisition agency for Naval aircraft, airborne weapons, and aviation systems. Currently, NAVAIR has very formal processes, procedures, and doctrine on how the systems engineering process is to be performed throughout the acquisition process. A good example is the Systems Engineering Technical Review (SETR) process, which requires programs to go through formal review steps to ensure that the systems engineering process is being conducted in a satisfactory manner. The Test and Evaluation (T&E) community, however, lacks similar direction. There is very limited guidance as to how T&E should be integrated into each stage of the acquisition process. As a result, the T&E community is often brought in on an "as-needed" basis whenever the program manager or systems engineer recognizes that T&E help is needed. This in turn causes the vast majority of T&E participation on programs to occur post-Milestone B. T&E participation and insight during the earlier stages of the program may be very beneficial but rarely occur in an effective manner due to lack of guidance in the T&E community.

The situation described has led the NAVAIR T&E community to begin an initiative to develop better guidance on how the community can integrate better with the other competencies (engineering, systems engineering, program management, logistics, etc.) and acquisition policies/procedures during all phases of the acquisition process, especially prior to Milestone B. This thesis will support this initiative by identifying areas of weakness integrating T&E into the acquisition process and by seeking opportunities for improvement.

B. PURPOSE

The purpose of this thesis is to understand shortcomings experienced by elements of the Naval Aviation acquisition community integrating T&E processes and procedures into all phases of the system acquisition process. Further, this thesis makes recommendations to overcome these shortcomings.

C. RESEARCH QUESTIONS

1. What guidance is currently provided by Department of Defense (DoD), Department of Navy (DoN), and Naval Air Systems Command (NAVAIR) regarding integrating T&E into the systems acquisition process?
2. What areas of weakness exist regarding integrating T&E into the systems acquisition process?
3. What improvements can be made to policies, procedures, and guidance to better integrate T&E into the systems acquisition process?

D. BENEFITS OF STUDY

This thesis provides a basis of knowledge that can be used by NAVAIR and leveraged by other DoD T&E activities, improving the integration of T&E into the systems acquisition process.

E. SCOPE

This thesis focuses on processes for integrating T&E into the systems acquisition process as derived from analysis of T&E policy, guidance, and input from senior Naval Aviation T&E managers, systems engineers, and program managers. Much of the analysis is dependent on interview responses.

F. METHODOLOGY

1. Conducted literature review of T&E and systems acquisition regulations, policy, procedures, guidance, other pertinent T&E related material.
2. Analyzed regulations, policy, procedures, and guidance to determine shortcomings.
3. Developed appropriate interview questions.
4. Interviewed senior Naval Aviation T&E managers, engineers, systems engineers, and program managers and analyzed responses to determine current shortcomings.
5. Developed recommendations for improving guidance for integrating T&E into the systems acquisition process.

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II. T&E IN THE SYSTEMS ENGINEERING PROCESS

A. INTRODUCTION

Before looking at how T&E is currently integrated into the Naval Aviation acquisition process through policy and guidance, this chapter will examine:

- What is the systems engineering process?
- What is T&E's role in the systems engineering process?

While various resources will be used in this exploration of the systems engineering process, including those from government, industry and academia, this chapter will focus on reviewing the systems engineering process as given in DoD resources, as this should form the basis for DoD T&E guidance. By investigating how T&E is "supposed" to be integrated into the systems engineering process, later chapters will then identify and analyze any shortcomings of the current DoD, DoN, and NAVAIR policies and guidance.

B. THE SYSTEMS ENGINEERING PROCESS

Systems engineering has been defined in many ways, including:

> Systems engineering is an interdisciplinary approach encompassing the entire technical effort to evolve and verify an integrated and total lifecycle balanced set of system, people, and process solutions that satisfy customer needs. Systems engineering is the integrating mechanism across the technical efforts related to the development, manufacturing, verification, deployment, operations, support, disposal of, and user training for systems and their life cycle processes. System engineering develops technical information to support the program management decision-making process. [1]

> The function of systems engineering is to guide the engineering of complex systems. [2]

> An interdisciplinary approach and means to enable the realization of successful systems. [3]

> Systems engineering is an interdisciplinary approach to evolve and verify an integrated and optimally balanced set of product and process designs that satisfy user needs and provide information for management decision making. [4]

Through the practice of systems engineering, a systematic methodology has been developed for transforming a set of requirements into an operational system that meets those requirements. The systems engineering process may be defined as:

> The systems engineering process is the iterative logical sequence of analysis, design, test, and decision activities that transforms an operational need into the descriptions required for production and fielding of all operational and support system elements. [4]

While the systems engineering process is defined and visualized using many different models, this thesis will focus on how it is defined and presented in the Defense Acquisition Guidebook (DAG) [1] as this provides official guidance on how the systems engineering process should be accomplished in DoD programs. The DAG divides the systems engineering process into eight technical processes (three design processes and five realization process) and eight technical management processes. These processes are illustrated in Figure 1 and further discussed below.

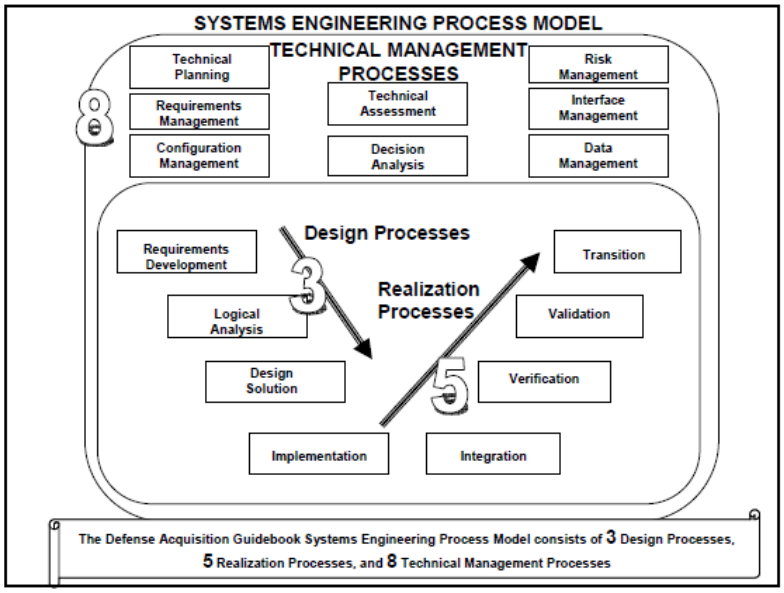

FIGURE 1. SYSTEMS ENGINEERING PROCESS MODEL [FROM 5]

The system developer uses technical processes to transform a system from an identified need all the way to a fielded system. The first technical process is requirements development.

The requirements development process translates inputs from the relevant stakeholders into technical requirements. Working with the user, the system developer translates the user's needs into performance parameter objectives and thresholds, affordability constraints, schedule constraints, and technical constraints. Requirements development is an iterative process with the goal of outputting requirements with the proper balance between performance and affordable cost.

Next, each system level function is analyzed using logical analysis. This is a recursive process, allocating requirements from higher levels to lower levels, providing traceable requirements. Logical analysis obtains sets of logical solutions to better understand the defined requirements and the relationships among them. Once these solution sets are formed, performance parameters and constraints can be allocated. Technical requirements can then be defined from the allocated performance parameters. The product of this step is a description of the system in functional terms.

Through the design solution process, the system developer then translates the functional architecture developed during logical analysis into the physical hardware and software component design. Each design element must be consistent with the functional analysis, performing the function that is intended to the level of performance required. The output of this process is the physical architecture that forms the basis for design definition documentation.

Next, implementation produces the lowest level system elements in the system hierarchy. This may be accomplished by making, buying, or reusing the system elements. This process may also include developing a manufacturing process if the implementation involves production.

During integration, the lower-level system elements are integrated into higher-level system elements in the physical architecture. This process assembles the full system from its components.

The verification process confirms that the system meets the design-to or built-to specifications. Through developmental testing, verification answers the question, "Did you build it right?"

The validation process evaluates the performance of the system within its intended operational environment with intended operational users. Through operational testing, validation answers the question, "Did you build the right thing?"

Finally, the transition process moves the system to the use of the end-term users.

C. SYSTEMS ENGINEERING AND THE DOD ACQUISITION PROCESS

Systems engineering is a critical aspect of the DoD acquisition process. Department of Defense Instruction (DoDI) 5000.02 mandates that systems engineering be integrated into the DoD acquisition process, stating:

> Systems engineering shall be embedded in program planning and be designed to support the entire acquisition life cycle. [6]

Figure 2 shows how the systems engineering technical processes described above are implemented across the DoD Defense Acquisition Management System.

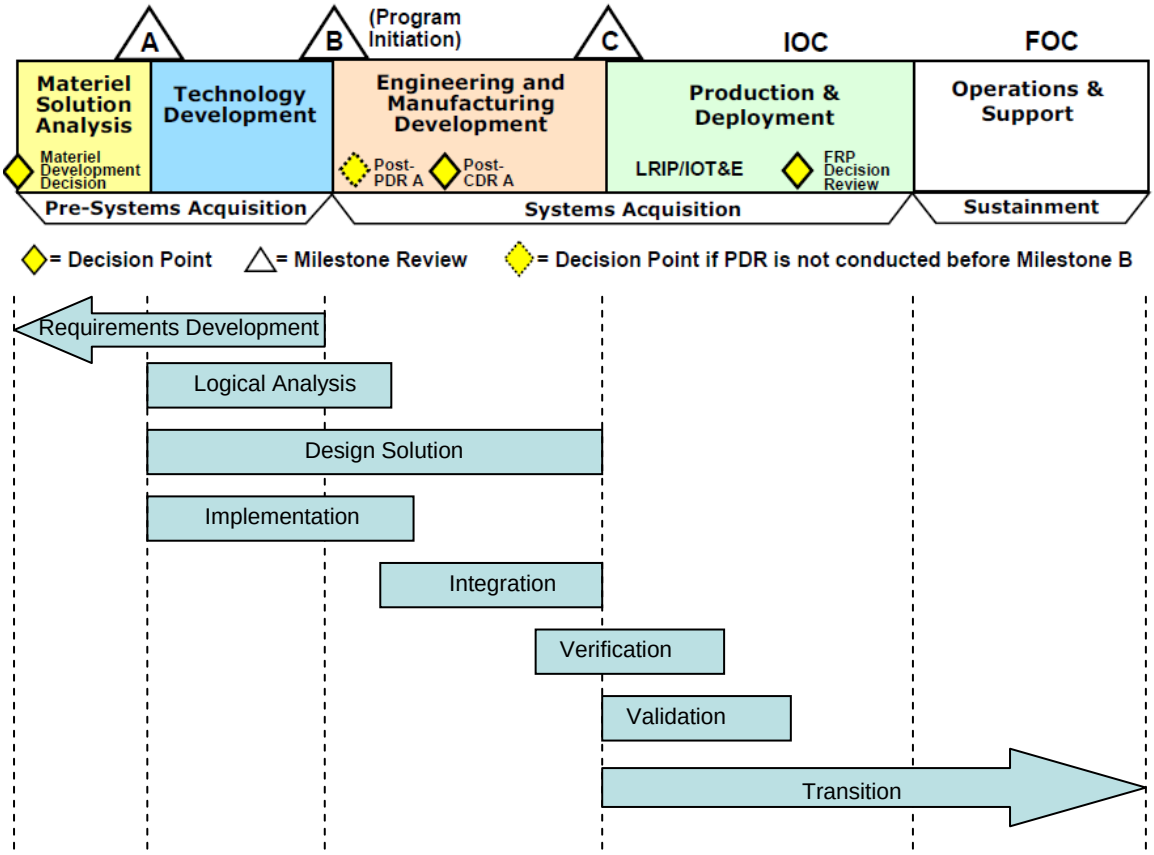

FIGURE 2. SYSTEMS ENGINEERING PROCESS AND DEFENSE ACQUISITION FRAMEWORK [AFTER 6]

D. TEST AND EVALUATION IN THE SYSTEMS ENGINEERING PROCESS

The terms Test and Evaluation are often used interchangeably. However, while related, the terms test and evaluation have two distinct definitions. Testing is the process of obtaining and providing data. Evaluation is the process of analyzing the data that testing produces.

T&E is incorporated throughout the systems engineering process. T&E is the mechanism for accomplishing verification in the systems engineering process and

characterizing technical risk of achieving a proper final design solution. While some steps of the systems engineering technical processes such as verification and validation are obviously T&E related, T&E is a critical and continuous activity throughout the systems engineering process to ensure that cost, schedule, and performance requirements are satisfied with acceptable levels of risk.

At each stage of the systems engineering process, T&E confirms that people, product, and process solutions meet or exceed the user's requirements. T&E provides the feedback loop to the systems engineering process. During early stages of the systems engineering process T&E activities may take the form of analysis, modeling, simulation, and proof of concept tests for system, subsystem, and component levels. Later stages will focus more on examination, demonstration, and testing to verify the function of the design and validate the produced systems meets user requirements.

T&E is involved from the beginning of the systems engineering process during requirements analysis and logical analysis. For DoD systems, the requirements flow from the user in the form of the Initial Capabilities Document (ICD), followed by the Capabilities Development Document (CDD), and finally the Capabilities Production Document (CPD), with the requirements becoming more mature and detailed with each successive iteration. System performance requirements are described in terms of attributes, which are characteristics that describe an aspect of a system capability. T&E input is important during these stages to develop good requirements. Specifically, T&E input is critical to ensure that all requirements are testable. Test techniques and laboratory/range capabilities must exist or must be capable of being developed to test to the requirement. While a requirement may sound good on paper, it is of no value if it cannot be verified through practical testing. T&E may also be used to refine requirements and concepts of operations by modeling, simulation, and prototype testing. T&E involvement is also important to give the T&E community insight to enable development and execution of a successful T&E strategy.

During the design solution phase of the systems engineering process, T&E may take the form of Modeling and Simulation (M&S). During early phases of the acquisition process (prior to Milestone B), T&E in the form of M&S provides an evaluation of

system concepts and technology alternatives using early performance parameter objectives and thresholds. By modeling different proposed designs, performance can be predicted and design tradeoffs can be accomplished, long before the system is even built.

During implementation, integration, and verification, T&E is conducted continually to determine if the produced items perform as they were designed. During implementation, component level testing verifies the performance of each component. This is followed by subassembly testing during integration, as components are brought together to form subsystems. Verification entails full-system Developmental Test and Evaluation (DT&E) to verify system performance against the system design specifications. DT&E is used to assist engineering design, system development, risk identification, and evaluate the contractor's ability to attain desired technical performance in system specifications. DT&E is normally performed by engineers, technicians, and contractors in a controlled environment to verify that design requirements are met. This testing is often accomplished on a developmental test article. The results of developmental tests feed back into the design solution process. Normally, DT&E is initially conducted by the developing contractor during system design and transitioned to combined contractor and government DT&E as the system design matures.

The validation process determines whether the system satisfactorily meets the user's requirement through Operational Test and Evaluation (OT&E). OT&E may be accomplished early-on through combined DT&E and OT&E or Integrated Test (IT) in order to give the operational tester an early look at the system and maximize efficiencies gathering data that both DT&E and OT&E testers have an interest in. OT&E is normally performed by the end-user of the system on a production representative test article in a realistic operational environment where the system must interact with the environment, personnel, threat, interoperable systems, doctrine and tactics to validate that the user's requirements are met. The results of OT&E feed back into the requirements development and design solution processes if and when deficiencies are discovered.

Finally, additional DT and Follow-on Operational Test and Evaluation (FOT&E) is conducted during transition to full operation to test system components that could not be fully tested during verification and validation and to test new upgrades to the system.

DT and FOT&E is also used to test future increments, modifications, and upgrades and help refine doctrine, tactics, techniques, and training programs.

Figure 3 graphically illustrates the role of T&E throughout the systems engineering process.

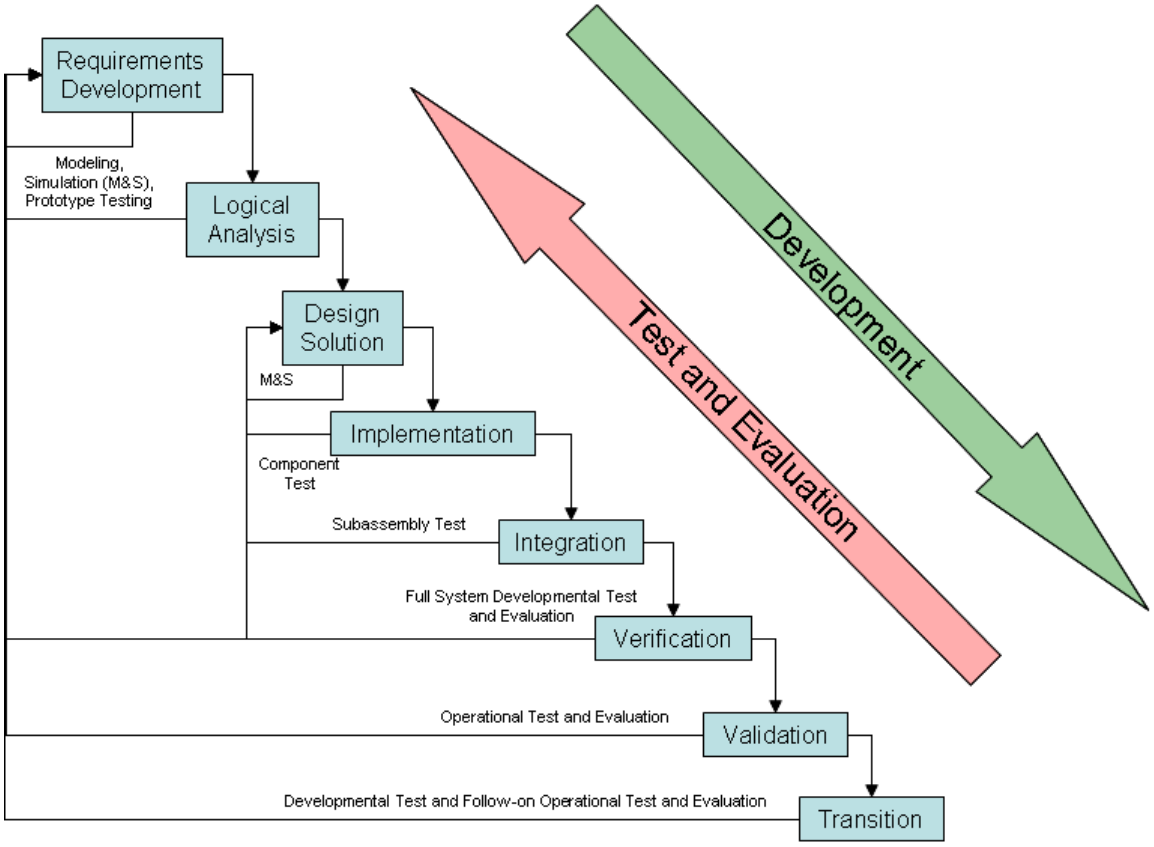

FIGURE 3. ROLE OF T&E IN THE SYSTEMS ENGINEERING PROCESS

III. T&E GUIDANCE REVIEW

A. INTRODUCTION

This chapter will answer the research question,

> What guidance is currently provided by Department of Defense (DoD), Department of Navy (DoN), and Naval Air Systems Command (NAVAIR) regarding integrating T&E into the systems acquisition process?

T&E direction for Naval Aviation acquisition programs flows from federal law to DoD, to DoN, to NAVAIR in the form of statutory, regulatory, and discretionary guidance. At each level, the statutory guidance tells what must be done by law, the regulatory guidance tells what must be done by policy, and the discretionary guidance tells how it should be done as learned from experience.

This chapter will review T&E guidance that is currently guiding Naval Aviation acquisition down through the chain of federal law, DoD, DoN, and NAVAIR. This chapter will then review T&E guidance from other organizations and services within DoD.

B. FEDERAL LAW T&E GUIDANCE

Title 10 of U.S. Code dictates statutory requirements for the conduct and oversight of operational testing.

Specifically, Section 139 establishes the office of Director Operational Test and Evaluation (DOT&E) to serve as the principal adviser to the Secretary of Defense and the Under Secretary of Defense for Acquisition, Technology, and Logistics on Operational Test and Evaluation (OT&E) in DoD and the principal OT&E official within the senior management of DoD [7]. Title 10 outlines responsibilities of DOT&E, including providing oversight to operational test planning and execution.

Section 2399 of Title 10 defines the timing, conduct, and reporting requirements of Operational Test (OT) in support of DoD acquisition programs [7]. Title 10 requires that completion of Initial Operational Test and Evaluation (IOT&E) of a major defense acquisition program is required prior to proceeding beyond Low-Rate Initial Production (LRIP). The DOT&E must approve the adequacy of OT&E and submit a report at the conclusion of OT.

Finally, Section 2366 of Title 10 requires major systems and munitions programs to undergo survivability testing and lethality testing, otherwise known as Live-Fire Test and Evaluation (LFT&E) prior to full-rate production [7].

C. DOD T&E GUIDANCE

1. Defense Acquisition System, DoD Directive 5000.1

DoD Directive 5000.1 provides management principles and mandatory policies and procedures for managing all acquisition programs [8]. Regarding T&E, DoD Directive 5000.1 provides two mandatory policies.

First, it requires that each military branch establish an independent operational test agency to plan and conduct operational tests, report results, and provide evaluations of effectiveness and suitability.

Second, it requires that T&E be integrated throughout the defense acquisition process. It gives direction to the purpose of T&E in the defense acquisition process, stating:

> Test and evaluation shall be structured to provide essential information to decision-makers, assess attainment of technical performance parameters, and determine whether systems are operationally effective, suitable, survivable, and safe for intended use. The conduct of test and evaluation, integrated with modeling and simulation, shall facilitate learning, assess technology maturity and interoperability, facilitate integration into fielded forces, and confirm performance against documented capability needs and adversary capabilities as described in the system threat assessment. [8]

2. Operation of the Defense Acquisition System, DoDI 5000.02

DoDI 5000.02 provides regulatory requirements for the operation of the defense acquisition system [6]. In addition to the statutory OT and LFT&E requirements of Title 10, DoDI 5000.02 provides regulatory T&E planning and reporting requirements including development of the Component LFT&E Report, the Operational Test Agency (OTA) Report of OT&E Results, the Test and Evaluation Master Plan (TEMP), and the Test and Evaluation Strategy (TES).

DoDI 5000.02 emphasizes the importance of early involvement of the T&E community in the systems acquisition process. Direction is given to bring T&E expertise "to bear at the beginning of the system life cycle . . . so that appropriate and timely corrective actions can be developed prior to fielding the system [6]."

DoDI 5000.02 sets the following T&E related regulatory requirements:

- Integration of all T&E activities into an efficient continuum
- Responsibility of the Program Manager (PM) to design DT&E objectives appropriate to each phase and milestone of an acquisition program
- TES development
- TEMP development
- T&E planning requirements
- DT&E requirements
- Readiness for OT&E
- OT&E requirements
- LFT&E requirements
- Use of M&S throughout the acquisition lifecycle
- Foreign comparative testing requirements
- T&E of evolutionary acquisition programs

3. Defense Acquisition Guidebook

The purpose of the DAG is to complement the regulatory guidance of DoD Directive 5000.1 and DoDI 5000.02 by providing the acquisition workforce with discretionary best practices [1]. While discretionary in nature, the DAG provides non-mandatory DoD staff expectations for satisfying the mandatory requirements of DoD Directive 5000.1 and DoDI 5000.02.

Chapter 9 of the DAG is focused on Integrated Test and Evaluation (IT&E), giving discretionary guidance on how to fulfill the mandatory requirements of the DoD 5000-series policy.

The DAG:

- Provides and introduction of general topics associated with T&E
- Presents an overview of T&E support and oversight provided by the Office of the Secretary of Defense (OSD)
- Describes the relationship of Joint Capabilities Integration and Development System (JCIDS) documents to T&E
- Explains the philosophy behind IT
- Provides guidelines for conduct of DT&E
- Describes the purpose and value of a Test and Evaluation Working Integrated Product Team (T&E WIPT)
- Provides best practices for the use of M&S in DT&E
- Provides guidelines for conduct of OT&E
- Gives guidance for the development of the TES and TEMP
- Presents guidance for the preparation of mandatory T&E reports
- Discusses T&E best practices

D. DON T&E GUIDANCE

1. Implementation and Operation of the Defense Acquisition System and the Joint Capabilities Integration and Development System, SECNAVINST 5000.2D

Secretary of the Navy Instruction (SECNAVINST) 5000.2D provides mandatory procedures for DoN implementation of DoD 5000-series acquisition and JCIDS policy [9]. Chapter 5 of SECNAVINST is focused on T&E. This chapter delineates the mandatory roles, responsibilities, procedures, and requirements for DoN acquisition programs.

SECNAVINST 5000.2D addresses:

- DoN Responsibilities for T&E
- T&E Strategy Requirements
- T&E Planning Requirements
- DT&E Requirements
- Certification of Readiness for Operational Testing
- OT&E Requirements
- The Annual OSD T&E Oversight List
- LFT&E Requirements
- Comparative Testing Requirements
- T&E Reporting Requirements

2. DoN Acquisition and Capabilities Guidebook

The DoN Acquisition and Capabilities Guidebook is a companion document to SECNAVINST 5000.2D [10]. Following the same chapter/enclosure/paragraph structure, the Guidebook incorporates all the information given in the Instruction, adding discretionary guidance to the mandatory guidance of the instruction.

E. NAVAIR T&E GUIDANCE

Acquisition Test and Evaluation, NAVAIR Instruction (NAVAIRINST) 3960.2D states policy, assigns responsibilities and provides procedures for acquisition-related T&E activities of programs and systems managed by NAVAIR [11]. Just as SECNAVINST 5000.2D provides mandatory procedures for DoN implementation of DoD 5000-series acquisition policy, the NAVAIRINST 3960.2D provides mandatory procedures for NAVAIR implementation of both the DoD and SECNAV level policy relating to T&E.

NAVAIRINST 3960.2D provides guidance in the following areas:

- Outlines membership, frequency, and conduct of T&E WIPTs
- TEMP preparation procedures
- Conduct of the T&E Executive Strategy Review (T&E ESR)
- Policies and procedures for planning and conduct of the Operational Test Readiness Review (OTRR) and pre-OTRR
- Process for Fleet Research, Development, Test and Evaluation (RDT&E) Support requests

F. DEFENSE ACQUISITION UNIVERSITY (DAU) T&E GUIDANCE

The T&E Management Guide published by DAU is a non-Service specific technical management educational guide [12]. The Guide is intended primarily for use in courses taught by DAU, but is also useful as a desk reference. The T&E Management Guide provides information on the following areas:

- T&E contributions leading to each milestone
- A summary of T&E activities during each phase of the acquisition process
- A summary of T&E documents developed during each phase of the acquisition process
- A description of T&E within the systems engineering process

- T&E policy structure and oversight mechanisms
- Program-office responsibilities for T&E
- M&S to support T&E
- T&E resources
- Software T&E
- LFT&E
- Logistics T&E
- Multi-service T&E
- International T&E programs
- Commercial and Non-Developmental Items (NDI) T&E

G. T&E GUIDANCE FROM OTHER SERVICES

1. Air Force T&E Guidance

a. T&E Process, Air Force Policy Directive AFPD 99-1

Air Force Policy Directive (AFPD) 99-1 establishes Air Force policies for the T&E process and infrastructure [13]. Specifically, this directive:

- Establishes policy requirements for DT&E, Qualification Test and Evaluation (QT&E), Contractor Testing (CT), Initial Operational Test and Evaluation (IOT&E), and FOT&E
- Requires operation, maintenance and improvements to T&E facilities
- Provides a requirement for the Weapon System Evaluation Program (WSEP)
- Establishes T&E related responsibilities and authorities

b. Capabilities-Based Test and Evaluation, AFI 99-103

Air Force Instruction (AFI) 99-103 implements AFPD 99-1 by describing planning, conduct, and reporting of cost effective T&E programs as an efficient continuum of integrated testing known as seamless verification [14]. Specifically, this instruction provides Air Force policy regarding:

- Air Force vision and implementation concepts
- Types of T&E
- T&E responsibilities
- T&E activities supporting each milestone
- T&E oversight and reporting

c. Air Force T&E Guidebook

The Air Force T&E Guidebook contains information, guidance, best practices, and lessons-learned about T&E and related subjects that were not published in AFI 99-103 [15]. Discretionary in nature, it is intended to supplement and expand on the policies and guidance of AFPD 99-1 and AFI 99-103. Specifically, the Guidebook provides guidance in the following areas:

- Hierarchy of T&E policy and guidance
- Relationships with OSD
- T&E support to the requirements process
- T&E support to the acquisition process
- The IT process
- Integrated Test Team (ITT) tools and techniques
- ITT products
- DT&E

- OT&E
- Space Systems T&E
- T&E resources
- Deficiency reporting

2. Army T&E Guidance

a. Test and Evaluation Policy, AR 73-1

Army Regulation (AR) 73-1 implements the policies and procedures contained in the DOD-5000 series and DAG and specifically prescribes implementing policies for the Army's testing and evaluation program [16]. AR 73-1 provides Army-specific policy on the following areas:

- T&E roles and responsibilities
- T&E in support of systems acquisition and development
- DT, OT, and Evaluation
- T&E WIPTs
- Conduct of the Test Schedule and Review Committee
- T&E review and reporting requirements
- T&E budget and financial considerations

b. Test and Evaluation in Support of Systems Acquisition, DA PAM 73-1

Department of the Army Pamphlet (DA PAM) 73-1 implements the policies contained in AR 73-1. Specifically it [17]:

- Provides an overview of the T&E process in support of Army acquisition systems
- Describes the T&E WIPT

- Provides detailed guidance and procedures for the preparation, staffing, and approval of the TEMP
- Provides an overview of the Army Critical Operational Issues and Criteria development and approval processes
- Provides an overview of the Army System Evaluation and System Assessment proves
- Provides an overview of Army developmental and operational testing processes

IV. ANALYSIS OF THE CURRENT GUIDANCE

A. INTRODUCTION

This chapter and the following chapter will answer the remaining research questions:

1. What areas of weakness exist regarding integrating T&E into the systems acquisition process?
2. What improvements can be made to policies, procedures, and guidance to better integrate T&E into the systems acquisition process?

As seen from the previous chapter, Naval Aviation weapons systems acquisition guidance and policy flows downward from Federal law, to DoD, to DoN, to NAVAIR. This guidance and policy specifies what actions need to take place during the acquisition process, when they need to take place, and how they should be accomplished.

This chapter describes how T&E's integration into the systems acquisition process is guided by this policy. It also presents results of the author's analysis of weaknesses in guidance and policy and recommends steps for improvement.

B. REVIEW OF POLICY AND GUIDANCE GOVERNING T&E'S INTEGRATION INTO THE SYSTEMS ACQUISITION PROCESS

Tables 1–9 illustrate T&E involvement at significant events along the acquisition process. These tables show the phases of the defense acquisition framework along the vertical axis, with major events and tasks involving T&E input noted within each phase. For each event, the input that T&E provides along with the governing guidance from DoD, DoN, NAVAIR, and other sources is noted. Each event or task is assessed as Good, Marginal, or Poor. Good means that the guidance sufficiently addresses T&E's role in the event or task. Marginal means that the guidance addresses T&E's role, but that the guidance is incomplete and could still be improved upon. Poor means that the guidance either does not address T&E's role at all, or is severely insufficient. The

assessments of Good, Marginal, and Poor are color-coded green, yellow, and red, respectively. Acquisition phases in the first column are color coded to match the code used for program phases in Figure 2.

The author's assessments of guidance quality are based on the rationale provided in the Notes/Comments column. The assessment is based on the author's opinion from review of the guidance along with views expressed from the interview subjects. The interviews are discussed in detail in the next chapter.

Acq Phase		Event or Task	T&E Input	GOVERNING GUIDANCE				Assessment of Guidance	Notes / Comments
				DoD	DoN	NAVAIR	OTHER		
Materiel Solution Analysis	Pre-Systems Acquisition	Initial Capabilities Document (ICD) Development	Provide Subject Matter Experts (SMEs) for requirements testability and review of the ICD for reasonable requirements	Joint Capabilities Integration and Development System, CJCSI 3170.01G [Reference 18]	SECNAVINST 5000.2D			Poor	The CJCSI does not define responsibilities below the Services. The SECNAVINST requires the draft ICD to be forwarded to the SYSCOM for information only. N091 is the Navy organization responsible for review of ICD for testability and resolving test issues.
		Analysis of Alternatives (AoA)	Review alternatives to develop applicable T&E strategiy to each alternative.	DoDI 5000.02 Encl 7, Para. 5	SECNAVINST 5000.2D, Para. 6.4	NAVAIR Acquisition Guide [Reference 19], Para. 5.3B		Poor	No mention of T&E's role in the development of the AOA is given in any of the guidance/policy documents.
		Technology Development Strategy (TDS)	Provide T&E input to preliminary acquisition strategy, including overall cost, schedule, and performance goals for the total research and development program	DoDI 5000.02, Encl 2, Para. 5.c.7	SECNAVINST 5000.2D, para.3.4	NAVAIR Acquisition Guide, Para 5.4		Poor	The SECNAVINST states that the PM is responsible for developing the TDS, however it gives no guidance regarding who it should be coordinated with.
		Request for Proposals (RFP)	Notional T&E requirements and strategy	Federal Acquisition Regulation (FAR) [Reference 20]; DoDI 5000.02	SECNAVINST 5000.2D	NAVAIRINST 4200.39B [Reference 21]		Poor	No mention of T&E in the NAVAIR instruction. The SECNAVINST states that N091 is in an advisory capacity.

TABLE 1. T&E INTEGRATION INTO THE SYSTEMS ACQUISITION PROCESS (TABLE 1 OF 9)

Acq Phase		Event or Task	T&E Input	GOVERNING GUIDANCE				Assessment of Guidance	Notes / Comments
				DoD	DoN	NAVAIR	OTHER		
Material Solutions Analysis	Pre-Systems Acquisition	Source Selection	T&E Strategies for competing Alternatives – cost, schedule and performance	FAR, DoDI 5000.02	SECNAVINST 5000.2D	NAVAIRINST 4200.39B		Poor	No mention of T&E in the NAVAIR instruction. The SECNAVINST states that N091 is in an advisory capacity.
		Initial Technical Review (ITR)	Notional test requirements, cost estimate; initial schedule		Naval Systems Engineering Resource Center (NSERC) SETR Checklist, [Reference 22]	NAVAIRINST 4355.19D [Reference 23]		Good	Assistant Program Manager for Test and Evaluation (APMT&E) identified on technical review board to ensure that all T&E requirements are addressed. However, no guidance exists for specific T&E participation.
		Alternative Systems Review (ASR)	Notional test requirements, cost estimate; initial schedule, Draft T&E Strategy.		NSERC SETR Checklist	NAVAIRINST 4355.19D		Marginal	APMT&E identified on technical review board to ensure that all T&E requirements are met. However, no guidance exists for specific T&E participation. T&E requirements for alternative systems not well addressed in ASR checklist
		Test and Evaluation Strategy (TES)	Overall test approach for integrating DT&E, OT&E, and LFT&E and addresses resource planning	DoDINST 5000..02, Encl 6, Para. 2.a; DAG, Para. 9.6.1	SECNAVINST 5000.2D, Para. 5.3			Good	DAG provides guidance for contents and format of TES.

TABLE 2. T&E INTEGRATION INTO THE SYSTEMS ACQUISITION PROCESS (TABLE 2 OF 9)

Acq Phase		Event or Task	T&E Input	GOVERNING GUIDANCE				Assessment of Guidance	Notes / Comments
				DoD	DoN	NAVAIR	OTHER		
Material Solution Analysis	Pre-Systems Acquisition	Systems Engineering Plan (SEP)	T&E role in the systems engineering process	DoDINST 5000.02, Encl. 12, Para. 2; DAG, Para. 4.5.1; USD(AT&L) SEP Preparation Guide [Reference 24]	ASN(RD&A) Memorandum of 16 November 2007 [Reference 25]			Good	SEP Preparation Guide emphasizes documenting relationships between systems engineering and test and evaluation
MS A									
Technology Development		Capabilities Development Document (CDD)	Provide Subject Matter Experts (SMEs) for requirements testability and review of the CDD for reasonable requirements	CJCSI 3170.01G	SECNAVINST 5000.2D			Poor	The CJCSI does not define responsibilities below the Services. The SECNAVINST requires the draft CDD to be forwarded to the SYSCOM for information only. N091 is the Navy organization responsible for review of CDD for testability and resolving test issues.
		System Requirements Review (SRR) - I	M&S role in testing identified, requirement verification methodology, preliminary test requirements, updated cost estimate, preliminary schedule, Draft TEMP.		NSERC SETR Checklist	NAVAIRINST 4355.19D		Marginal	DT and OT personnel identified as technical review participants. However, no guidance exists for specific T&E participation.
		SRR - II	M&S role in testing identified, Draft Verification and Validation (V&V) methodology defined for each Specification requirement, Draft TEMP updated, updated requirement verfication methodology		NSERC SETR Checklist	NAVAIRINST 4355.19D		Marginal	DT and OT personnel identified as technical review participants. However, no guidance exists for specific T&E participation.

TABLE 3. T&E INTEGRATION INTO THE SYSTEMS ACQUISITION PROCESS (TABLE 3 OF 9)

Acq Phase		Event or Task	T&E Input	GOVERNING GUIDANCE				Assessment of Guidance	Notes / Comments
				DoD	DoN	NAVAIR	OTHER		
Technology Development	Pre-Systems Acquisition	Formation of T&E WIPT	The T&E WIPT serves as the forum for planning and cooridinating the T&E activities of the program, fostering cooridination and communication between DT, OT, and other T&E stakeholders	DAG, Chap. 9	SECNAVINST 5000.2D, Para. 5.4.3	NAVAIRINST 3960.2D, Encl. 1		Good	NAVAIRINST 3960.2D Encl. 1 provides guidance outlining the membership, frequency and conduct of T&E WIPTs.
		System Functional Review (SFR)	Functional requirements assigned to M&S, Draft software test plan, if not a software intensive program (and no SSR is planned)		NSERC SETR Checklist	NAVAIRINST 4355.19D		Marginal	DT and OT personnel identified as technical review participants. However, no guidance exists for specific T&E participation.
		TEMP	Planned DT&E, OT&E, and LFT&E, including measures to evaluate the performance of the system during these test periods; an integrated test schedule; and the resource requirements to accomplish the planned testing.	DoDINST 5000..02, Encl 6, Para. 2.b; DAG, Para 9.6.2	SECNAVINST 5000.2D, Para. 5.3	NAVAIRINST 3960.2D, Encl. 2		Good	DAG provides guidance for contents of TEMP. NAVAIRINST 3960.2D, Encl. 2 provides NAVAIR specific policy.
		Acquisition Strategy	Provide T&E input to time-phased workload assessment identifying the manpower and functional competency requirements for successful program execution and the associated staffing plan, including the roles of government and non-government personnel	DoDI 5000.02, Encl 2, Para 6.d.7; DAG, Para. 2.3	SECNAVINST 5000.2D, Para.3.4	NAVAIR Acquisition Guide, Para 8.A		Good	The DAG states "The program manager should engage the Test and Evaluation Working-Level Integrated Product Team in the development of the acquisition strategy, and harmonize the acquisition strategy and the Test and Evaluation Strategy."

TABLE 4. T&E INTEGRATION INTO THE SYSTEMS ACQUISITION PROCESS (TABLE 4 OF 9)

Acq Phase		Event or Task	T&E Input	GOVERNING GUIDANCE				Assessment of Guidance	Notes / Comments
				DoD	DoN	NAVAIR	OTHER		
Technology Development	Pre-Systems Acquisition	Capabilities Production Document (CPD)	Provide Subject Matter Experts (SMEs) for requirements testability and review of the CPD for reasonable requirements	CJCSI 3170.01G	SECNAVINST 5000.2D			Poor	The CJCSI does not define responsibilities below the Services. The SECNAVINST requires the draft CPD to be forwarded to the SYSCOM for information only. N091 is the Navy organization responsible for review of CPD for testability and resolving test issues.
MS B									
Engineering, Manufacturing and Development	Systems Acquisition	Preliminary Design Review (PDR)	Test verfication matrix covering sub-system allocations, traceability from design documentation to sub-system test requirements, identfication of engineering data requirements needed from testing		NSERC SETR Checklist	NAVAIRINST 4355.19D		Marginal	APMT&E identified on technical review board to ensure that all T&E requirements are addressed. However, no guidance exists for specific T&E participation.
		Critical Design Review (CDR)	Test verfication matrix, engineering data requirements from testing, test plans, M&S role in testing defined, finalized V&V of Systems Integraton Lab (SIL) plan		NSERC SETR Checklist	NAVAIRINST 4355.19D		Marginal	APMT&E identified on technical review board to ensure that all T&E requirements are addressed. However, no guidance exists for specific T&E participation.
		Operational Assessment (OA)	OA Test Plans and Reports				Operational Test Director's Manual, COMOPTEV-FORINST 3980.1, [Reference 26]	Good	Establishes policy and guidance on all aspects of OT&E, including planning, conduct and reporting.

TABLE 5. T&E INTEGRATION INTO THE SYSTEMS ACQUISITION PROCESS (TABLE 5 OF 9)

Acq Phase		Event or Task	T&E Input	GOVERNING GUIDANCE				Assessment of Guidance	Notes / Comments
				DoD	DoN	NAVAIR	OTHER		
Engineering, Manufacturing and Development	Systems Acquisition	Risk Management	Risk elements affecting successful accomplishment of T&E program and risk elements identfied by T&E results	Risk Management Guide for DoD Acquisition Sixth Edition [Reference 27]		NAVAIR Risk Assessment Handbook [Reference 28]		Poor	No guidance given on T&E's participation in the risk management process.
		DT Test Planning	DT Test Plans			Project Test Plan Policy and Guide NAVAIRINST 3960.4B [Reference 29]		Good	NAVAIRINST 3960.4B establishes NAVAIR policies, processes, responsibilities, and requirements for preparation, review, and execution of flight, ground, and laboratory tests of air vehicles, air vehicle weapons, and air vehicle installed systems.
		Test Readiness Review (TRR)	Requirements verification matrix, test plan, test and validation procedures, plan for test reporting, functional anomaly reporting system		NSERC SETR Checklist	NAVAIRINST 4355.19D		Good	Senior AIR-5.1 person designated to serve as co-chair of review. APMT&E identified on technical review board to ensure that all T&E requirements are addressed. A TRR must have an appropriate T&E SME representative for the system under test.
		Flight Readiness Review (FRR)	Finalized engineering data requirements from flight test, defined data reduction and analysisroles and responsibilities, test plans, flight test requirements supporting M&S validation		NSERC SETR Checklist	NAVAIRINST 4355.19D		Good	AIR-5.1 Test Wing Commander designated as co-chair or review. APMT&E identified on technical review board to ensure that all T&E requirements are addressed.

TABLE 6. T&E INTEGRATION INTO THE SYSTEMS ACQUISITION PROCESS (TABLE 6 OF 9)

Acq Phase		Event or Task	T&E Input	GOVERNING GUIDANCE				Assessment of Guidance	Notes / Comments
				DoD	DoN	NAVAIR	OTHER		
Engineering, Manufacturing and Development	Systems Acquisition	DT Test Reporting	DT Test Reports			RDT&E Report Writing Handbook [Reference 30]; Director's Note 1, Test Reporting [Reference 31]		Good	Report Writing Handbook provides formats and guidance for reporting test results from NAVAIR test events.
		System Verification Review (SVR)	T&E input to technical review checklist and preparation		NSERC SETR Checklist	NAVAIRINST 4355.19D		Good	APMT&E identified on technical review board to ensure that all T&E requirements are addressed.
		Production Readiness Review (PRR)	T&E input to technical review checklist and preparation			NAVAIRINST 4355.19D		Good	APMT&E identified on technical review board to ensure that all T&E requirements are addressed.
MS C									
Production and Deployment		IOT&E Planning	OT Test Plans				Operational Test Director's Manual, COMOPTEV-FORINST 3980.1	Good	Establishes policy and guidance on all aspects of OT&E, including planning, conduct and reporting

TABLE 7. T&E INTEGRATION INTO THE SYSTEMS ACQUISITION PROCESS (TABLE 7 OF 9)

Acq Phase		Event or Task	T&E Input	GOVERNING GUIDANCE				Assessment of Guidance	Notes / Comments
				DoD	DoN	NAVAIR	OTHER		
Production and Deployment	Systems Acquisition	Operational Test Readiness Review (OTRR)	Completed TEMP, DT test reports and results, T&E risk identification		SECNAVINST 5000.2D, Para. 5.6	NAVAIRINST 3960.2D, Encl. 3		Good	NAVAIRINST 3960.2D further defines the requirements of SECNAVINST 5000.3D, which establishes the minimum criteria required for certification of readines to commence operational testing.
		IOT&E Reporting	OT Test Reports				Operational Test Director's Manual, COMOPTEV-FORINST 3980.1	Good	OT Director's Manual establishes policy and guidance on all aspects of OT&E, including planning, conduct and reporting
Operations and Support	Sustainment	Follow-on Developmental Test and Evaluation Planning	DT Test Plans			NAVAIRINST 3960.4B		Good	NAVAIRINST 3960.4B establishes NAVAIR policies, processes, responsibilities, and requirements for preparation, review, and execution of flight, ground, and laboratory tests of air vehicles, air vehicle weapons, and air vehicle installed systems.
		Follow-on Developmental Test and Evaluation Reporting	DT Test Reports			RDT&E Report Writing Handbook Director's Note 1, Test Reporting		Good	Report Writing Handbook provides formats and guidance for reporting test results from NAVAIR test events.

TABLE 8. T&E INTEGRATION INTO THE SYSTEMS ACQUISITION PROCESS (TABLE 8 OF 9)

Acq Phase		Event or Task	T&E Input	GOVERNING GUIDANCE				Assessment of Guidance	Notes / Comments
				DoD	DoN	NAVAIR	OTHER		
Operations and Support	Sustainment	Follow-on Operational Test and Evaluation (FOT&E) Planning	OT Test Plans				Operational Test Director's Manual, COMOPTEV-FORINST 3980.1	Good	OT Director's Manual establishes policy and guidance on all aspects of OT&E, including planning, conduct and reporting
		FOT&E Reporting	OT Test Reports				Operational Test Director's Manual, COMOPTEV-FORINST 3980.1	Good	OT Director's Manual establishes policy and guidance on all aspects of OT&E, including planning, conduct and reporting

TABLE 9. T&E INTEGRATION INTO THE SYSTEMS ACQUISITION PROCESS (TABLE 9 OF 9)

C. ANALYSIS RESULTS

From review of Tables 1–9, it is evident that guidance governing certain phases, events, and tasks of the systems acquisition process better address the integration of T&E than others. As an overall trend, Tables 1-9 show that guidance governing T&E integration improves as the program matures through the defense acquisition framework. Specifically, events and tasks prior to Milestone B tend to address T&E integration into the process less sufficiently than those after Milestone B. Review of the guidance governing T&E throughout the systems acquisition process reveals many specific areas of interest. These areas are explored in greater depth in the following paragraphs.

1. Requirements Development

As described in Paragraph II.D, requirements for DoD systems are detailed in a series of documents; the ICD, the CDD, and the CPD. These documents are developed in series by the user representative, with each one becoming more specific as the development of the system matures. The progression of requirements documents from ICD to CDD to CPD is shown in Figure 4.

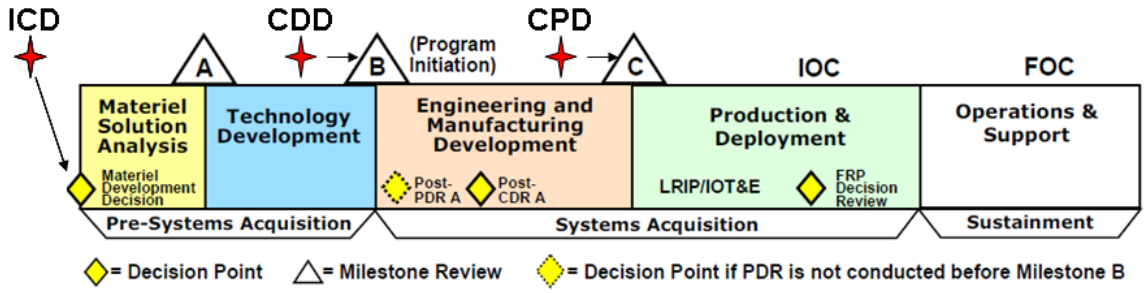

FIGURE 4. PROGRESSION OF REQUIREMENTS DOCUMENTS IN THE DEFENSE ACQUISITION FRAMEWORK [AFTER 6]

After the user representative develops these requirements documents, the program manager is responsible for translating the requirements into system specifications that define the design of the system.

Guidance governing the integration of T&E into the development of the ICD, CDD, and CDD were assessed as "Poor" on Tables 1, 3, and 5, respectively. Development of the requirements documents that ultimately define the design of the system is driven by the Joint Capabilities Integration and Development System (JCIDS), which is governed by Chairman of the Joint Chiefs of Staff Instruction (CJCSI) 3170.01G [18]. The instruction makes no specific reference to T&E. Responsibilities are not given below the service level. SECNAVINST 5000.2D further defines DoN's role in the requirements development process. However, regarding T&E's participation in the requirements development process, it only states that the Chief of Naval Operations (CNO) Director of Test and Evaluation and Technology Requirements (N091) is responsible to the CNO for reviewing the capabilities documents for testability [9].

While this at least touches on T&E's role in the requirements development process, it is not sufficient. In addition to reviewing for testability, the T&E community is also the ideal group to review the mission relevancy and reasonableness of technical requirements. Even if testability were the only concern, CNO (N091) is not where this responsibility should solely reside. Made-up of primarily of active-duty service members directly from the fleet with little to no formal T&E experience, CNO (N091) is not adequately staffed to perform this significant task. Reviewing the testability of a technical requirement must involve the end-state-tester to determine if the technology, facilities, and techniques exist to test to the precision necessary to evaluate the system's achievement of the requirement and if it can be done within reasonable cost and schedule. While CNO (N091) should provide an oversight role, there must be guidance and policy to involve the responsible test organizations in the review of requirements documents for testability, mission relevancy, and reasonableness.

2. Selection of Concept/System to be Developed

The DoD systems acquisition process utilizes many processes to analyze and decide upon the system to be developed. These processes include Analysis of Alternatives (AoA), Request for Proposal (RFP), and Source Selection.

Guidance governing these processes was assessed as "Poor" in Tables 1 and 2. Various guidance and policy documents from DoD, DoN, and NAVAIR govern these processes. From the federal and DoD level, these guidance and policy documents include DoDI 5000.02, and the Federal Acquisition Regulation (FAR). From the DoN level, they include SECNAVINST 5000.2D, and from the NAVAIR level, they include the NAVAIR Acquisition Guide and NAVAIRINST 4200.39B.

No T&E related guidance is provided for the AoA. Since the AoA is conducted without direction from the PM, per SECNAVINST 5000.2D, without any T&E related guidance, there is little to no chance of significant input from the DT or OT community. Without this input, T&E related impacts of choosing a particular alternative are unlikely to be considered.

RFP and Source Selection also lack sufficient T&E related guidance, with NAVAIRINST 4200.39B making no mention of T&E at all. SECNAVINST 5000.2D only states that CNO (N091) shall act in an advisory capacity.

Guidance for these processes, especially at the NAVAIR level, should be revised to include participation of the T&E discipline (AIR-5.1 for NAVAIR) in order to benefit from the insight of the T&E related impacts of each alternative system.

3. SETR Process Participation

NAVAIR utilizes the Systems Engineering Technical Review (SETR) process as an integral part of the systems engineering and life cycle management process to enable an independent assessment of emerging designs against plans, processes, and key knowledge points in the development process [23]. The SETR process consists of a series of reviews conducted at strategic points along the systems acquisition process. Figure 5 shows the timing of SETR reviews during the acquisition process.

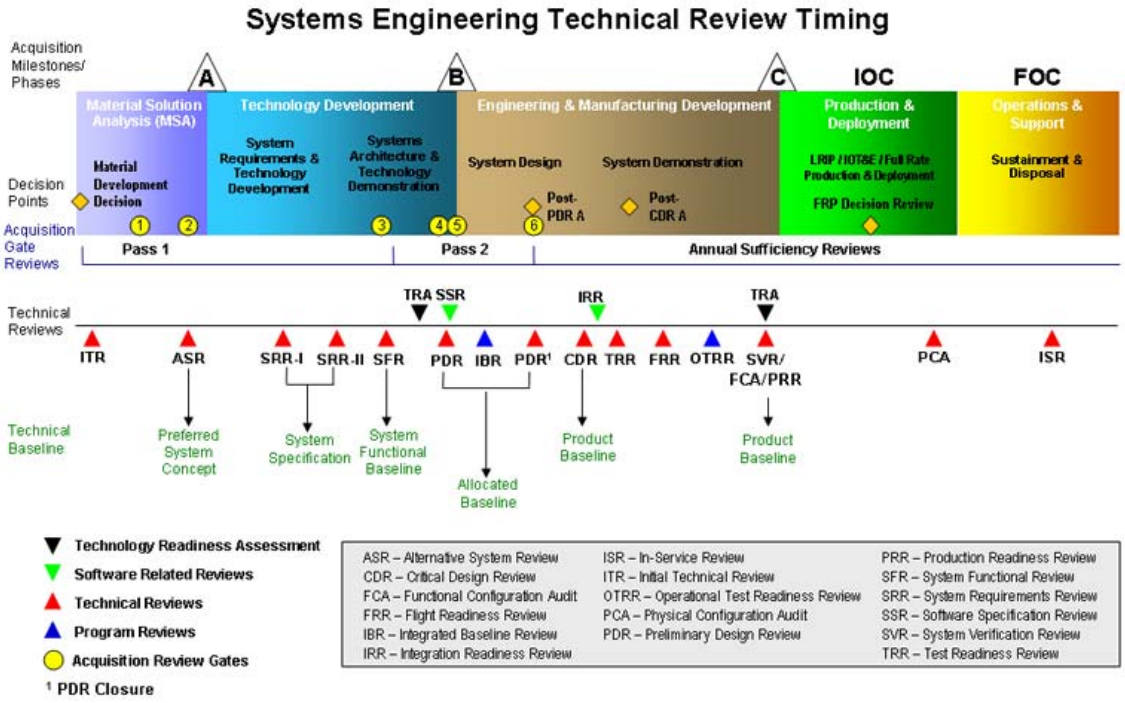

FIGURE 5. TIMING OF SETR REVIEWS [FROM 23]

Reviews that are either T&E related or have major input from or impact on T&E are included in Tables 1–7. Guidance governing these reviews was assessed as "Marginal" to "Good" depending on the specific review. Guidance for conducting SETR reviews for NAVAIR managed programs is given in NAVAIRINST 4355.19D.

The major deficiency noted during analysis of the guidance was incomplete direction regarding review participation from members of the T&E community. The guidance for the Initial Technical Review (ITR), Alternative Systems Review (ASR), Preliminary Design Review (PDR), and Critical Design Review (CDR) identifies the Assistant Program Manager for Test and Evaluation (APMT&E) to serve on the technical review board to ensure that all T&E requirements are addressed. However, no further guidance is given for specific T&E participation. The guidance for the System Requirements Review (SRR) and the System Functional Review (SFR) does not even go that far, stating only that DT and OT personnel should participate in the reviews.

There is no standardized process for determining who (by function and level of authority) should participate at each review from the T&E community. As a result of this lack in guidance, the selection of T&E personnel to participate in SETR events tends to be *ad hoc*. This results in inconsistent representation of the T&E competency both across programs and across SETR events within the same program.

This deficiency does not primarily reside with the overarching guidance given in NAVAIRINST 4355.19C, but with the NAVAIR T&E community's implementation of the policy. To correct this inconsistency, the NAVAIR T&E community should develop a standardized procedure for determining who (by function and authority level) should participate at each SETR event. Flexibility should be provided in this standardized procedure to account for differences in program type, scope, size, and visibility. For example, individual(s) selected for a radar system review would be different from those chosen for an aircrew system review. Also, different individual(s) would be appropriate for an ACAT IV review as compared to those attending a high-visibility ACAT I review.

D. RECOMMENDATIONS

From review and analysis of guidance and policy governing T&E's integration into the systems acquisition process, as described in the preceding paragraphs, the following recommendations are made:

1. Provide guidance and policy to involve the responsible test organizations in the review of requirements documents for testability, mission relevancy, and reasonableness.
2. Revise NAVAIR guidance related to AoA, RFP, and Source Selection, to include participation of the T&E discipline, AIR-5.1.
3. Develop NAVAIR T&E discipline standardized procedure for determining who (by function and authority level) should participate at each SETR event. Flexibility should be provided in this standardized procedure to account for differences in program type, scope, size, and visibility.

V. ANALYSIS OF INTERVIEWS

A. INTRODUCTION

In order to better understand the challenges experienced by acquisition professionals integrating T&E into the acquisition process for Naval Aviation, interviews were conducted with senior leaders and subject matter experts. The interview subjects had widely varied experience and expertise from the fields of program management, systems engineering, and T&E across multiple programs and PEOs within NAVAIR. The interview subjects were:

- CAPT Richard Muldoon
  Program Manager, PMA-261, H-53 Heavy Lift Helicopters

- CAPT Jeffrey Penfield
  Program Manager, PMA-259, Air-to-Air Missile Systems

- Mr. Joseph Wascavage
  Head, Systems Test and Experimentation Management Division

- Mr. Robin Locksley
  Assistant Program Executive Officer (APEO) for Test and Evaluation, PEO(Unmanned Aviation and Strike Weapons)

- Mr. Michael Gomes
  APEO for Engineering, PEO(Air ASW, Assault, and Special Mission Programs)

- Mr. Gary Evans
  APEO for Engineering, PEO(Unmanned Aviation and Strike Weapons)

- Mr. Neal Siegel
  Head, T&E Processes, Standards, and Special Programs Office

- Mr. David Roberts
  Chief Test Engineer, Atlantic Test Range

- Mr. Christian Rice
  Chief Test Engineer, HX-21 Rotary Wing Test Squadron

- Mr. James Schmidt
  APM(T&E), PMA-261, H-53 Heavy Lift Helicopters

The interview questions used to guide the interviews are provided in the Appendix.

B. ANALYSIS RESULTS

The interview responses were reviewed and analyzed to look for common themes. While the interview responses were very wide-reaching, with each interview subject naturally tending to focus on their particular areas of expertise and experience, several common themes emerged regarding areas for improvement integrating T&E into the acquisition process for Naval Aviation. These areas are discussed in greater depth in the following paragraphs.

1. Development of Test Program Estimates

One area of weakness commonly cited by the interview subjects was developing cost and schedule estimates for T&E programs. These estimates, done very early in the system's development, form the foundation of the T&E program, as they establish the funding and schedule profile allocated to the test program. However, the interviews identified a major shortcoming in the test program estimation process.

Although flight test is relatively mature as a process, having been done in a relatively systematic manner since the establishment of formal test pilot training programs in the late 1940s, flight test execution data has not been captured and recorded in a manner that easily aids estimation and planning for future flight test programs.

There is currently no tool that captures test efficiency and test throughput of past test programs. Test efficiency and throughput are significant factors impacting the ability to hold to a test schedule. Major factors that impact test efficiency and throughput include aircraft availability due to maintenance, weather, range scheduling, and the necessity to re-fly test points due to test complexity.

If a computer-aided tool or database captured the results of prior flight test programs, it would be of great use for planning future test programs. An example of information that could be derived from such a tool might be that for aircraft platform 'W' operating out of flight test location 'X' performing 'Y' type of testing, the average throughput is 'Z' test sorties per month. While no two test programs are exactly alike, this information would provide a base of knowledge to make realistic estimates for planning future test programs.

A lot of this historical information is already partially captured in the minds of those who experienced the test programs. While this corporate knowledge is very valuable, it has two significant shortcomings.

First, because the information exists only in the minds of those who experienced it, it is only valuable if they personally participate in and influence planning for the next test program. If they either are not personally involved in the test planning or if those who are personally involved aren't aware of the experienced persons' knowledge and do not seek it out, it is lost and is of no value to estimating the schedule and resources for the next test program.

Second, because the knowledge is often anecdotal in nature, it may not be effective in justifying and defending test program estimates when they are challenged. Due to tight fiscal constraints, there is tremendous pressure to make program schedules and budgets success-oriented. This leads to pressure to develop test schedules and funding profiles that assume success and high levels of efficiency and throughput. It is the test team's role to challenge this pressure by pushing for schedules and resources that are realistic, based on historical test efficiency and throughput. However, if this information is only anecdotal in nature, it is challenging to justify adding time and resources to achieve a realistic plan. If a recognized tool existed to formally record and present this information, justification of T&E schedules and budgets based on 'realistic' assumptions would be greatly aided. It is much easier to defend planning assumptions made based on documented historical data rather than anecdotal knowledge.

Development of such a test program planning tool would require significant effort to develop and maintain; however, the investment would yield great returns in the form of realistic, justifiable and defendable estimates of test schedules and budgets. Data to support development of a tool should be available in DT&E and OT&E reports from previous programs. Inputs from both Navy and Air Force test programs could contribute to the database.

2. Education of T&E Workforce

Another area frequently cited in the interview responses was the need for education of the T&E workforce. Although the Naval Aviation T&E workforce as a whole is seen as highly educated and well trained, there are certain knowledge areas that were cited as weak and in need of improvement.

a. T&E Schedule and Cost Estimation Training

One of those areas is inadequate training for developing T&E schedules and cost estimates. As noted, T&E estimates performed very early in the T&E planning process lay the foundation for the test. Although foundational, this area of T&E planning may be the weakest area of knowledge and skill within the T&E workforce.

As will be further illustrated in the next section, DT&E practitioners are given extensive training on detailed test planning, test execution, and test reporting. However, no formal training is provided on the skill of long-term T&E schedule and cost estimation. Combined with a lack of formal tools for estimation as described in the section above, the resulting estimates tend to be of widely varying degrees of quality, primarily based on informal rules of thumb, rather than a rigorous, systematic process.

This problem is compounded by the attitudes and values of those who are tasked to perform T&E estimates, mainly testers. T&E, particularly Naval Aviation flight test, tends naturally to attract people whose interests and skills are focused on the hands-on, near-term tasks of preparing for and executing flight test operations. They are

often not interested in or formally trained in performing long-term cost and schedule estimates. As a result, this aspect of the job tends to get little attention compared to execution of flight test operations.

To overcome these challenges, formal training in T&E schedule and cost estimation is necessary to give the T&E workforce both the necessary skills to perform high-quality estimates and an appreciation for the impact early estimating has on the success of the overall T&E program.

b. Training of OT OTDs

Another area of weakness, most often cited by interview subjects with experience working within the field of OT, is insufficient training for OT personnel, particularly Commander Operational Test and Evaluation Force (COMOPTEVFOR) Operational Test Directors (OTDs).

OTDs are responsible for conducting detailed OT planning, supervision of test execution, and documentation of test results [26]. OTDs are typically O-3/O-4 level officers (Lieutenants and Lieutenant Commanders) pulled directly from the fleet with no prior T&E experience. They are given tremendous responsibility, considering that the tests that they plan and the reports that they write will be seen as the final report card for an acquisition program, recommending whether or not a system should be fielded. These tests and test reports have very high visibility, having great political and public relations impact for the program under test.

However, the training given to OTDs to prepare them for such a high responsibility is insufficient. New OTDs reporting to COMOPTEVFOR are given a three-day course, "To provide OTD and support personnel with a baseline knowledge of weapon system acquisition, and introduce them to policies, procedures, documentation and reports required by DOD and SECNAV in conducting OT&E [33]." While the course does an admirable job presenting the material as well as possible, given the time constraints, three days is simply not enough to cover the material in sufficient depth. This is especially true given that the typical OTD has no prior T&E or acquisition-related experience and is given such a high-level of responsibility to properly perform the OT&E

function of the systems acquisition process. As a result, the vast majority of learning how to plan, conduct and report on OT is accomplished "on-the-job" getting unofficial anecdotal guidance from peers [33].

The degree of insufficiency a three-day course provides is made even more evident when contrasted with the level of formal training given to the OTD's counterpart in the DT&E world, the DT project officer. Nearly all Naval Aviation DT project officers are sent through the United States Naval Test Pilot School (USNTPS) or another service equivalent such as the United States Air Force Test Pilot School. The USNTPS curriculum is 48 weeks long, proving instruction in "academics, flight test preparation, flight test conduct, data collection, data reduction, and test report preparation [44]." While the USNTPS and OTD Course curricula do differ significantly in areas of focus, the disparity between a 48-week course for DT project officers and a 3-day course for OTDs clearly shows a disconnect in the value that is being placed on their professional educations. This is especially troubling given the tremendous impact the OT report has on the success or failure of an acquisition program.

The inadequate training of OTDs often forces them to rely on their DT counterparts or development contractors for support in planning and analysis of OT&E. While this can be helpful, the DT testers and development contractors have different objectives and their views are sometime in conflict with OT&E policies. OT&E, by law and policy, must be performed independently from and uninfluenced by development organizations.

3. Selection of Test Facilities

One of the most important decisions made early in the test planning process is selection of the test facilities to be used. For Naval Aviation, this includes the selection of laboratories and engineering centers for component level testing as well as flight test centers and major ranges for system level flight testing. Selection of these test facilities

has a major impact on the cost, schedule, and performance of the test program. As significant as this decision is, the interviews revealed areas of weakness impacting this decision-making process.

a. Knowledge of Test Facility Capabilities

There currently exists no single source for detailed information regarding test facility capabilities. Across each of the services, DoD as a whole, other federal government organizations, and private industry, there exists a wealth of test capability. However without a common source of test capability information, test teams are generally dependent upon the "tribal knowledge" within the team regarding the capabilities of test facilities. As a result, many appropriate facilities, within both the government and private industry are never considered unless the test planning team had prior experience or knowledge of testing at those facilities.

A single searchable repository of test facility capabilities would greatly aid the ability of the test planner to choose the test facility that best meets the technical, schedule, and fiscal requirements of the test program. An example of how such a repository might be used is if a test planner was planning for a test that required the measurement of an aircraft's or aircraft component's radar cross section, he could do a search of the tool for "radar cross section measurement" and find a list of all facilities, both government and private industry that have the capability for radar cross section testing. The proposed tool should list at a minimum a short description of the facility's capabilities in that field along with a point of contact for further information.

Development of such a tool would require participation from test facilities to provide the necessary information and periodic updates. However, the test facility would be motivated to provide this information as it would advertise their capability and promote the use of their facility. The "owner" of this tool could be either at the NAVAIR T&E competency level or at a higher DoN or DoD organization to promote its use throughout these higher levels. At the DoD level, a logical organization to own this tool is the Test Resource Management Center (TRMC) within USD(AT&L).

b. Selection of Contractor vice DoD T&E Facilities

An area of guidance weakness related to test facilities identified by the interviews is the decision to use DoD or contractor test facilities for a test program. Currently, the selection of DoD or contractor test facilities rests solely with the individual program. No guidance currently exists that requires that the impact of test facility selection (DoD or contractor) on DoD as a whole be assessed. For example, while the choice of using the prime contractor's test facility over a DoD operated test facility may be advantageous to an individual program from a cost and schedule perspective, it may have a negative overall impact on DoD.

As the number of new DoD programs continues to decrease, the impact of any individual program choosing not to use DoD test facilities has a greater impact on the health of those facilities. Choosing contractor facilities over government test facilities not only has a direct financial impact, but more importantly has a long-term impact from lost opportunity to sustain/develop DoD-held expertise and experience in core T&E disciplines.

Policy and guidance should be developed to require this assessment be conducted as a part of the test facility selection process. Choosing to use a contractor test facility instead of a government test facility is not inherently bad and in many cases may be the best decision for DoD, however the short-term gains for the individual program must be weighed against the impact to NAVAIR, DoN, and DoD test capabilities as a whole.

4. Traceability of Test Requirements

An identified area of needed improvement by the interview subjects was traceability of test requirements. Adequate traceability of test events to technical requirements is key to a successful T&E program. Test requirements traceability ensures that sufficient test data is generated to allow evaluation of the system's technical requirements. Traceability also serves to justify the scope of a test program, documenting that the right amount of testing is being accomplished, without "gold-

plating" the test requirements or succumbing to the natural engineering perspective of "more data is better." This allows the test team to defend the test program when cost and schedule are "in the cross-hairs" for programmatic cuts.

Within Naval Aviation, traceability of test requirements is currently left up to individual programs to determine the manner in which it is to be done. As a result, traceability of test requirements is done in an *ad hoc* fashion among T&E programs. While larger major acquisition programs often use formal tools such as IBM's DOORS® software, there is no standardized tool or format for requirements traceability.

A prescriptive policy is needed to provide guidance on T&E requirements traceability across Naval Aviation T&E programs. An added benefit is that a standardized policy would also aid the schedule and cost estimating processes discussed earlier by providing input to the T&E estimator regarding test data required, which directly drives schedule and funding required.

5. Developmental Test Reporting Process

The final area that was commonly cited as an area where improvement is necessary was the developmental test reporting process. The purpose of the test report is to provide feedback to the developer with decision-level quality data. The shortcoming commonly noted regarding NAVAIR's test reporting process was not regarding the quality of the report, but the timeliness of the report.

Review of the applicable guidance illustrates a disparity between OT reporting requirements and DT reporting requirements. SECNAVINST 5000.2D requires that,

> COMOPTEVFOR shall issue operational test reports for ACAT I and IA programs within 90 days following completion of testing. All other operational test reports are due within 60 days of test completion. [9]

This guidance is flowed down and repeated in the COMOPTEVFOR OTD Manual [26]. No such timeline guidance is given for developmental test. SECNAVINST 5000.2D only states that,

> A report of results for all DT&E conducted in DoN shall be provided to the appropriate decision authority and to the OTA as needed. [9]

Accordingly, the guidance documents that govern NAVAIR DT&E report writing are silent regarding timelines for issuing test reports following completion of testing [30, 31]. Naturally, this leads to widely disparate results regarding timely report issuance. These disparate results are not only due to widely varied times from end of test to completion of the draft report, but also widely varied times to completion of the test report approval process.

Unfortunately, this often results in the completed reports being delivered to the decision authority after the necessary decisions which the report supports are required to be made. For example, readiness for OT&E cannot be assessed adequately without a DT&E report, thus the OTRR decision is impacted by late delivery of a DT&E report. This forces the decision maker to either delay making decisions or, more likely, make decisions based on informal or incomplete data. The current processes are often failing to deliver decision-level quality data at the time the decision needs to be made. To correct this, policy should be provided to mandate reporting timelines for DT test reports, holding both the report provider and reviewing authorities accountable to deliver test reports in a timely manner.

C. RECOMMENDATIONS

From review and analysis of the interview responses given in the preceding paragraphs, the following recommendations are made:

1. Develop a tool to capture, record, and present historical flight test data to provide the basis for realistic assumptions of flight test efficiency and throughput for developing flight test schedule and budget estimations.
2. Provide formal training on T&E schedule and cost estimation to T&E personnel involved in performing these tasks.

3. Provide additional formal training to OTDs and support personnel to prepare them for the tasks of OT planning, supervision of test execution, and documentation of test results.
4. Develop a tool to provide a single repository of test facility capabilities to aid the selection of test facilities that best meet the technical, fiscal, and schedule requirements of the test program.
5. Develop policy and guidance to assess the impact of choosing contractor vice government test facilities on NAVAIR, DoN, and DoD as a whole to aid the selection of test facilities.
6. Develop policy and guidance to standardize traceability of test requirements across Naval Aviation T&E programs.
7. Develop policy and guidance for DT&E reporting timelines to hold both the report provider and approval authorities accountable for timely delivery of test reports.

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VI. CONCLUSION AND RECOMMENDATIONS

A. CONCLUSIONS

T&E is incorporated throughout both the systems engineering and DoD system acquisition processes. T&E is the mechanism for accomplishing verification in the systems engineering process and characterizing technical risk of achieving a proper final design solution. T&E is a critical and continuous activity throughout the DoD systems acquisition process to ensure that cost, schedule, and performance requirements are satisfied with acceptable levels of risk.

At each stage of the process, T&E confirms whether people, product, and process solutions meet or exceed the user's requirements. During early phases of the DoD acquisition process, T&E activities may take the form of analysis, modeling, simulation, and proof of concept tests for system, subsystem, and component levels. Later stages will focus more on examination, demonstration, and testing to verify the function of the design and validate the produced system meets user requirements.

Guidance for integration of T&E into the systems acquisition process for Naval Aviation flows from Federal law, to DoD, to DoN, to NAVAIR for implementation through NAVAIR policy and guidance. Through analysis of this guidance along with interviews of senior acquisition professionals, the following areas of weakness were discovered regarding integrating T&E into the systems acquisition process:

1. Requirements Development
2. Selection of Concept/System to be Developed
3. SETR Process Participation
4. Development of Test Program Estimates
5. Education of the T&E Workforce
6. Selection of Test Facilities

7. Traceability of Test Requirements
8. Developmental Test Reporting Requirements

B. RECOMMENDATIONS

Through analysis of T&E related guidance and interviews of senior acquisition professionals, the following recommendations are made to address the areas of weakness cited above:

1. Provide guidance and policy to involve the responsible test organizations in the review of requirements documents for testability, mission relevancy, and reasonableness.
2. Revise NAVAIR guidance related to AoA, RFP, and Source Selection, to include participation of the T&E discipline, AIR-5.1.
3. Develop NAVAIR T&E discipline standardized procedures for determining who (by function and authority level) should participate at each SETR event. Flexibility should be provided in this standardized procedure to account for differences in program type, scope, size, and visibility.
4. Develop a tool to capture, record, and present historical flight test data to provide the basis for realistic assumptions of flight test efficiency and throughput for developing flight test schedule and budget estimations.
5. Provide formal training on T&E schedule and cost estimation to T&E personnel involved in performing these tasks.
6. Provide additional formal training to OTDs and support personnel to prepare them for the tasks of OT planning, supervision of test execution, and documentation of test results.
7. Develop a tool to provide a single repository of test facility capabilities to aid the selection of test facilities that best meet the technical, fiscal, and schedule requirements of the test program.

8. Develop policy and guidance to assess the impact of choosing contractor vice government test facilities on NAVAIR, DoN, and DoD as a whole to aid the selection of test facilities.
9. Develop policy and guidance to standardize traceability of test requirements across Naval Aviation T&E programs.
10. Develop policy and guidance for DT&E reporting timelines to hold both the report provider and approval authorities accountable for timely delivery of test reports.

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APPENDIX: INTERVIEW QUESTIONS

The following questions were used to guide each interview:

1. In what capacities have you been involved with T&E during the acquisition process?

2. Do you believe that current policies and guidance do a satisfactory job of integrating T&E into the acquisition process?

3. What areas of weakness do you see in current guidance governing T&E?

4. Are there any areas of T&E guidance that you have seen routinely not followed?

5. What challenges have you experienced integrating T&E into the acquisition process?

6. What improvements can be made to policies, procedures, and guidance to better integrate T&E into the systems acquisition process?

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