TRANSITION

BRIEFING BOOK

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Section I. Organization and Management

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Director, Operational Test & Evaluation
Mission Statement

Mission Statement

The Director, Operational Test and Evaluation will ensure that weapons systems are realistically and adequately tested and will provide complete and accurate evaluations of operational effectiveness, suitability, and survivability/lethality to the Secretary of Defense, other decision makers in the Department of Defense, and Congress. The Director, Operational Test and Evaluation will accomplish this by providing policy, test approval, independent reports, and overseeing and investing in test and evaluation facilities and infrastructure.

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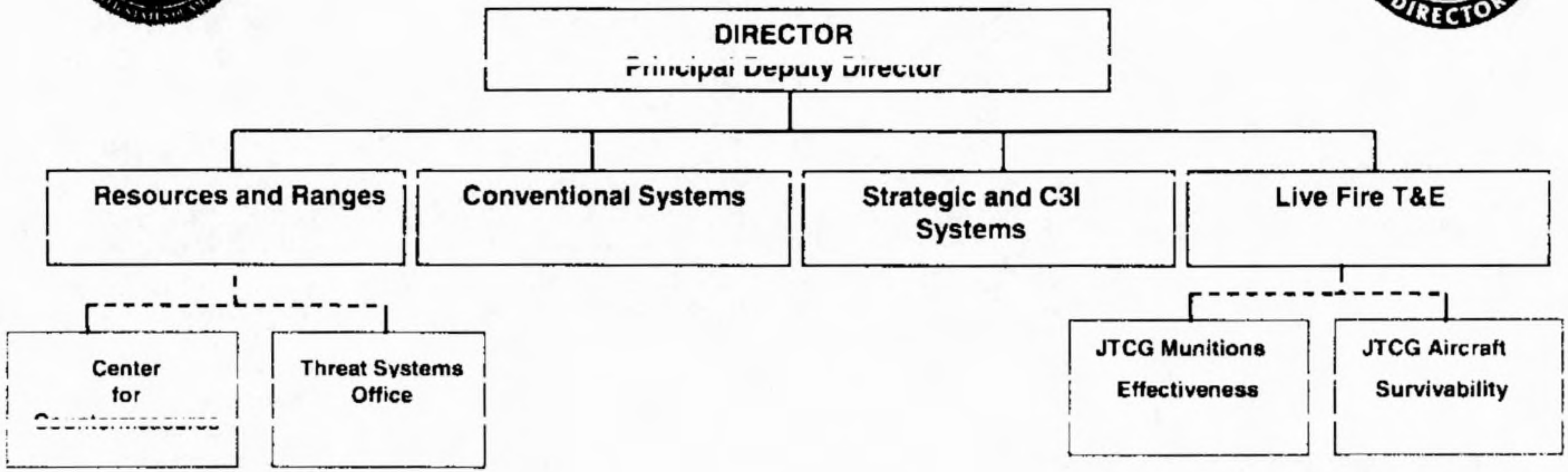

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Director, Operational Test and Evaluation Goals

Director, Operational Test and Evaluation Vision

"WEAPONS THAT WORK" - increased military capability, efficiently integrated into the warfighting force. An effective efficient Department of Defense test and evaluation team, supported by a state-of-the-art infrastructure, that is vital to effective program management, realistic testing, and value-added evaluations.

A Test and Evaluation Strategic Plan is Being Developed

After a decade of downsizing, the Test and Evaluation Executive Agent, comprised of the Service Vice Chiefs and the Director, Operational Test and Evaluation, determined that a more corporate approach to test and evaluation issues is necessary. This approach must consider not only future test and evaluation requirements, as identified by Joint Vision 2020, but also current realities, such as workforce reductions, skill and retention issues, and aging and deteriorating facilities. To respond to these many demands, the Test and Evaluation Executive Agent is developing a corporate Test and Evaluation Strategic Plan.

This Strategic Plan will guide the Military Departments and Defense Agencies in developing their Program Objective Memorandums (POMs) and in examining resource requirements 10 to 15 years beyond the Program Objective Memorandums. The plan will institutionalize a strategic review as part of the test and evaluation investment process and should serve to bridge the gap between today's capabilities and tomorrow's technology. A successful Strategic Plan requires full participation from members of the Test and Evaluation Enterprise. To achieve this end, the Test and Evaluation Executive Agent has initiated a series of meetings and reviews by members of the Executive Agent, test range commanders, operational test agency commanders, members of the acquisition community (including representatives of the Service Acquisition Executives), and representatives of industry.

Members of the Executive Agent developed initial vision and mission statements and drafted goals for the plan. Test range and operational test agency commanders reviewed these items and recommended modifications, which were incorporated into the current draft of the Strategic Plan.

> ***Vision:*** The world's best T&E capabilities for the world's best testers - test and evaluation capabilities to thoroughly and realistically test and evaluate weapons and support systems for the warfighter.

> ***Mission:*** Provide world-class, decision support information to acquisition program managers, decision makers, and warfighters, using the full spectrum research, development, test and evaluation infrastructure, to ensure operationally effective and suitable systems are fielded, while continuing to be responsible stewards of the environment.

The draft Strategic Plan currently includes eight goals. These goals focus on the developmental and operational test workforce, the decision makers, defense planners, infrastructure investments, policies, strategic partnerships, and test environments. The goals will be successfully met through the accomplishment of supporting objectives. These objectives and their implementation action plans are currently being developed.

Goal 1 - An experienced, trained, flexible multi-skilled government civilian, military, and contractor workforce; continuously infused with new talent; to meet the nations T&E needs.

Goal 2 - A new, more complete appreciation of the value of T&E by acquisition decision makers, program managers, program executive officers, operators defense planners, congressional members and staff, and other stakeholders.

Goal 3 - Improved infrastructure management of and better informed investments in test capabilities, facilities, and equipment to: 1) keep pace with advancing weapons technologies and changing operational conditions, and 2) ensure efficient and economical test and evaluation.

Goal 4 - Consistent core T&E standards, policies, practices, and processes for execution of T&E and full cost visibility to support "best value" determination.

Goal 5 - Policies and processes in place to test and evaluate rapidly evolving information technologies of systems ensuring real world interoperability.

Goal 6 - Early OTA involvement as an integral part of acquisition supporting warfighter requirements interpretation, program manager early insights into operational issues and where appropriate, combined T&E.

Goal 7 - Expert management of environmental and encroachment issues associated with T&E activities thus ensuring continued access to critical land, air, sea, and space environments.

Goal 8 - Strategic partnerships with program managers, other governmental agencies, industry, and academia to sustain superior T&E of weapon systems.

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Director, Operational Test and Evaluation Functions

(Documented in Department of Defense Directive 5141.2)

Under the direction of the Secretary of Defense, the Director, Operational Test and Evaluation is the principal staff assistant and advisor to the Secretary and Deputy Secretary of Defense on Operational Test and Evaluation, Live Fire Test and Evaluation, and the Major Range and Test Facility Base in the Department of Defense and the principal Operational Test and Evaluation/Live Fire Test and Evaluation official within the senior management of the Department of Defense. The Director, Operational Test and Evaluation is responsible for the following functional areas:

- Prescribe policies and procedures for the conduct of Operational Test and Evaluation and Live Fire Test and Evaluation, and for the composition and operations of the Major Range and Test Facility Base within the Department of Defense.
- Provide advice and make recommendations to the Secretary and Deputy Secretary of Defense and the Under Secretary of Defense (Acquisition, Technology, and Logistics). Issue guidance to and consult with the heads of the Department of Defense Components with respect to Operational Test and Evaluation, Live Fire Test and Evaluation, and the test and evaluation infrastructure in the Department of Defense in general, and with respect to specific Operational Test and Evaluation and Live Fire Test and Evaluation to be conducted in connection with programs under Director, Operational Test and Evaluation oversight and to specific issues regarding the Major Range and Test Facility Base.
- Designate, as appropriate, selected special interest weapons, equipment, or munitions for Director, Operational Test and Evaluation oversight.
- Monitor and review all Operational Test and Evaluation and Live Fire Test and Evaluation in the Department of Defense, and activities of the Major Range and Test Facility Base, to ensure adherence to approved policies and standards.
- Analyze the results of Operational Test and Evaluation and Live Fire Test and Evaluation conducted on programs under Director, Operational Test and Evaluation Test and Evaluation oversight, and prior to a decision to proceed beyond low-rate initial production, submit reports to the Secretary of Defense, the Under Secretary of Defense (Acquisition, Technology, and Logistics), and the congressional defense committees as follows:
  - For Operational Test and Evaluation, report the adequacy of the test and evaluation performed and whether the results confirm the operational effectiveness and operational suitability for combat of the items or components actually tested.
  - For Live Fire Test and Evaluation, report the results of the testing and an overall assessment.

- Report annually to the Secretary of Defense, the Under Secretary of Defense (Acquisition, Technology, and Logistics), and Congress summarizing the Operational Test and Evaluation and Live Fire Test and Evaluation activities and the condition of the test and evaluation infrastructure and resources of the Department of Defense during the preceding fiscal year. The report shall include comments and recommendations on resources and facilities available for test and evaluation and levels of funding made available for Operational Test and Evaluation and Live Fire Test and Evaluation activities.

- Provide evaluation reports as requested by the Secretary of Defense or the Under Secretary of Defense (Acquisition, Technology, and Logistics) in support of system acquisition reviews and the Defense Acquisition Executive Summary preparation.

- Ascertain the status of interoperability of information technology and national security systems by assisting the Commanders in Chief and Components planning exercises, experiments, and training activities which will verify proposed solutions to identified shortfalls.

- Co-oversee Joint Test and Evaluation projects and co-charter and jointly approve Joint Test and Evaluation test plans with the Under Secretary of Defense (Acquisition, Technology, and Logistics) to obtain information pertinent to joint operational doctrine, tactics, and procedures and to ensure an operational test focus.

- Manage the Joint Live Fire program to obtain information pertinent to improving system design, operational doctrine, tactics, and procedures relative to survivability and lethality

- Oversee and direct the activities of the Central Test and Evaluation Investment Program, the Joint Technical Coordinating Groups on Aircraft Survivability and for Munitions Effectiveness, Department of Defense Threat Systems Office, the Precision Guided Weapons Countermeasures Test and Evaluation Directorate, and the Defense Test and Evaluation Professional Institute.

- Establish Department of Defense-wide investment strategies, business processes, and policies for improving the realism, responsiveness, and productivity of the test and evaluation infrastructure. Review Department of Defense component budget submissions to determine the adequacy of Operational Test and Evaluation and Live Fire Test and Evaluation funding, and the adequacy of funding, for all test investments, and recapitalization of ranges and facilities and other resources used for test and evaluation.

- Promote coordination, cooperation, and mutual understanding within the Department of Defense and between the Department of Defense and other federal agencies, state, local, and foreign governments and the civilian community with regard to test and evaluation matters.

B

Section I. Organization and Management

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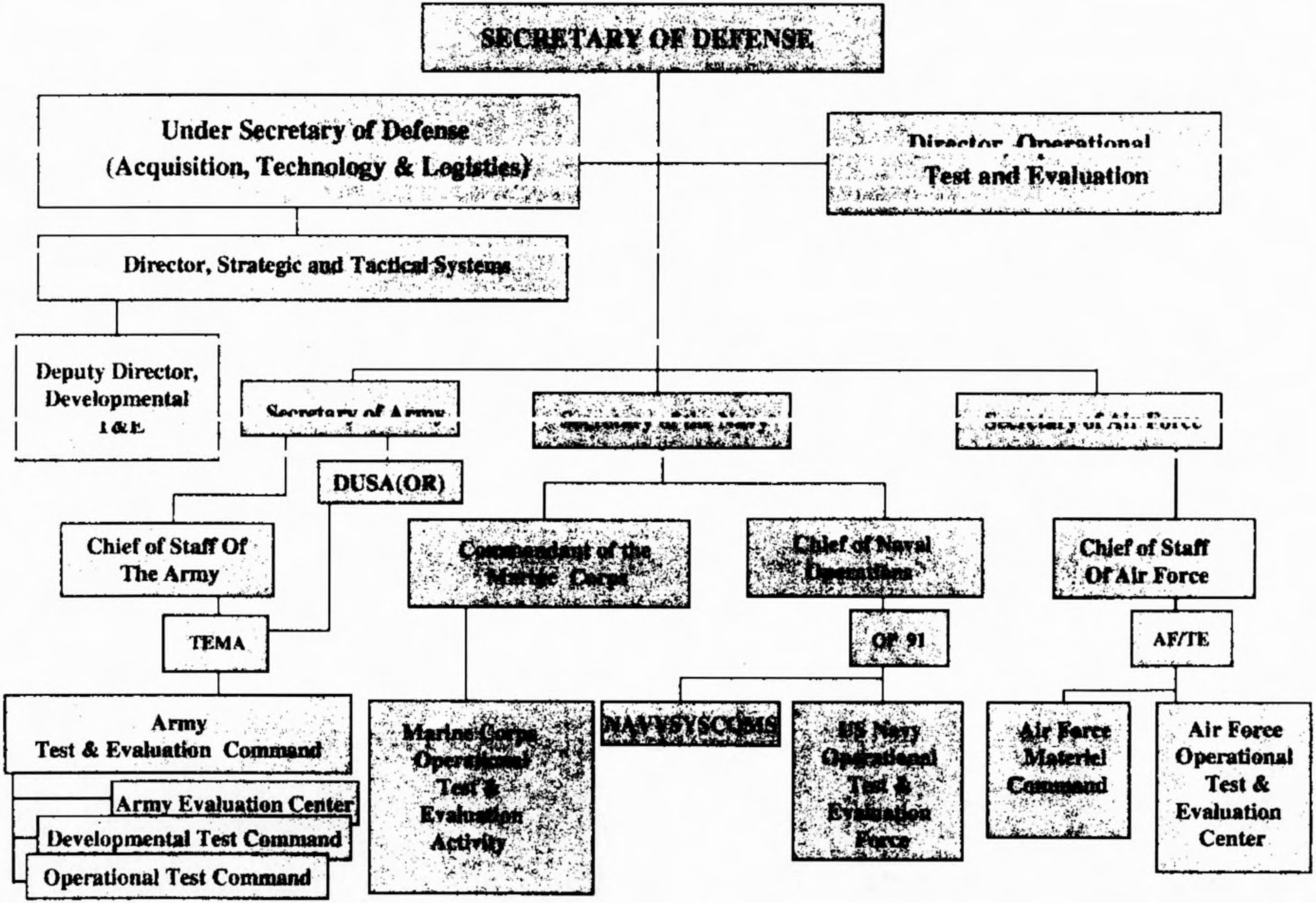
Test & Evaluation Chain of Command



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Regulatory Authority

The Director, Operational Test and Evaluation derives his regulatory authority from five sources.

1. Title 10, United States Code, Sections 139, 2366, 2399 and 2400 provides for the establishment of the Office of the Director, Operational Test and Evaluation, outlines the authority of the office, and establishes governing direction.

2. Department of Defense Acquisition Regulations commonly referred to as the Department of Defense 5000 series Directives. The 5000 series Directives are comprised of three documents:

   a. Department of Defense Directive 5000.1 "The Defense Acquisition System," signed by the Deputy Secretary of Defense on October 23, 2000, describes management principles applicable to all Department of Defense acquisition programs. It stresses interoperability, time-phased requirements and evolutionary acquisition, use of commercial products and integrated test and evaluation.

   b. Department of Defense Instruction 5000.2 "Operation of the Defense Acquisition System," signed by the Under Secretary of Defense (Acquisition, Technology and Logistics), the Assistant Secretary of Defense (Command, Control, Communications and Intelligence) and the Director, Operational Test and Evaluation on October 23, 2000, establishes a general approach for managing acquisition programs while acknowledging that every technology project and acquisition program is unique and that any particular project or program, particularly non-major programs, need not follow the entire process.

   c. Department of Defense Regulation 5000.2-R, to be signed by the same three parties as the Instruction in early January 2001, puts forth mandatory procedures and formats for major defense acquisition programs.

3. Department of Defense Directive 5141.2, "Director of Operational Test and Evaluation," which was signed by the Deputy Under Secretary of Defense on May 25, 2000. This Directive was recently reissued to update the responsibilities, functions, relationships, and authorities of the Director, Operational Test and Evaluation.

4. Department of Defense Directive 3200.11, "Major Range and Test Facility Base," has been updated, coordinated, and is currently awaiting signature by the Deputy Secretary of Defense. This Directive was updated to reflect changes in oversight authority.

5. Department of Defense Directive 5129.47, "Center for Countermeasures," has been updated, coordinated, and is currently awaiting signature by the Deputy Secretary of Defense. This Directive was updated to reflect changes in oversight authority.

A copy of or a summary of relevant information from each of the above items can be found in the following subordinate tabs.

A

Statutory Language

[NOTE: All the following sections are from Title 10, U.S. Code (10 USC)]

SEC. 139. DIRECTOR OF OPERATIONAL TEST AND EVALUATION

(a)(1) There is a Director of Operational Test and Evaluation in the Department of Defense, appointed from civilian life by the President, by and with the advice and consent of the Senate. The Director shall be appointed without regard to political affiliation and solely on the basis of fitness to perform the duties of the office of Director. The Director may be removed from office by the President. The President shall communicate the reasons for any such removal to both Houses of Congress.

(2) In this section:

(A) The term "operational test and evaluation" means--

(i) the field test, under realistic combat conditions, of any item of (or key component of) weapons, equipment, or munitions for the purpose of determining the effectiveness and suitability of the weapons, equipment, or munitions for use in combat by typical military users; and (ii) the evaluation of the results of such test.

(B) The term "major defense acquisition program" means a Department of Defense acquisition program that is a major defense acquisition program for purposes of section 2430 of this title or that is designated as such a program by the Director for purposes of this section.

(b) The Director is the principal adviser to the Secretary of Defense and the Under Secretary of Defense for Acquisition, Technology, and Logistics on operational test and evaluation in the Department of Defense and the principal operational test and evaluation official within the senior management of the Department of Defense. The Director shall--

(1) prescribe, by authority of the Secretary of Defense, policies and procedures for the conduct of operational test and evaluation in the Department of Defense;

(2) provide guidance to and consult with the Secretary of Defense and the Under Secretary of Defense for Acquisition, Technology, and Logistics and the Secretaries of the military departments with respect to operational test and evaluation in the Department of Defense in general and with respect to specific operational test and evaluation to be conducted in connection with a major defense acquisition program

(3) monitor and review all operational test and evaluation in the Department of Defense;

(4) coordinate operational testing conducted jointly by more than one military department or defense agency;

(5) review and make recommendations to the Secretary of Defense on all budgetary and financial matters relating to operational test and evaluation, including operational test facilities and equipment, in the Department of Defense; and

(6) monitor and review the live fire testing activities of the Department of Defense provided for under section 2366 of this title.

(c) The Director may communicate views on matters within the responsibility of the Director directly to the Secretary of Defense and the Deputy Secretary of Defense without obtaining the approval or concurrence of any other official within the Department of Defense. The Director shall consult closely with, but the Director and the Director's staff are independent of, the Under Secretary of Defense for Acquisition, Technology, and Logistics and all other officers and entities of the Department of Defense responsible for acquisition.

(d) The Director may not be assigned any responsibility for developmental test and evaluation, other than the provision of advice to officials responsible for such testing.

(e)(1) The Secretary of a military department shall report promptly to the Director the results of all operational test and evaluation conducted by the military department and of all studies conducted by the military department in connection with operational test and evaluation in the military department.

(2) The Director may require that such observers as he designates be present during the preparation for and the conduct of the test part of any operational test and evaluation conducted in the Department of Defense.

(3) The Director shall have access to all records and data in the Department of Defense (including the records and data of each military department) that the Director considers necessary to review in order to carry out his duties under this section.

(f) The Director shall prepare an annual report summarizing the operational test and evaluation activities (including live fire testing activities) of the Department of Defense during the preceding fiscal year. Each such report shall be submitted concurrently to the Secretary of Defense, the Under Secretary of Defense for Acquisition, Technology, and Logistics, and the Congress not later than 10 days after the transmission of the budget for the next fiscal year under section 1105 of title 31. If the Director submits the report to Congress in a classified form, the Director shall concurrently submit an unclassified version of the report to Congress. The report shall include such comments and recommendations as the Director considers appropriate, including comments and recommendations on resources and facilities available for operational test and evaluation and levels of funding made available for operational test and evaluation activities. The Secretary may comment on any report of the Director to Congress under this subsection.

(g) The Director shall comply with requests from Congress (or any committee of either House of Congress) for information relating to operational test and evaluation in the Department of Defense.

(h) The President shall include in the Budget transmitted to Congress pursuant to section 1105 of title 31 for each fiscal year a separate statement of estimated expenditures and proposed appropriations for that fiscal year for the activities of the Director of Operational Test and Evaluation in carrying out the duties and responsibilities of the Director under this section.

(i) The Director shall have sufficient professional staff of military and civilian personnel to enable the Director to carry out the duties and responsibilities of the Director prescribed by law.

SEC. 2366. MAJOR SYSTEMS AND MUNITIONS PROGRAMS: SURVIVABILITY TESTING AND LETHALITY TESTING REQUIRED BEFORE FULL-SCALE PRODUCTION

(a) Requirements.--(1) The Secretary of Defense shall provide that--

(A) a covered system may not proceed beyond low-rate initial production until realistic survivability testing of the system is completed in accordance with this section and the report required by subsection (d) with respect to that testing is submitted in accordance with that subsection; and

(B) a major munition program or a missile program may not proceed beyond low-rate initial production until realistic lethality testing of the program is completed in accordance with this section and the report required by subsection (d) with respect to that testing is submitted in accordance with that subsection.

(2) The Secretary of Defense shall provide that a covered product improvement program may not proceed beyond low-rate initial production until--

(A) in the case of a product improvement to a covered system, realistic survivability testing is completed in accordance with this section; and

(B) in the case of a product improvement to a major munitions program or a missile program, realistic lethality testing is completed in accordance with this section.

(b) Test Guidelines.--(1) Survivability and lethality tests required under subsection (a) shall be carried out sufficiently early in the development phase of the system or program (including a covered product improvement program) to allow any design deficiency demonstrated by the testing to be corrected in the design of the system, munition, or missile (or in the product modification or upgrade to the system, munition, or missile) before proceeding beyond low-rate initial production.

(2) The costs of all tests required under that subsection shall be paid from funds available for the system being tested.

(c) Waiver Authority.--(1) The Secretary of Defense may waive the application of the survivability and lethality tests of this section to a covered system, munitions program, missile program, or covered product improvement program if the Secretary, before the system or program enters engineering and manufacturing development, certifies to Congress that live-fire testing of such system or program would be unreasonably expensive and impractical.

(2) In the case of a covered system (or covered product improvement program for a covered system), the Secretary may waive the application of the survivability and lethality tests of this section to such system or program and instead allow testing of the system or program in combat by firing munitions likely to be encountered in combat at components, subsystems, and subassemblies, together with performing design analyses, modeling and simulation, and analysis of combat data. Such alternative testing may not be carried out in the case of any covered system (or covered product improvement program for a covered system) unless the Secretary certifies to Congress, before the system or program enters engineering and manufacturing development, that the survivability and lethality testing of such system or program otherwise required by this section would be unreasonably expensive and impracticable.

(3) The Secretary shall include with any certification under paragraph (1) or (2) a report explaining how the Secretary plans to evaluate the survivability or the lethality of the system or program and assessing possible alternatives to realistic survivability testing of the system or program.

(4) In time of war or mobilization, the President may suspend the operation of any provision of this section.

(d) Reporting to Congress.--At the conclusion of survivability or lethality testing under subsection (a), the Secretary of Defense shall submit a report on the testing to the congressional defense committees Each such report shall describe the results of the survivability or lethality testing and shall give the Secretary's overall assessment of the testing.

(e) Definitions.--In this section

(1) The term "covered system" means a vehicle, weapon platform, or conventional weapon system--

(A) that includes features designed to provide some degree of protection to users in combat; and

(B) that is a major system within the meaning of that term in section 2302(5) of this title.

(2) The term "major munitions program" means--

(A) a munition program for which more than 1,000,000 rounds are planned to be acquired; or

(B) a conventional munitions program that is a major system within the meaning of that term in section 2302(5) of this title.

(3) The term "realistic survivability testing" means, in the case of a covered system (or a covered product improvement program for a covered system), testing for vulnerability of the system in combat by firing munitions likely to be encountered in combat (or munitions with a capability similar to such munitions) at the system configured for combat, with the primary emphasis on testing vulnerability with respect to potential user casualties and taking into equal consideration the susceptibility to attack and combat performance of the system.

(4) The term "realistic lethality testing" means, in the case of a major munitions program or a missile program (or a covered product improvement program for such a program), testing for lethality by firing the munition or missile concerned at appropriate targets configured for combat.

(5) The term "configured for combat," with respect to a weapon system, platform, or vehicle, means loaded or equipped with all dangerous materials (including all flammables and explosives) that would normally be on board in combat.

(6) The term "covered product improvement program" means a program under which--

(A) a modification or upgrade will be made to a covered system which (as determined by the Secretary of Defense) is likely to affect significantly the survivability of such system; or

(B) a modification or upgrade will be made to a major munitions program or a missile program which (as determined by the Secretary of Defense) is likely to affect significantly the lethality of the munition or missile produced under the program.

(7) The term "congressional defense committees" means--

(A) the Committee on Armed Services and the Committee on Appropriations of the Senate; and

(B) the Committee on Armed Services and the Committee on Appropriations of the House of Representatives.

SEC. 2399. OPERATIONAL TEST AND EVALUATION OF DEFENSE ACQUISITION PROGRAMS

(a) Condition for Proceeding Beyond Low-Rate Initial Production.-- (1) The Secretary of Defense shall provide that a major defense acquisition program may not proceed beyond low-rate initial production until initial operational test and evaluation of the program is completed.

(2) In this subsection the term "major defense acquisition program" means--

(A) a conventional weapons system that is a major system within the meaning of that term in section 2302(5) of this title; and

(B) is designed for use in combat.

(b) Operational Test and Evaluation.--(1) Operational testing of a major defense acquisition program may not be conducted until the Director of Operational Test and Evaluation of the Department of Defense approves (in writing) the adequacy of the plans (including the projected level of funding) for operational test and evaluation to be conducted in connection with that program.

(2) The Director shall analyze the results of the operational test and evaluation conducted for each major defense acquisition program. At the conclusion of such testing, the Director shall prepare a report stating the opinion of the Director as to--

(A) whether the test and evaluation performed were adequate; and

(B) whether the results of such test and evaluation confirm that the items or components actually tested are effective and suitable for combat.

(3) The Director shall submit each report under paragraph (2) to the Secretary of Defense, the Under Secretary of Defense for Acquisition, Technology, and Logistics, and the congressional defense committees. Each such report shall be submitted to those committees in precisely the same form and with precisely the same content as the report originally was submitted to the Secretary and Under Secretary and shall be accompanied by such comments as the Secretary may wish to make on the report.

(4) A final decision within the Department of Defense to proceed with a major defense acquisition program beyond low-rate initial production may not be made until the Director has

submitted to the Secretary of Defense the report with respect to that program under paragraph (2) and the congressional defense committees have received that report.

(5) In this subsection the term "major defense acquisition program" has the meaning given that term in section 139(a)(2)(B) of this title.

(c) Determination of Quantity of Articles Required for Operational Testing.--The quantity of articles of a new system that are to be procured for operational testing shall be determined by--(1) the Director of Operational Test and Evaluation of the Department of Defense, in the case of a new system that is a major defense acquisition program (as defined in section 139(a)(2)(B) of this title); or

(2) the operational test and evaluation agency of the military department concerned, in the case of a new system that is not a major defense acquisition program.

(d) Impartiality of Contractor Testing Personnel.--In the case of a major defense acquisition program (as defined in subsection (a)(2)), no person employed by the contractor for the system being tested may be involved in the conduct of the operational test and evaluation required under subsection (a). The limitation in the preceding sentence does not apply to the extent that the Secretary of Defense plans for persons employed by that contractor to be involved in the operation, maintenance, and support of the system being tested when the system is deployed in combat.

(e) Impartial Contracted Advisory and Assistance Services.--(1) The Director may not contract with any person for advisory and assistance services with regard to the test and evaluation of a system if that person participated in (or is participating in) the development, production, or testing of such system for a military department or Defense Agency (or for another contractor of the Department of Defense).

(2) The Director may waive the limitation under paragraph (1) in any case if the Director determines in writing that sufficient steps have been taken to ensure the impartiality of the contractor in providing the services. The Inspector General of the Department of Defense shall review each such waiver and shall include in the Inspector General's semi-annual report an assessment of those waivers made since the last such report.

(3)(A) A contractor that has participated in (or is participating in) the development, production, or testing of a system for a military department or Defense Agency (or for another contractor of the Department of Defense) may not be involved (in any way) in the establishment of criteria for data collection, performance assessment, or evaluation activities for the operational test and evaluation.

(B) The limitation in subparagraph (A) does not apply to a contractor that has participated in such development, production, or testing solely in testing for the Federal Government.

(f) Source of Funds for Testing.--The costs for all tests required under subsection (a) shall be paid from funds available for the system being tested.

(g) Director's Annual Report.-- As part of the annual report of the Director under section 139 of this title, the Director shall describe for each program covered in the report the status of test and evaluation activities in comparison with the test and evaluation master plan for that program, as approved by the Director. The Director shall include in such annual report a description of each waiver granted under subsection (e)(2) since the last such report.

(h) Definitions.--In this section

(1) The term "operational test and evaluation" has the meaning given that term in section 139(a)(2)(A) of this title. For purposes of subsection (a), that term does not include an operational assessment based exclusively on--

(A) computer modeling;

(B) simulation; or

(C) an analysis of system requirements, engineering proposals, design specifications, or any other information contained in program documents.

(2) The term "congressional defense committees" means--

(A) the Committee on Armed Services and the Committee on Appropriations of the Senate; and

(B) the Committee on Armed Services and the Committee on Appropriations of the House of Representatives.

SEC. 2400. LOW-RATE INITIAL PRODUCTION OF NEW SYSTEMS

(a) Determination of Quantities To Be Procured for Low-Rate Initial Production.--(1) In the course of the development of a major system, the determination of what quantity of articles of that system should be procured for low-rate initial production (including the quantity to be procured for preproduction verification articles) shall be made--

(A) when the milestone II decision with respect to that system is made; and

(B) by the official of the Department of Defense who makes that decision.

(2) In this section, the term "milestone II decision" means the decision to approve the engineering and manufacturing development of a major system by the official of the Department of Defense designated to have the authority to make that decision.

(3) Any increase from a quantity determined under paragraph (1) may only be made with the approval of the official making the determination.

(4) The quantity of articles of a major system that may be procured for low-rate initial production may not be less than one operationally configured production unit unless another quantity is established at the milestone II decision.

(5) The Secretary of Defense shall include a statement of the quantity determined under paragraph (1) in the first SAR submitted with respect to the program concerned after that quantity is determined. If the quantity exceeds 10 percent of the total number of articles to be produced, as determined at the milestone II decision with respect to that system, the Secretary shall include in the statement the reasons for such quantity. For purposes of this paragraph, the term "SAR" means a Selected Acquisition Report submitted under section 2432 of this title.

(b) Low-Rate Initial Production of Weapon Systems.--Except as provided in subsection (c), low-rate initial production with respect to a new system is production of the system in the minimum quantity necessary--

(1) to provide production-configured or representative articles for operational tests pursuant to section 2399 of this title;

(2) to establish an initial production base for the system; and

(3) to permit an orderly increase in the production rate for the system sufficient to lead to full-rate production upon the successful completion of operational testing.

(c) Low-Rate Initial Production of Naval Vessel and Satellite Programs.--With respect to naval vessel programs and military satellite programs, low-rate initial production is production of items at the minimum quantity and rate that (1) preserves the mobilization production base for that system, and (2) is feasible, as determined pursuant to regulations prescribed by the Secretary of Defense.

B

Summary of Defense Acquisition Regulation Test and Evaluation Provisions

Overview

The 5000 series defense acquisition regulations is comprised of three documents:

1. Department of Defense Directive 5000.1 "The Defense Acquisition System," signed by Deputy Secretary of Defense on October 23, 2000, describes management principles applicable to all DoD acquisition programs. It stresses interoperability, time-phased requirements and evolutionary acquisition use of commercial products and integrated test and evaluation.
2. Department of Defense Instruction 5000.2 "Operation of the Defense Acquisition System," signed by Under Secretary of Defense (Acquisition, Technology and Logistics), Assistant Secretary of Defense (Command, Control, Communications and Intelligence) and Director Operational Test and Evaluation on October 23, 2000, establishes a general approach for managing acquisition programs while acknowledging that every technology project and acquisition program is unique and that any particular project or program, particularly non-major programs, need not follow the entire process.
3. Department of Defense Regulation 5000.2-R, to be signed by the same three parties as the Instruction in early January 2001, puts forth mandatory procedures and formats for major defense acquisition programs.

Test and Evaluation Provisions

The hierarchy of these documents reinforces five major Secretary of Defense themes for test and evaluation:

1. Early operational assessment by the Director, Operational Test and Evaluation and the Operational Test Agency in the "Test and Evaluation Continuum" as part of an *integrated test team*, responsible for planning, programming, budgeting, and executing an efficient integrated test and evaluation program that supports program decisions.
2. Combined development test/operational test throughout the system development and demonstration phases, followed by the independent initial operational test and evaluation required by law.
3. Sufficiently early emphasis on the vulnerability analysis and testing of components, subsystems, and whole systems to permit correction of vulnerability deficiencies.
4. Within each program, establishment of a mechanism to feed back continuous test and evaluation results on a near-real-time basis to the designers/developers.
5. Early commitment by programs and testers to development and accreditation of appropriate modeling and simulation tools.

Director, Operational Test and Evaluation Responsibilities:

The Director, Operational Test and Evaluation exercises the statutory authorities of Title 10 through the 5000 series documents. Procedures for test planning, execution, and reporting are contained in Department of Defense Regulation 5000.2-R. Director, Operational Test and Evaluation staff are members of the Defense Acquisition Policy Working Group (DAPWG) and Steering Group (DAPSG), which manage changes to the 5000 series documents.

Department of Defense

DIRECTIVE

NUMBER 5000.1

October 23, 2000

USD(AT&L)

SUBJECT: The Defense Acquisition System

References: (a) DoD Directive 5000.1, "Defense Acquisition," March 15, 1996 (hereby canceled)
(b) DoD Instruction 5000.2, "Operation of the Defense Acquisition System," October 23, 2000
(c) DoD 5000.2-R, "Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) Acquisition Programs," March 15, 1996 (hereby canceled)
(d) Under Secretary of Defense (Acquisition, Technology and Logistics), Assistant Secretary of Defense (Command, Control, Communications, and Intelligence), and Director, Operational Test and Evaluation Memorandum, "Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) Acquisition Programs," October 23, 2000
(e) through (h), see enclosure 1

1. PURPOSE

This Directive

1.1. Reissues reference (a).

1.2. Reauthorizes publication of reference (b).

1.3. Cancels reference (c).

1.4. Provides policies and principles for all Department of Defense (DoD) acquisition programs.

1.5. Describes management principles applicable to all DoD acquisition programs. Reference (b) describes a simple and flexible approach for managing all acquisition programs. Reference (d) describes operating procedures that are mandatory only for major defense acquisition programs and major automated information systems, and for other programs as defined specifically in reference (d). The Chairman of the Joint Chiefs of Staff Instruction 3170.01A (reference (e)) establishes policies and procedures for the DoD requirements generation system.

1.6. This Directive and references (b) and (d) provide mandatory policies and procedures for the management of acquisition programs, except when statutory requirements override. If there is any conflicting guidance pertaining to contracting, the Federal Acquisition Regulation (FAR) (reference (f)) and/or the Defense FAR (DFAR) Supplement (reference (g)) shall take precedence.

2. APPLICABILITY

2.1. This Directive applies to the Office of the Secretary of Defense, the Military Departments, the Chairman of the Joint Chiefs of Staff, the Combatant Commands, Office of the Inspector General of the Department of Defense, the Defense Agencies, DoD Field Activities, and all organizational entities within the Department of Defense (hereafter collectively referred to as "the DoD Components").

2.2. The policies in this Directive are applicable to all on-going acquisition programs regardless of their stage of development.

3. DEFINITIONS

Terms used in this Directive are defined in enclosure 2.

4. POLICY

The following policies and principles govern the operation of the Defense Acquisition System, and are divided into five major categories.

4.1. Achieving Interoperability

4.1.1 Interoperability is the ability of systems, units, or forces to provide data, information, materiel, and services to and accept the same from other systems, units, or forces, and to use the data, information, materiel, and services so exchanged to enable them to operate effectively together. Interoperability within and among United States forces and U.S. coalition partners is a key goal that must be satisfactorily addressed for all Defense systems so that the Department of Defense has the ability to conduct joint and combined operations successfully. The use of standardized data shall be considered to facilitate interoperability and information sharing. The Department of Defense must have a framework for assessing the interrelationships among and interactions between U.S., Allied, and coalition systems. Mission area focused, integrated architectures shall be used to characterize these interrelationships. This end-to-end approach focuses on mission outcomes and provides further understanding of the full range of interoperability issues attendant to decisions regarding a single program or system.

4.1.2 The Defense Acquisition System shall emphasize acquisition judgment based on consideration of a relevant family-of-systems, including those that cross Component organizational boundaries. To that end, the requirements community shall specify key performance parameters and the acquisition and test and evaluation communities shall adopt a family-of-systems management approach to ensure that their reviews of individual systems include a thorough understanding of critical system interfaces related to the system under review and the flow of consistent and reliable data, information, and services among systems in the battlefield. The objective is an environment characterized by mutual understanding of key systems in a given mission area; shared decision making and close cooperation between the requirements, test and evaluation, and acquisition communities; and disciplined control over the development and introduction of acceptable interoperable systems.

4.2. Rapid and Effective Transition From Science and Technology to Products

4.2.1 The fundamental role of the DoD Science and Technology (S&T) program is to enable a technologically superior military force. The S&T program shall address user needs; maintain a broad-based program spanning all Defense-relevant sciences and technologies to anticipate future needs and those not being pursued by civil or commercial communities; preserve long-range research; and enable rapid transition from the S&T base to useful military products. S&T projects shall focus on increasing the effectiveness of a capability while decreasing cost, increasing operational life, and incrementally improving products through planned upgrades. S&T executives shall encourage the use of initiatives, such as advanced technology demonstrations, designed to accelerate the transition from the S&T base to useful military products. Basic and applied research are the foundation for equipping tomorrow's user. To protect and ensure the success of the warfighter on the battlefield, the protection of dual-use and leading-edge military technologies begins during research and development in the laboratories (whether Government or commercial) and extends through the acquisition life cycle. Thus it is imperative to maintain a strong technology base investment to develop options for the long term, beyond the threats, scenarios, and budgets that today's analysts can currently predict.

4.2.2. Time-Phased Requirements and Communications with Users. Validated time-phased requirements generation is an evolutionary approach to specifying operational requirements in an incremental manner over time matched with projected threat assessments and available technology. Time-phased requirements are essential to evolutionary acquisition strategies and are strongly encouraged as a preferred approach to establishing and documenting operational needs. The Defense acquisition and requirements communities shall maintain continuous and effective communications with each other and with the operational user. The objective is to gain a sound understanding of the users' needs and to work with them to achieve a proper balance among cost, schedule, and performance considerations.

4.2.3. Use of Commercial Products, Services, and Technologies. In response to user requirements, priority consideration shall always be given to the most cost-effective solution over the system's life cycle. In general, decision-makers, users, and program managers shall first consider the procurement of commercially available products, services, and technologies, or the development of dual-use technologies, to satisfy user requirements, and shall work together to modify requirements, whenever feasible, to facilitate such procurements. Market research and analysis shall be conducted to determine the availability, suitability, operational supportability, interoperability, and ease of integration of existing commercial technologies and products and of non-developmental items prior to the commencement of a development effort.

4.2.4. Performance-Based Acquisition. In order to maximize competition, innovation, and interoperability, and to enable greater flexibility in capitalizing on commercial technologies to reduce costs, performance-based strategies for the acquisition of products and services shall be considered and used whenever practical. For products, this includes all new procurements and major modifications and upgrades, as well as the reprocurement of systems, subsystems, and spares that are procured beyond the initial production contract award. When using performance-based strategies, contractual requirements shall be stated in performance terms, limiting the use of military specifications and standards to Government-unique requirements only. Configuration management decisions shall be based on factors that best support implementation of performance-based strategies throughout the product life cycle.

4.3. Rapid and Effective Transition from Acquisition To Deployment and Fielding

4.3.1 Evolutionary Acquisition. To ensure that the Defense Acquisition System provides useful military capability to the operational user as rapidly as possible, evolutionary acquisition strategies shall be the preferred approach to satisfying operational needs. Evolutionary acquisition strategies define, develop, and produce/deploy an initial militarily useful capability ("Block I") based on proven technology, time-phased requirements, projected threat assessments, and demonstrated manufacturing capabilities, and plan for subsequent development and production/deployment of increments beyond the initial capability over time (Blocks II, III, and beyond). The scope, performance capabilities, and timing of subsequent increments shall be based on continuous communications between the requirements, acquisition, intelligence, and budget communities. In planning evolutionary acquisition strategies, program managers shall strike an appropriate balance among key factors, including the urgency of the operational requirement; the maturity of critical technologies; and the interoperability, supportability, and affordability of alternative acquisition solutions. To facilitate evolutionary acquisition, program managers shall use appropriate enabling tools, including a modular open systems approach to ensure access to the latest technologies and products, and facilitate affordable and supportable modernization of fielded assets. Sustainment strategies must evolve and be refined throughout the life cycle, particularly during development of subsequent blocks in an evolutionary strategy.

4.3.2 Integrated Test and Evaluation. Test and evaluation is the principal tool with which progress in system development is measured. The complexity of modern weapon systems demands that test and evaluation programs be integrated throughout the defense acquisition process. Test and evaluation shall be structured to support the defense acquisition process and the user by providing essential information to decision-makers, assessing attainment of technical performance parameters, and determining whether systems are operationally effective, suitable, and survivable for intended use. Test and evaluation is conducted to facilitate learning, assess technical maturity and interoperability, facilitate integration into fielded forces, and confirm performance. Test and evaluation shall be closely integrated with requirements definition, threat projections, systems design, and development, and shall support the user through assessments of a system's contributions to mission capabilities. Test and evaluation planning shall begin early in the acquisition process. To the greatest extent possible, the DoD Components shall gather test data to identify the total cost of ownership, and at a minimum, the major drivers of life-cycle costs. Each Military Department shall establish an independent operational test and evaluation agency, reporting directly to the Service Chief, to plan and conduct operational tests, report results, and provide evaluations of effectiveness and suitability.

4.3.3. Competition. Competition is critical for providing innovation, product quality, and affordability. All DoD Components shall acquire systems, subsystems, equipment, supplies and services in accordance with the statutory requirements for competition. Competition provides major incentives to industry and Government organizations to reduce cost and increase quality. The Department must take all necessary actions to promote a competitive environment, including examination of alternative systems to meet stated mission needs; structuring Science and Technology investments and acquisition strategies to ensure the availability of competitive suppliers throughout a program's life and for future programs; ensuring that prime contractors foster effective competition for major and critical products and technologies; and ensuring qualified international sources are permitted to compete. Acquisition, technology, and logistics decisions shall be made with full consideration of their impacts on a competitive industrial base, including not only the prime contractor level but also the subcontractor level.

4.3.4. Departmental Commitment to Production. Milestone decision authorities shall not commit the Department to the initiation of low-rate initial production (or any production in the case of systems where low-rate initial production is not required) of an acquisition program unless and until certain fundamental criteria have been considered and evaluated. These criteria include, but are not necessarily limited to, demonstrated technology maturity; well-defined and understood user requirements that respond to identified threats; acceptable interoperability, affordability, and supportability; and a strong plan for rapid acquisition using evolutionary approaches as the preferred strategy, open systems designs, and effective competition.

4.4. Integrated and Effective Operational Support

4.4.1. Total Systems Approach. Acquisition programs shall be managed to optimize total system performance and minimize total ownership costs by addressing both the equipment and the human part of the total system equation, through application of systems engineering. Program managers shall give full consideration to all aspects of system support, including logistics planning; manpower, personnel, and training; human, environmental, safety, occupational health, accessibility, survivability, and security factors; and spectrum management and the operational electromagnetic environment.

4.4.2. Logistics Transformation. Logistics transformation is fundamental to acquisition reform. Decision-makers shall take all appropriate enabling actions to integrate acquisition and logistics to ensure a superior product support process. The Department shall strive for an integrated acquisition and logistics process characterized by constant focus on total cost of ownership; supportability as a key design and performance factor; logistics emphasis in the systems engineering process; and that meets the challenges of rapidly evolving logistics systems supporting joint operational forces.

4.4.3. Logistics transformation shall be accomplished through:

4.4.3.1. Streamlined logistics infrastructure requirements.

4.4.3.2. Reduced logistics response cycle times.

4.4.3.3. Weapon system supply chains integrated with the Department of Defense and commercial logistics systems and focused on customer service and system readiness.

4.4.3.4. Use of competitive sourcing to select best-value providers from Government, industry, or public-private partnerships.

4.4.3.5. A support environment that maintains long-term competitive pressures; continuous improvement of weapon system reliability, maintainability, and supportability through technology refreshment and other means; and effective integration of weapon system-focused support to provide total mission logistics and optimum support to the user. Acquisition program managers shall focus on logistics considerations early in the design process to ensure that they deliver reliable systems that can be cost-effectively supported and provide users with the necessary support infrastructure to meet peacetime and wartime readiness requirements.

4.5. Effective Management

4.5.1. Tailoring. There is no one best way to structure an acquisition program so that it accomplishes the objectives of the Defense Acquisition System. Decision-makers and program managers shall tailor acquisition strategies to fit the particular conditions of an individual program, consistent with common sense, sound business management practice, applicable laws and regulations, and the time-sensitive nature of the user's requirement. Proposed programs may enter the acquisition process at various decision points, depending on concept and technology maturity. Tailoring shall be applied to various aspects of the acquisition system, including program documentation, acquisition phases, the timing and scope of decision reviews, and decision levels. Milestone decision authorities shall promote flexible, tailored approaches to oversight and review based on mutual trust and a program's dollar value, risk, and complexity.

4.5.2. Cost and Affordability. Fiscal constraint is a reality that all participants in the acquisition system must recognize. Cost must be viewed as an independent variable, and the DoD Components shall plan programs based on realistic projections of funding likely to be available in future years. To the greatest extent possible, the DoD Components shall identify the total costs of ownership, and at a minimum, the major drivers of total ownership costs. Consistent with the Chairman of the Joint Chiefs of Staff guidance on requirements generation, the user shall treat cost as a military requirement and state the amount the Department should be willing to invest to obtain, operate, and support the needed capability over its expected life cycle. Acquisition managers shall establish aggressive but realistic objectives for all programs and follow through by working with the user to trade off performance and schedule, beginning early in the program (when the majority of costs are determined).

4.5.3. Program Stability. To maximize program stability, the DoD Components shall develop realistic program schedules, long-range investment plans, and affordability assessments, and shall strive to ensure stable program funding. The milestone decision authority shall determine the appropriate point at which to fully fund an acquisition program. This point shall be no later than entry into the systems demonstration and development phase, but may be earlier if warranted by the acquisition strategy and the timing of the decision relative to the programming and budgeting process. In general, full funding shall be required when there is a mature system concept and architecture (based on proven technologies). Full funding shall be based on the cost of the most likely system alternative. The acquisition community shall actively participate in the various phases of the Planning, Programming, and Budgeting System to ensure that acquisition management issues and full funding are properly addressed.

4.5.4. Simulation-Based Acquisition. Program managers shall plan and budget for effective use of modeling and simulation to reduce the time, resources, and risk associated with the entire acquisition process; increase the quality, military worth and supportability of fielded systems; and reduce total ownership costs throughout the system life cycle.

4.5.5. Innovation, Continuous Improvement, and Lessons Learned. The Department shall continuously focus on developing and implementing major initiatives necessary to streamline and improve the Defense Acquisition System. Through a commitment to reengineering, the Department shall increase its ability to fund warfighting requirements and continued research and development. Decision-makers at all levels shall encourage the continuous examination and adoption of innovative practices – including best commercial practices and electronic business solutions - that reduce cycle time and cost, and encourage team work, and shall provide meaningful incentives for innovation, such as reinvestment of cost savings and career recognition and advancement. In addition, decision-makers at all levels shall encourage and facilitate the documentation and institutionalization of lessons learned – both good and bad - from past experience. Proper incentives must be in place to encourage a culture friendly to the documentation of valuable lessons learned and the sharing of knowledge. The objective is a learning culture that embraces change and continuously adapts to new challenges.

4.5.6. Streamlined Organizations and a Professional Workforce. The Department shall use a streamlined management structure in the acquisition system characterized by short, clearly defined lines of responsibility, authority, and accountability. In general, the chain of command shall include the program manager, program executive officer, the Component Acquisition Executive (CAE), reporting through the Head of the Component, and the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) or the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence (ASD(C3I)). In all cases, no more than two levels of review shall exist between a program manager and the Milestone Decision Authority. The Department of Defense shall maintain a fully proficient acquisition, technology, and logistics workforce that is flexible and highly skilled across a range of management, technical, and business disciplines. To ensure this, the USD(AT&L) shall establish education, training, and experience standards for each acquisition position based on the level of complexity of duties carried out in that position. In addition, the USD(AT&L) shall encourage the use of cross-training programs to ensure that all disciplines and communities within USD(AT&L) have a full understanding of the overall system. Defense acquisition works best when all of the DoD Components work together as a team focused on the customer.

5. RESPONSIBILITIES

The Under Secretary of Defense (Acquisition, Technology, and Logistics) (USD(AT&L)), the Assistant Secretary of Defense (Command, Control, Communications, and Intelligence) (ASD(C3I)), and the Director of Operational Test and Evaluation (DOT&E) are key officials of the Defense Acquisition System. They may jointly issue DoD Instructions, DoD Publications, and one-time directive-type memoranda, consistent with DoD 5025.1-M (reference (h)), that implement the policies contained in this Directive. Any such issuance shall be jointly signed by the USD(AT&L), the ASD(C3I), and the DOT&E.

6. EFFECTIVE DATE

This Directive is effective immediately.

Rudy de Leon
Deputy Secretary of Defense

Enclosures - 3
- E1. References, continued
- E2. Definitions
- E3. Overview

E1. ENCLOSURE 1

REFERENCES, continued

(e) Chairman of the Joint Chiefs of Staff Instruction 3170.01A, "Requirements Generation System," August 10, 1999
(f) Federal Acquisition Regulation (FAR), current edition
(g) Defense Federal Acquisition Regulation (DFAR) Supplement, current edition
(h) DoD 5025.1-M, "DoD Directives System Procedures," August 1994

E2. ENCLOSURE 2

DEFINITIONS

E2.1.1. Acquisition Executive. The individual within the Department and Components charged with overall acquisition management responsibilities within his or her respective organization. The Under Secretary of Defense for Acquisition, Technology, and Logistics is the Defense Acquisition Executive responsible for all acquisition matters within the Department of Defense. The Component Acquisition Executives (CAE) for each of the Components are the Secretary of the Military Departments or Heads of Agencies with power of redelegation. The CAEs are responsible for all acquisition matters within their respective Component.

E2.1.2. Acquisition Program. A directed, funded effort designed to provide a new, improved, or continuing materiel, weapon or information system capability, or service, in response to a validated operational or business need. Acquisition programs are divided into categories, which are established to facilitate decentralized decision-making, execution, and compliance with statutory requirements.

E2.1.3. Automated Information System (AIS). An acquisition program that acquires Information Technology (IT), except IT that:

E2.1.3.1. Involves equipment that is an integral part of a weapon or weapons system; or

E2.1.3.2. Is a tactical communication system.

E2.1.4. Information Technology (IT). Any equipment, or interconnected system or subsystem of equipment, that is used in the automatic acquisition, storage, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of data or information.

E2.1.4.1. The term "equipment" means any equipment used by the DoD Component directly or used by a contractor under a contract with the Component that requires the use of such equipment, or the use, to a significant extent, of such equipment in the performance of a service or the furnishing of a product.

E2.1.4.2. The term "IT" includes computers, ancillary equipment, software, firmware, and similar procedures, services (including support services), and related resources. The term "IT" also includes National Security Systems. It does not include any equipment that is acquired by a Federal contractor incidental to a Federal contract.

E2.1.5. Milestone Decision Authority. The individual designated in accordance with criteria established by the Under Secretary of Defense for Acquisition, Technology, and Logistics, or by the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence for AIS programs, to approve entry of an acquisition program into the next phase of the acquisition process.

E2.1.6. National Security System (NSS). Any telecommunications or information system operated by the U.S. Government, the function, operation, or use of which:

E2.1.6.1. Involves intelligence activities;

E2.1.6.2. Involves cryptologic activities related to national security;

E2.1.6.3. Involves command and control of military forces;

E2.1.6.4. Involves equipment that is an integral part of a weapon or weapons system; or,

E2.1.6.5. Subject to the limitation below, is critical to the direct fulfillment of military or intelligence missions. This does not include a system that is to be used for routine administrative and business applications (including payroll, finance, logistics, and personnel management applications).

E2.1.7. Program Executive Officer (PEO). A military or civilian official who has primary responsibility for directing several major defense acquisition programs and for assigned major system and non-major system acquisition programs. A PEO has no other command or staff responsibilities within the Component, and only reports to and receives guidance and direction from the DoD Component Acquisition Executive.

E2.1.8. Program Manager (PM). The individual designated in accordance with criteria established by the appropriate Component Acquisition Executive to manage an acquisition program, and appropriately certified under the provisions of the Defense Acquisition Workforce Improvement Act (10 U.S.C. §1701 et seq.). A PM has no other command or staff responsibilities within the Component.

E2.1.9. Requirements Authority. The individual within the DoD Components charged with overall requirements definition and validation. The Vice-Chairman of the Joint Chiefs of Staff, in the role as Chairman of the Joint Requirements Oversight Council (JROC), is the requirements authority for all potential major defense acquisition programs and is responsible for all requirements policy and procedures, including Mission Need Statements, Capstone Requirements Documents, and Operational Requirements Documents. The Requirements Authority for other acquisition category programs is specified in reference (e).

E3. ENCLOSURE 3

OVERVIEW

The Defense Acquisition System exists to secure and sustain the nation's investments in technologies, programs, and product support necessary to achieve the National Security Strategy and support the United States Armed Forces. The Department's investment strategy must be postured to support not only today's force, but also the next force, and future forces beyond that:

E3.1.1. ACQUISITION. The primary objective of Defense acquisition is to acquire quality products that satisfy user needs with measurable improvements to mission accomplishment and operational support, in a timely manner, and at a fair and reasonable price. The Department of Defense shall use performance and results-based management to ensure an efficient and effective acquisition system. Successful acquisition programs are fundamentally dependent upon competent people, rational priorities, validated requirements, performance measurement, and clearly defined responsibilities

E3.1.2. TECHNOLOGY. A robust Science and Technology program provides the essential foundation for a technologically superior military force. The Department's acquisition executives shall ensure that users have superior, supportable, and affordable technology to support their missions and give them revolutionary war-winning capabilities.

E3.1.3. OPERATIONAL SUPPORT. Effective operational support must provide for systems that are suitable, supportable, and survivable, and must utilize a total systems approach for the full range of systems support considerations throughout the life cycle of the system.

Department of Defense
INSTRUCTION

NUMBER 5000.2
October 23, 2000

USD(AT&L)

SUBJECT: Operation of the Defense Acquisition System

References: (a) DoD Directive 5000.1, "The Defense Acquisition System,"
(b) OMB Circular A-11, Part 3, July 1999 and "Supplemental Capital Programming Guide: Planning, Budgeting, and Acquisition of Capital Assets," July 1997
(c) USD(AT&L), ASD(C3I), and DOT&E Memorandum, "Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) Acquisition Programs,"
(d) DoD Directive 5025.1, "DoD Directives System," July 27, 2000
(e) through (ww), see enclosure 1

1. PURPOSE

This Instruction:

1.1. Establishes a simplified and flexible management framework for translating mission needs and technological opportunities, based on validated mission needs and requirements, into stable, affordable, and well-managed acquisition programs that include weapon systems and automated information systems.

1.2. Establishes a general approach for managing acquisition programs while acknowledging that every technology project and acquisition program is unique and that any particular project or program, particularly non-major programs, need not follow the entire process.

1.3. Consistent with statutory requirements and reference (a), authorizes Milestone Decision Authorities (MDAs) to tailor procedures in order to achieve cost, schedule, and performance goals.

1.4. Implements reference (a), the guidelines of OMB Circular A-11, Part 3 (reference (b)), and current laws, and the procedures in reference (c).

1.5. Authorizes the publication of DoD 5000.2-R, which establishes procedures to be followed for Major Defense Acquisition Programs (MDAPs), Major Automated Information Systems (MAISs), and those non-major systems specifically identified in the Regulation in accordance with DoD Directive 5025.1 (reference (d)).

2. APPLICABILITY AND SCOPE

This Instruction applies to:

2.1. The Office of the Secretary of Defense, the Military Departments, the Chairman of the Joint Chiefs of Staff, the Combatant Commands, the Office of the Inspector General of the Department of Defense, the Defense Agencies, DoD Field Activities, and all other organizational entities within the Department of Defense (hereafter referred to collectively as "the DoD Components").

2.2. All defense technology projects and acquisition programs. Some requirements, where stated, apply only to MDAPs and MAISs.

2.3. In general, highly sensitive classified, cryptologic, and intelligence projects and programs shall follow the guidance in this Instruction and reference (c) for technology projects and acquisition programs of equivalent acquisition category. The MDA shall approve proposed tailoring of the systems acquisition process for these projects and programs.

3. DEFINITIONS

Terms used in this Instruction are defined in enclosure 2.

4. PROCEDURES

4.1. MDAs shall establish mandatory procedures for assigned programs. These procedures shall not exceed the requirements for MDAPs and MAIS acquisition programs established in this Instruction or in reference (c). The Heads of the DoD Components shall keep the issuance of any directives, instructions, policy memorandums, or regulations necessary to implement the mandatory procedures contained in this Instruction and reference (c) to a minimum. The Heads of the DoD Components shall provide copies of all such documents to the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) PRIOR TO publication. Waivers or requests for exceptions to the provisions of this Instruction shall be submitted to the USD(AT&L), Assistant Secretary of Defense for Command, Control, Communications, and Intelligence (ASD(C3I)), or Director of Operational Test and Evaluation (DOT&E), as appropriate via the Component Acquisition Executive (CAE). Statutory requirements cannot be waived unless the statute specifically provides for waiver of the stated requirements.

4.2. The DoD Components (including Office of the Secretary of Defense (OSD) staff offices) shall coordinate proposed policy memoranda and changes to individual sections of this Instruction or reference (c) with the Executive Secretary of the Defense Acquisition Policy Steering Group (DAPSG) (reference (e)) prior to Department-wide staffing of the change. The purpose of this policy is to maintain administrative control of this Instruction and is not intended to imply any approval authority on the part of the Executive Secretary.

4.3. The DAPSG shall submit proposed changes to the USD(AT&L), ASD(C3I), and DOT&E, who jointly have the authority to change this Instruction. All three officials shall jointly sign future changes. Proposed changes shall be considered annually by the Defense Acquisition Policy Working Group (DAPWG).

4.4. This Instruction and references (a) and (c) are located in the Reference Library of the Defense Acquisition Deskbook (reference (f)). Mandatory and discretionary acquisition information, practical advice, and lessons learned are also located in the Deskbook.

4.5. Programs planned in accordance with the 1999 version of DoD Directive 5000.1 (reference (g)) and the 1996 version of DoD 5000.2-R (reference (h)) shall be executed in accordance with approved program documentation. That documentation shall not be updated solely to satisfy the requirements of this Instruction. Programs already approved to enter Engineering and Manufacturing Development shall continue to follow the sequence of milestones established in their program documentation. The new policies in this Instruction, including the new decision points and phases, shall be applied to efforts that have not yet been approved as acquisition programs (usually pre-Milestone I) unless otherwise directed by the MDA. The new policies in this Instruction, including the new decision points and phases, shall be applied to programs that are post-Milestone I but that are not yet in Engineering and Manufacturing Development at the discretion of the MDA. For purposes of complying with applicable laws, Milestone A will serve as Milestone 0; Program Initiation, when it occurs at or during Component Advanced Development, will serve as Milestone I; Milestone B will serve as Milestone II; Milestone C will serve as the Low-Rate Initial Production decision point; and the Full-Rate Production Decision Review will serve as Milestone III. In addition, System Development and Demonstration will serve as Engineering and Manufacturing Development.

4.6. Characteristics of the Defense Acquisition System. Successful Department of Defense acquisition is dependent on smooth integration of the three principal decision systems in the Department and on attention to critical key capability enablers.

4.6.1. Integrated Management Framework. The policies in this Instruction are intended to forge a close and effective interface among the Department's principal decision support systems: the Requirements Generation System, the Defense Acquisition System, and the Planning, Programming, and Budgeting System.

4.6.1.1. Requirements Generation System. The Requirements Generation System (reference (i)) produces information for decision makers on the projected mission needs of the user. The user defines mission needs in broad operational terms and then evolves the needs to specific operational requirements (see subparagraph 4.8.1., below). The Joint Requirements

Oversight Council (JROC), or other appropriate requirements authority, validates and approves the mission need, confirms the fact that a non-materiel solution alone cannot satisfy the identified need, and identifies that a potential new concept or system materiel solution should be considered.

4.6.1.2. Defense Acquisition System

4.6.1.2.1. The Defense Acquisition System establishes a management process to translate user needs (broadly stated mission needs responding to a postulated threat and developed in the Requirements Generation System or business needs responding to new ways of doing business and developed by the appropriate staff office) and technological opportunities (developed or identified in the Science and Technology program based on user needs) into reliable and sustainable systems that provide capability to the user.

4.6.1.2.2. The Defense Acquisition System is a continuum composed of three activities with multiple paths into and out of each activity. Technologies are researched, developed, or procured in pre-system acquisition (science and technology and concept development and demonstration). Systems are developed, demonstrated, produced or procured, and deployed in systems acquisition. The outcome of systems acquisition is a system that represents a judicious balance of cost, schedule, and performance in response to the user's expressed need; that is interoperable with other systems (U.S., Coalition, and Allied systems, as specified in the operational requirements document); that uses proven technology, open systems design, available manufacturing capabilities or services, and smart competition; that is affordable; and that is supportable. Once deployed, the system is supported throughout its operational life and eventual disposal in post-systems acquisition using prudent combinations of organic and contractor service providers, in accordance with statutes.

4.6.1.3. Planning, Programming, and Budgeting System. The Planning, Programming, and Budgeting System (PPBS) (reference (j)) provides for a cyclic process that provides the operational commanders-in-chief the best mix of forces, equipment, and support attainable within fiscal constraints.

4.6.1.4. Integrated Reviews. As new ways of using technology development, evolutionary acquisition, and interoperability permeate the acquisition process, the Department of Defense must increasingly review programs on a family-of-systems basis, as well as conduct mission area reviews. The objective of these more comprehensive reviews is to better reconcile requirements, resources, and programs to support the goals of cost-effectiveness and interoperability and to assess where limited resources are best spent. A number of existing mechanisms support such objectives, including front-end assessments, mission area assessments, and special studies. Any of these mechanisms, or others, may be used to conduct family-of-systems and mission area reviews on a selective basis to support requirements, acquisition, and budget decisions.

4.6.2. Key Capability Enablers. To meet operational requirements for Joint, Combined, and Coalition military missions across warfighting to peace-keeping spectrums, all systems and families-of-systems must be designed, developed, tested, and supported to ensure information superiority and interoperability.

4.6.2.1. Information Superiority

4.6.2.1.1. Information superiority is defined as the capability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying an adversary's ability to do the same. Information superiority is achieved in a non-combat situation or one in which there are no clearly defined adversaries when friendly forces have the information necessary to achieve operational objectives.

4.6.2.1.2. Forces will attain information superiority through the acquisition of systems and families of systems that are secure, reliable, interoperable, and able to communicate across a universal information technology (IT) infrastructure, to include national security systems (NSS). This IT infrastructure includes the data, information, processes, organizational interactions, skills, and analytical expertise, as well as systems, networks, and information exchange capabilities.

4.6.2.1.3. For the DoD Components to provide these capabilities in a cost-effective manner, they must identify and evaluate IT (including NSS) infrastructure and supportability and interoperability from the beginning of each program's life cycle. This identification shall include appropriate system and family of systems requirements associated with critical infrastructure protection, information assurance, space control, and related missions that are consistent with DoD policies, standards (e.g., the Joint Technical Architecture), and mission-area integrated architectures. In addition, the evaluation of IT (including NSS) supportability and interoperability shall be documented in the Command, Control, Communications, Computers, and Intelligence Support Plan (C4ISP) (reference (c)). The results of this planning shall be discussed in the system acquisition strategy.

4.6.2.1.4. All programs shall be managed and engineered using best processes and practices to reduce security risks; ensure programs are synchronized; be designed to be mutually compatible with other electric or electronic equipment and the operational electromagnetic environment; identify critical program information that requires protection to prevent unauthorized disclosure or inadvertent transfer of leading-edge technologies and sensitive data or systems; require hardening, redundancy, or other physical protection against attack; be certified for spectrum supportability; and comply with the provisions of the Clinger-Cohen Act (CCA) (reference (k)). Requirements for data structure and quality of information that support DoD Information Superiority objectives are defined in DoD Directive 8000.1 (reference (l)) and DoD Directive 8320.1 (reference (m)). Policy and process for ensuring information interoperability of IT (including NSS) is prescribed in DoD Directive 4630.5 (reference (n)) and DoD Instruction 4630.8 (reference (o)).

4.6.2.2. Interoperability

4.6.2.2.1. Interoperability is the ability of systems, units, or forces to provide data, information, materiel, and services to and accept the same from other systems, units, or forces, and to use the data, information, materiel, and services so exchanged to enable them to operate effectively together. In technology projects and acquisition programs, interoperability begins with a description of desired outcomes. An interoperability key performance parameter (KPP) is mandatory and shall be developed in accordance with Chairman of the Joint Chiefs of Staff (CJCS) Instruction 3170.01A (reference (i)) and CJCS Instruction 6212.01B (reference (p)) for all Capstone Requirements Documents (CRDs) and Operational Requirements Documents (ORDs). Interoperability needs shall be addressed as part of the Mission Need Statement (MNS) constraint section. Interoperability constraints will form the basis for the CRD and ORD interoperability KPPs. For the acquisition community, the interoperability requirements established in the requirements process shall be allocated from the requirements documents to the individual systems through the system engineering process.

4.6.2.2.2. Interoperability requirements shall be addressed in the C4ISP (reference (c)) and in integration plans for non-information interoperability requirements. The results of this planning shall be discussed in the system acquisition strategy.

4.6.2.2.3. The MDA shall make decisions on individual programs in the context of the family of systems. Those decisions shall be supported by the information provided by the Program Manager (PM) in the acquisition strategy.

4.6.2.2.4. The DOT&E shall consider interoperability as part of all early operational assessments, initial operational test and evaluations, and test plans to ensure interoperability is adequately tested and evaluated.

4.7. The Defense Acquisition Management Framework

4.7.1. General

4.7.1.1. All projects and programs, including highly sensitive classified, cryptologic, and intelligence projects and programs, shall accomplish activities described in this Instruction and reference (c) (for MDAPs, MAISs, and non-major systems as specified in the Regulation). How these activities are conducted shall be determined on a project-by-project or program-by-program basis through Integrated Product Teams (IPTs) and Integrated Product and Process Development (IPPD). How these activities are conducted shall be tailored to minimize the time it takes to satisfy an identified need consistent with common sense and sound business practice.

4.7.1.2. Extensive use of modeling, simulation, and analysis should be used throughout the acquisition process to integrate the activities of the principal decision support systems by creating information for decision-makers. Modeling and simulation (M&S) is useful in representing conceptual systems that do not exist and extant systems that cannot be subjected to actual environments because of safety requirements or the limitations of resources and facilities. The Program Manager should plan for the integrated use of M&S that maximizes the use of existing M&S before developing program unique products.

4.7.1.3. Developm nt and pr cureme t o a system is not the only type of solution that can satisfy a m ssion need Procurement of serv ces shall be considered as a way of meeting the operational requ irements a a reason ble cost to t e Department of Defense.

4.7.1.4. At each m lestone re view, the M DA shall assess the opportunities for cooperative develo ment or pr curemen . The MDA shall make this assessment based on an assessment of whet er or not a project o progra n si ilar to the one under consideration is in development or pro luction by one or m re major all es or NATO organizations; if such a project or program exists, determining if that project could s tisfy, or be modified in scope to satisfy, U.S. military requir ments; an l assess th e advantage and disadvantages with regard to program timing, developme tal and life-cycle cos s, techn lo y sharing, and interoperability with one or more major allies o NATO or anizatio s.

4.7.1.5. Through t the life of a tech olo gy project, service contract, or acquisition program, cost-effec ive compe ition (at l oth the prin e and sub-contractor levels) shall be maintained to the m aximum e tent pract cal by mea s of either head-to-head competition, competition of alte native ways to meet he mission need, reliance on market surveys for commercial alterna ives, or ch nging rec uiremen s (t rough the process of cost and performance trades) to allow inc eased competition. This com pet tion for best value to the Department of Defense shall be id ntified in the acquis tion stra egy. Wherever possible and appropriate, performance- and price-based acquisitio methoc s sl ould be used. The benefits of long-term contracting shall be explored. Contracto rs shall be e couraged to submit realistic cost proposals, including fair and r asonable rofit or fe amounts. "Buy-ins" shall be discouraged because they may decrease comp etition or lead to poo contract pe rformance. Cost proposals shall be tested to ensure cost-realism in accorda ce with t e Feder l A cquisition Regulation (reference (q)). Costs shall be tested to e sure cost-r alism (ba sed on k ow ledge gained during the acquisition process). Acquisiti ns shall be structure l in such a way that undue risk (such as through the use of firm fixed price ptions tha cover m re than five years) is not imposed on contractors, and so that excessive cont actor investment (be ond nor mal investments for plant, equipment, etc.) is not required. Cont actors are entitled to earn reason ble rewards on DoD contracts, including competitively awar led contracts. If com petition is n t available, PMs shall devise incentives to motivate contracto s in a way hat will y eld the b enefits of competition. Those benefits include innovation, improv d product quality an l perform an e, increased efficiency, and lower costs.

4.7.1.6. Programs ntering s stem ac quis tion will comply with requirements governing new star s (referenc (j)).

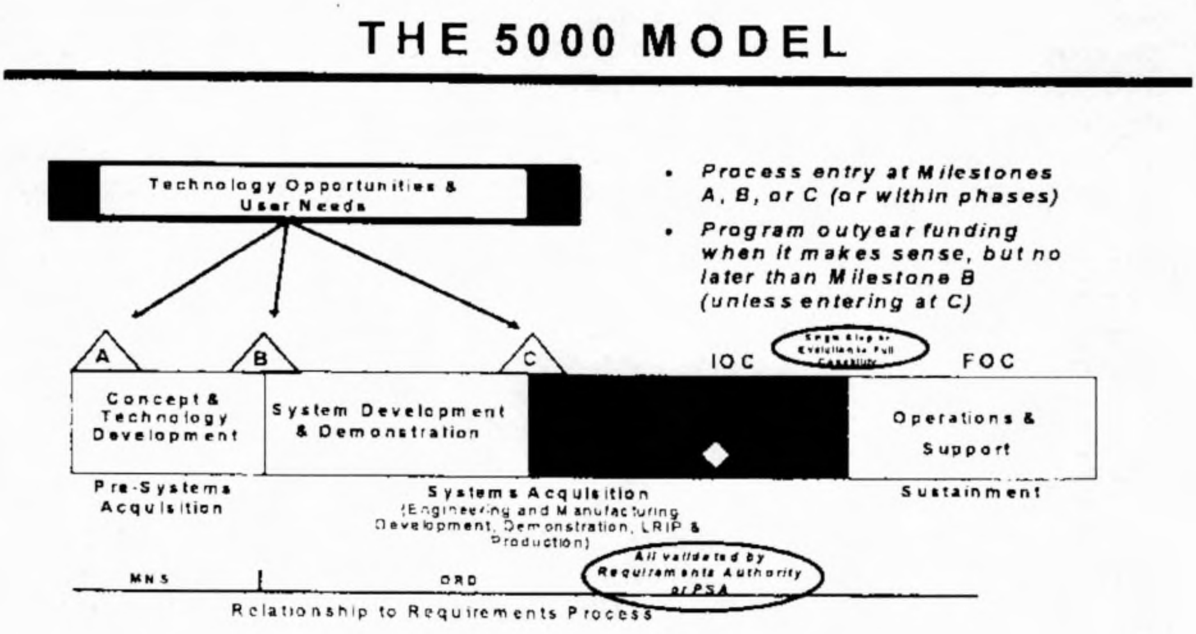
4.7.1.7. At each Milestone a d at the Ful -Rate Production Decision, the MDA has the option to contir ue the proj ct or pro ram, m dif the project or program, terminate the project or program, or proceed into the n ext phas . he MDA may hold other reviews to adjust plans, review progr ss, or dete rmine ho to proc ed to production.

4.7.1.8. While a m ateriel alt rnative may enter acquisition at multiple points, the appropriate point is guided by the ability to satisfy st ted entrance criteria, the content of each work effort within phase, and the cons deration at each milestone. Entrance criteria are minimum accomplishments required to be completed by each program prior to entry into the next phase or work effort.

4.7.1.9. There is no one best way to accomplish the objectives of the Defense Acquisition System. Proposed programs, for example, may enter the acquisition process at various decision points, depending on concept and technological maturity. Decision-makers and Program Managers shall tailor acquisition strategies to fit the particular conditions of an individual program, consistent with common sense, sound business management practice, applicable laws and regulations, and the time-sensitive nature of the user's requirement. Tailoring shall be applied to various aspects of the Acquisition system, including program documentation, acquisition phases, the timing and scope of decision reviews, and decision levels. Milestone decision authorities shall promote flexible, tailored approaches to oversight and review based on mutual trust and a program's dollar value, risk, and complexity.

4.7.1.10. A graphic representation of the Defense acquisition management framework is shown in Figure F1. The framework is divided into three activities (e.g., Systems Acquisition). Activities are divided into phases (e.g., System Development and Demonstration). Phases are divided into work efforts (e.g., System Integration). The remainder of this section will discuss each aspect of the framework.

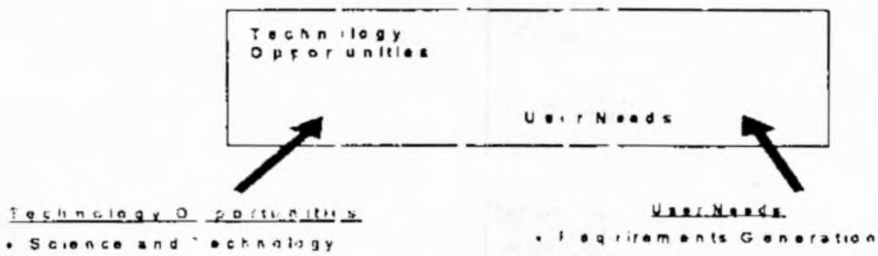
Figure F1.



4.7.2. Pre-Systems Acquisition. Pre-system acquisition is composed of on-going activities in development of user needs, in science and technology, and in concept development work specific to the development of a materiel solution to an identified, validated need. The responsible authority outside of this Instruction defines policies and directives for development of user needs and technological opportunities in science and technology.

Figure F2.

Technology Opportunities and User Needs Work Content



4.7.2.1. User Need Activities. The MNS shall identify and describe the projected mission needs of the user in the context of the threat to be countered or business need to be met. The user representative, with support from the operational test and evaluation community, develops the needs expressed in the MNS into requirements in the form of CRDs (if applicable) and ORDs. CRDs contain capabilities-based requirements that facilitate the development of individual ORDs by providing a common framework and operational concept to guide their development. The CRD is an oversight tool for overarching requirements for a family of systems (reference (i)). Validated ORDs translate the MNS and, if applicable, CRDs into broad, flexible, and time-phased operational goals that are further detailed and refined into specific operational capability requirements contained in the final ORD at System Demonstration. The appropriate requirements authority shall validate all MNSs, CRDs, and ORDs.

4.7.2.1.1. In the process of refining requirements, the user shall adhere to the following key concepts (in accordance with reference (i)):

4.7.2.1.1.1. Keep all reasonable options open and facilitate cost, schedule, and performance trades throughout the acquisition process.

4.7.2.1.1.2. Avoid early commitments to system-specific solutions, including those that inhibit future insertion of new technology and commercial or non-developmental items.

4.7.2.1.1.3. Define requirements in broad operational capability terms.

4.7.2.1.1.4. Develop time-phased requirements with associated objectives and thresholds (as appropriate).

4.7.2.1.1.5. Evaluate how the desired performance requirements could reasonably be modified to facilitate the potential use of commercial or non-developmental items and components.

4.7.2.1.1.6. Evaluate whether system will be able to survive and operate through the anticipated threat environment.

4.7.2.1.1.7. Consider critical information needs and intelligence support requirements.

4.7.2.1.1.8. Address cost in the ORD, in terms of a threshold and objective.

4.7.2.1.1.9. Include requirements for security, information assuredness, and critical infrastructure protection.

4.7.2.1.1.10. Consider supportability, data sharing, and interoperability needs of the family of systems in the operational environment.

4.7.2.1.1.11. Mandate interoperability as a key performance parameter (KPP) to be documented in all ORDs and CRDs (reference (p)) and included in the Acquisition Program Baseline (APB) (reference (c)).

4.7.2.1.2. For purposes of interoperability and supportability, all IT (including NSS) acquisition programs regardless of acquisition category, developed for use by U.S. forces are for joint, combined, and coalition use. The intent is to develop, acquire, and deploy IT that meet essential operational needs of U.S. forces. Interoperability and integration of IT requirements shall be determined during the requirements validation process by the DoD Components and Joint Staff (through review of all MNSs and ORDs) and shall be updated as necessary throughout the acquisition, deployment, and operational life of a system. Given the potential joint nature of AISs, all AIS MNSs and ORDs shall be submitted to the Joint Staff in accordance with CJSC Instruction 3170.01A (reference (i)) to determine if there is JROC special interest.

4.7.2.1.3. The Chairman of the Joint Chiefs of Staff shall establish procedures for the development, coordination, review, and validation of interoperability and supportability requirements for IT (including NSS) acquisition programs , regardless of acquisition category. The Chairman shall approve, document, and exercise doctrinal concepts and associated operational procedures to achieve interoperability and supportability of IT (including NSS) acquisition programs employed by U.S. forces and with coalition and allied forces. The Chairman has established procedures for ensuring compliance with certification of joint interoperability of IT (including NSS) acquisition programs throughout their life cycle and ensure that the Directors of the Defense Agencies are included in the review process (reference (p)).

4.7.2.1.4. The user or user's representative shall work with the Program Manager or other system developer (e.g., the Demonstration Manager for Advanced Concept and

Technology Development projects) to establish and refine cost as an independent variable (CAIV)-based cost and performance objectives and critical schedule dates. The CAIV-based parameters and critical schedule dates shall also be included in the APB.

4.7.2.2. Materiel Acquisition Requirement Questions. Before proposing a new acquisition program, DoD Components shall affirmatively answer the following questions:

4.7.2.2.1. Does the acquisition support core/priority mission functions that need to be performed by the Federal Government?

4.7.2.2.2. Does the acquisition need to be undertaken by the DoD Component because no alternative private sector or governmental source can better support the function?

4.7.2.2.3. Does the acquisition support work processes that have been simplified or otherwise redesigned to reduce costs, improve effectiveness, and make maximum use of commercial off-the-shelf technology?

4.7.2.3. <u>Technological Opportunity Activities</u>. Technological opportunities within DoD laboratories and research centers, from academia, or from commercial sources are identified within the Defense Science and Technology (S&T) Program. The DoD S&T Program mission is to provide the users of today and tomorrow with superior and affordable technology to support their missions, and to enable them to have revolutionary war-winning capabilities. The S&T Program is uniquely positioned to reduce the risks of promising technologies before they are assumed in the acquisition process. The Deputy Under Secretary of Defense (Science & Technology) (DUSD(S&T)) is responsible for the overall direction, quality, content, and oversight of the DoD S&T Program (including software capability). The DUSD(S&T) is also responsible for promoting coordination, cooperation and mutual understanding of the S&T program within the Department of Defense, other Federal Agencies, and the civilian community.

4.7.2.3.1. <u>S&T Program Content</u>. The S&T program consists of the following:

4.7.2.3.1.1. <u>Basic Research</u>. Scientific study and experimentation directed toward increasing knowledge and understanding in the science fields and discovering phenomena that can be exploited for military purposes.

4.7.2.3.1.2. <u>Applied Research</u>. Translates promising research into solutions for broadly defined military problems with efforts that may vary from applied research to sophisticated breadboard subsystems that establish the initial feasibility and practicality of proposed solutions or technologies.

4.7.2.3.1.3. <u>Advanced Technology</u>. Demonstrates the performance payoff, increased logistics or interoperability capabilities, or cost reduction potential of militarily relevant technology.

4.7.2.3.2. Technology Transition Objectives. The DUSD(S&T) shall provide support and oversight to the Component S&T Executives as they execute their statutory responsibilities. They shall:

4.7.2.3.2.1. Evaluate battlefield deficiencies as defined by the Joint Chiefs of Staff, Commanders-in-Chief (CINCs), and the Military Departments against ongoing S&T efforts.

4.7.2.3.2.2. Establish S&T projects when on-going S&T efforts are not available to address deficiencies.

4.7.2.3.2.3. Support the increased use of commercial technologies through the initiation of dual-use technology development projects to address deficiencies for both hardware and software.

4.7.2.3.2.4. For those technologies with the most promise for application to weapon systems or AISs, be responsible for maturing technology to a readiness level that puts the receiving MDA at low risk for systems integration and acceptable to the cognizant MDA, or until the MDA is no longer considering that technology.

4.7.2.3.2.5. Advise the requirements and acquisition communities of new technology developments and options that will contribute to meeting future warfighting objectives and ensure that technical advice is available to PMs throughout the system development process.

4.7.2.3.2.6. Conduct independent technology assessments and assist in determining the maturity of critical system technologies for transition to the System Acquisition process, during System Development and Demonstration and at Milestone C.

4.7.2.3.3. Technology Transition Mechanisms. To ensure the transition of innovative concepts and superior technology to the user and acquisition customer, the DoD Component S&T Executives shall use three mechanisms: Advanced Technology Demonstrations (ATDs), Advanced Concept Technology Demonstrations (ACTDs), and Experiments, both joint and Service-specific. The specific plans and processes for these transition mechanisms are described in the Joint Warfighting S&T Plan and the individual DoD Component S&T Plans. S&T activities shall be conducted in a way that facilitates or at least does not preclude the availability of competition for future acquisition programs.

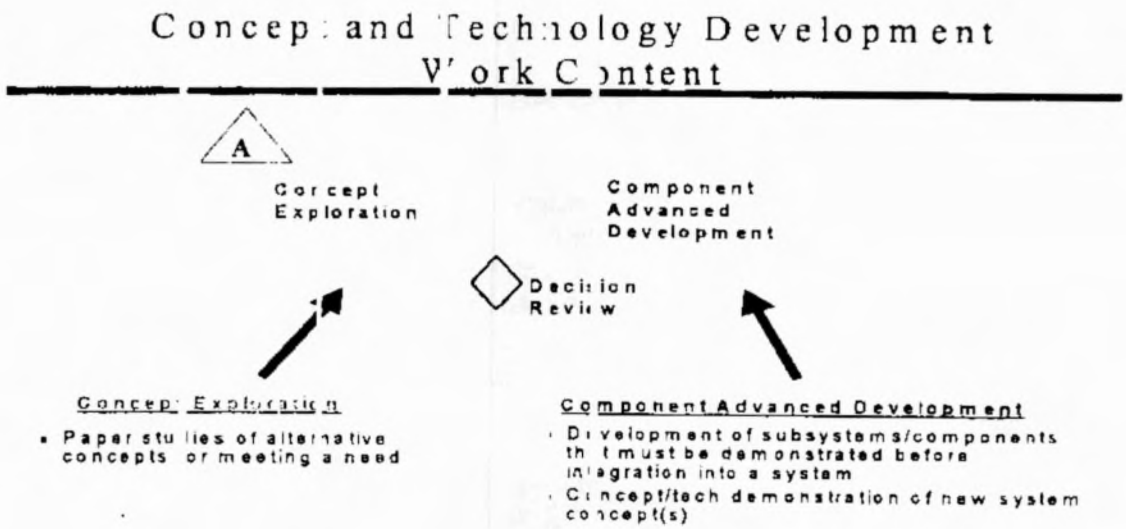
4.7.2.3.3.1. ATDs shall be used to demonstrate the maturity and potential of advanced technologies for enhanced military operational capability or cost effectiveness.

4.7.2.3.3.2. ACTDs shall be used to determine military utility of proven technology and to develop the concept of operations that will optimize effectiveness.

4.7.2.3.3.3. Experiments shall be used to develop and assess concept-based hypotheses to identify and recommend the best value-added solutions for changes to doctrine, organizational structure, training and education, materiel, leadership, and people required to achieve significant advances in future joint operational capabilities.

4.7.2.4. Analyze Alternatives and Develop Concepts and Technologies. One path into systems acquisition begins with examining alternative concepts to meet a stated mission need. This path begins with a decision to enter Concept and Technology Development at Milestone A. The phase ends with a selection of a system architecture(s) and the completion of entrance criteria into Milestone B and System Development and Demonstration Phase.

Figure F3.



4.7.2.4.1. Entrance Criteria. After the requirements authority validates and approves a MNS, the MDA (through the IPT process) will review the MNS, consider possible technology issues (e.g., technologies demonstrated in ATDs), and identify possible alternatives before making a Milestone A decision, based on an analysis of multiple concepts to be studied, and considering cooperative opportunities.

4.7.2.4.2. Milestone A

4.7.2.4.2.1 At Milestone A, the MDA shall approve the initiation of concept studies, designate a lead Component, approve Concept Exploration exit criteria, and issue the Acquisition Decision Memorandum. The leader of the concept development team, working with the integrated test team, shall develop an evaluation strategy that describes how the capabilities in the MNS will be evaluated once the system is developed. That evaluation strategy shall be approved by the DOT&E and the cognizant OIPT leader 180 days after Milestone A approval.

4.7.2.4.2.2. A favorable Milestone A decision DOES NOT yet mean that a new acquisition program has been initiated.

4.7.2.4.2.3. The tables in enclosure 3 identify all statutory and regulatory requirements applicable to Milestone A.

4.7.2.4.2.4. Milestone A approval can lead to Concept Exploration or Component Advanced Development depending on whether an evaluation of multiple concepts is desired or if a concept has been chosen, but more work is needed on key sub-systems or components before a system architecture can be determined and the technologies can be demonstrated in a relevant environment.

4.7.2.4.3. Concept Exploration

4.7.2.4.3.1. Concept Exploration typically consists of competitive, parallel, short-term concept studies. The focus of these efforts is to define and evaluate the feasibility of alternative concepts and to provide a basis for assessing the relative merits (i.e., advantages and disadvantages, degree of risk, etc.) of these concepts. Analyses of alternatives shall be used to facilitate comparisons of alternative concepts.

4.7.2.4.3.2. In order to achieve the best possible system solution, emphasis will be placed on innovation and competition. To this end, participation by a diversified range of businesses (i.e., small, new, domestic, and international) should be encouraged. Alternative system design concepts will be primarily solicited from private industry and, where appropriate, from organic activities, international technology and equipment firms, Federal laboratories, federally funded research and development centers, educational institutions, and other not-for-profit organizations.

4.7.2.4.3.3. The work in Concept Exploration normally shall be funded only for completion of concept studies contracts. The work shall be guided by the MNS.

4.7.2.4.3.4. The most promising system concepts shall be defined in terms of initial, broad objectives for cost, schedule, and performance; identification of interoperability, security, technology protection, operational support, and infrastructure requirements within a family of systems; opportunities for tradeoffs, and an overall acquisition strategy and test and evaluation strategy (including Development Test and Evaluation (DT&E), Operational Test and Evaluation (OT&E), and Live Fire Test and Evaluation (LFT&E)).

4.7.2.4.3.5. This work effort ends with a review, at which the MDA selects the preferred concept to be pursued for which technologies are available.

4.7.2.4.4. Decision Review. During Concept Exploration, the MDA may hold a decision review to determine if additional component development is necessary before key technologies will be sufficiently mature to enter System Development and Demonstration for one of the concepts under consideration. If the concepts do not require technologies necessitating additional component development, the appropriate milestone (B or C) shall be held in place of this review.

4.7.2.4.5. Program Initiation In Advance of Milestone B. The practical result of a preference for more mature technology is initiation of individual programs at later stages of development, after determination of technology maturity. As a consequence, most MDAPs will be initiated at Milestone B. On the rare occasions when an earlier program initiation is appropriate, it will take place at entry to or during Component Advanced Development. At program initiation in advance of Milestone B, the MDA shall approve the acquisition strategy, the acquisition program baseline, IT certification for MAISs (reference (r)), and exit criteria for the Component Advanced Development work effort if not already established.

4.7.2.4.6. Component Advanced Development. The project shall enter Component Advanced Development when the project leader has a concept for the needed capability, but does not yet know the system architecture. Unless otherwise determined by the MDA, the component technology to be developed shall have been proven in concept. The project shall exit Component Advanced Development when a system architecture has been developed and the component technology has been demonstrated in the relevant environment or the MDA decides to end this effort. This effort is intended to reduce risk on components and subsystems that have only been demonstrated in a laboratory environment and to determine the appropriate set of subsystems to be integrated into a full system. This work effort normally will be funded only for the advanced development work. The work effort will be guided by the validated MNS, but during this activity, an ORD shall be developed to support program initiation. Also, acquisition information necessary for a milestone decision (e.g., the acquisition strategy, program protection plan, etc.) shall be developed. This effort is normally followed by entry into the System Development and Demonstration phase after a Milestone B decision by the MDA.

4.7.3. Systems Acquisition

4.7.3.1. General

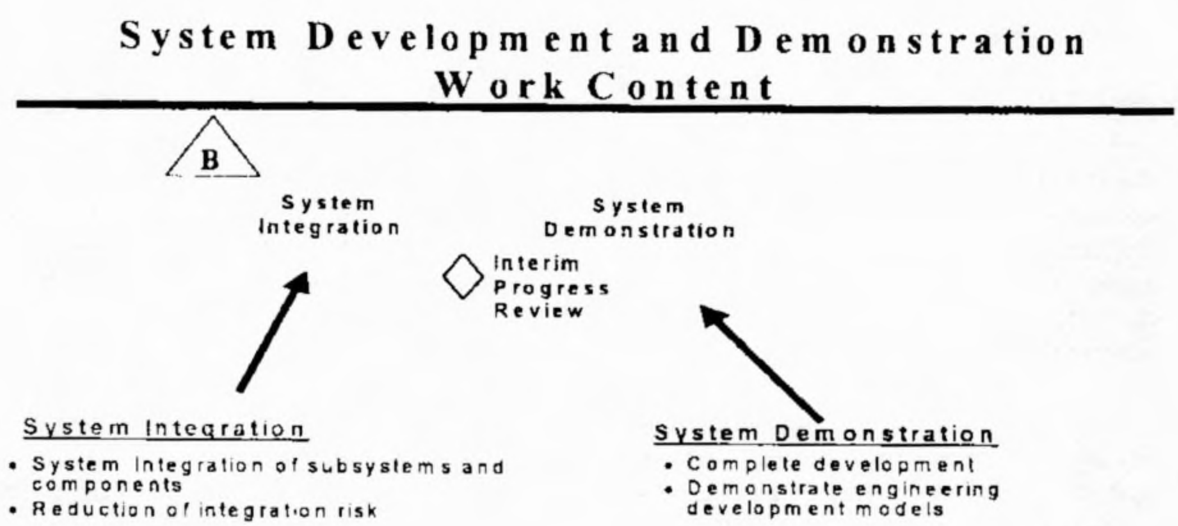
4.7.3.1.1. Systems acquisition is the process of developing concepts into producible and deployable products that provide capability to the user. The concept to exploit in systems acquisition is based on an analysis of alternative ways to meet the military need (done either in Concept Exploration or technological opportunities development), including commercial and non-developmental technologies and products and services determined through market analysis. The DoD Component (or appropriate principal staff office for MAIS programs) responsible for the mission area in which a deficiency or opportunity has been identified, but not the PM, shall normally prepare the analysis of alternatives (although the PM or PM's representative may participate in the analysis).

4.7.3.1.2. The goal is to develop the best overall value solution over the system's life cycle that meets the user's operational requirements. Generally, use or modification of systems or equipment that the DoD Components already own is more cost and schedule-effective than acquiring new materiel. If existing U.S. military systems or other on-hand materiel cannot be economically used or modified to meet the operational requirement, an acquisition program may be justified and acquisition decision-makers shall follow the following hierarchy of alternatives: the procurement (including modification) of commercially available domestic or international technologies, systems or equipment, or the additional production (including modification) of previously-developed U.S. military systems or equipment, or Allied systems or equipment; cooperative development program with one or more Allied nations; new joint Component or Government Agency development program; and a new Component-unique development program. Important in this evaluation process for new or modified systems are considerations for interoperability and supportability with existing and planned future components or systems.

4.7.3.1.3. DoD acquisition and procurement of weapons and weapon systems shall be consistent with all applicable domestic law and all applicable treaties, customary international law, and the law of armed conflict (also known as the laws and customs of war). The Head of each DoD Component shall ensure that all Component activities that could reasonably generate questions concerning compliance with obligations under arms control agreements to which the United States is a party shall have clearance from the USD(AT&L), in coordination with the General Counsel, DoD, and the Under Secretary of Defense (Policy), before such activity is undertaken. The Head of each DoD Component shall ensure that the Component's General Counsel or Judge Advocate General, as appropriate, conducts a legal review of the intended acquisition of a potential weapon or weapon system to determine that it is consistent with U.S. obligations. The review shall be conducted again before the award of a system development and demonstration contract for the weapon or weapon system and before the award of the initial production contract. Files shall be kept permanently. Additionally, legal reviews of new, advanced or emerging technologies that may lead to development of weapons or weapon systems are encouraged.

4.7.3.2. Begin Development and Develop and Demonstrate Systems

Figure F4.



4.7.3.2.1. General

4.7.3.2.1.1. The purpose of the System Development and Demonstration phase is to develop a system, reduce program risk, ensure operational supportability, design for producibility, ensure affordability, and demonstrate system integration, interoperability, and utility. Discovery and development are aided by the use of simulation-based acquisition and test and evaluation and guided by a system acquisition strategy and test and evaluation master plan (TEMP). System modeling, simulation, test, and evaluation activities shall be integrated into an efficient continuum planned and executed by a test and evaluation integrated product team (T&E IPT). This continuum shall feature coordinated test events, access to all test data by all involved Agencies, and independent evaluation of test results by involved Agencies. Modeling, simulation, and development test shall be under the direct responsibility of the PM or a designated test agency. All results of early operational assessments shall be reported to the Service Chief by the appropriate operational test activity and used by the MDA in support of decisions. The independent planning, execution, and evaluation of dedicated Initial Operational Test and Evaluation (IOT&E), as required by law, and Follow-on Operational Test and Evaluation (FOT&E), if required, shall be the responsibility of the appropriate operational test activity (OTA).

4.7.3.2.1.2. This phase can be entered either directly out of technology opportunity and user need activities or from Concept Exploration. The actual entry point depends on the maturity of the technologies, validated requirements (including urgency of need), and affordability. The MDA shall determine the appropriate entrance point, which shall be Milestone B. There shall be only one Milestone B per program, or evolutionary block.

4.7.3.2.1.3. Each DoD Component should maintain a transition fund in the out-years of the Fiscal Year Defense Program (FYDP) to allow rapid transition of military or commercial projects from technology opportunity and user needs activities to System Development and Demonstration or Commitment to Low-Rate Production. Each DoD Component shall determine the size of its transition fund. The transition fund for the first year of the program must be distributed to individual budget lines prior to submission of the Budget Estimate Submission for that year.

4.7.3.2.2. Entrance Criteria

4.7.3.2.2.1. Entrance into System Development and Demonstration is dependent on three things: technology (including software) maturity, validated requirements, and funding. Unless some other factor is overriding in its impact, the maturity of the technology will determine the path to be followed. Programs that enter the process at Milestone B shall have a system architecture and an operational architecture for their relevant mission area.

4.7.3.2.2.2. Technology is developed in S&T or procured from industry. Technology must have been demonstrated in a relevant environment (reference (c) for a discussion of technology maturity) or, preferably, in an operational environment (using the transition mechanisms) to be considered mature enough to use for product development in systems integration. If technology is not mature, the DoD Component shall use alternative technology that is mature and that can meet the user's needs. The determination of technology maturity is made by the DoD Component S&T Executive, with review of the determination for MDAPs by the DUSD(S&T). If the DUSD(S&T) does not concur with the determination, the DUSD(S&T) will direct an independent assessment. To promote increased consideration of technological issues early in the development process, the MDA shall, at each acquisition program decision, consider any position paper prepared by a Defense research facility on a technological issue relating to the major system being reviewed; and any technological assessment made by a Defense research facility (reference (s)). A defense research facility is a DoD facility that performs or contracts for the performance of basic research or applied research known as exploratory development.

4.7.3.2.2.3. Prior to entering System Development and Demonstration, there shall be an ORD validated by the requirements authority. The ORD contains operational performance requirements and addresses cost for a proposed concept or system. Time-phased ORDs must be validated by the requirements authority prior to program approval. If a mature technology, non-developmental item, or commercial item is being considered for transition to an acquisition program at Milestone B or C, it must have a validated ORD prior to being approved as an acquisition program.

4.7.3.2.2.4. The affordability determination is made in the process of addressing cost as a military requirement in the requirements process and included in each ORD, beginning with the acquisition cost but using life-cycle cost or total ownership cost where available and approved. Transition into System Development and Demonstration also requires full funding (i.e., inclusion in the budget and out-year program of the funding for all current and future efforts necessary to carry out the acquisition strategy), which shall be programmed when a system concept and design have been selected, a PM has been assigned, an ORD has been approved, and system-level development is ready to begin. In the case of a replacement system, when the Milestone B is projected to occur in the first 2 years of the FYDP under review, the program shall be fully funded in that PPBS cycle. In no case shall full funding be done later than Milestone B, unless a program first enters the acquisition process at Milestone C.

4.7.3.2.3. Milestone B. Milestone B is normally the initiation of an acquisition program. The purpose of Milestone B is to authorize entry into System Development and Demonstration.

4.7.3.2.3.1. Milestone Approval Considerations

4.7.3.2.3.1.1. Prior to approving entry into System Development and Demonstration at Milestone B, the MDA shall consider the validated ORD, System Threat Assessment, program protection, independent technology assessment and any technology issues identified by DoD research facilities, any early operational assessments or test and evaluation results, analysis of alternatives including compliance with the Department of Defense's strategic plan (based on the Government Performance and Results Act (GPRA), reference (t)), the independent cost estimate or, for MAISs, component cost analysis and the economic analysis, manpower estimate (if applicable), whether an application for frequency allocation has been made (if the system will require utilization of the electromagnetic spectrum), system affordability and funding, the proposed acquisition strategy, cooperative opportunities, and infrastructure and operational support.

4.7.3.2.3.1.2. At Milestone B the MDA shall confirm the acquisition strategy approved prior to release of the final Request for Proposal and approve the development acquisition program baseline, low-rate initial production quantities (where applicable), and System Development and Demonstration exit criteria (and exit criteria for interim progress review, if necessary). For shipbuilding programs, the lead ship engineering development model shall be authorized at Milestone B. Critical systems for the lead and follow ships shall be demonstrated given the level of technology maturity and the associated risk prior to ship installation. Follow ships may be initially authorized at Milestone B, to preserve the production base, with final authorization dependent on completion of critical systems demonstration, as directed by the MDA.

4.7.3.2.3.1.3. The DOT&E and the cognizant Overarching Integrated Product Team Leader shall approve the Test and Evaluation Master Plan (TEMP) (including the LFT&E strategy, if applicable) for all OSD test and evaluation oversight programs. If full-up, system-level LFT&E is unreasonably expensive and impractical, a waiver shall be approved by the USD(AT&L), for programs where he or she is the MDA, or by the CAE, for programs where he or she is the MDA, and an alternative LFT&E plan shall be approved by the DOT&E before entry into System Development and Demonstration (reference (u)).

4.7.3.2.3.1.4. For MDAPs, a Milestone B decision shall be the occasion for submission of a revised Selected Acquisition Report (DoD 5000.2-R, reference (h)). All new IT acquisition programs (regardless of ACAT) shall be registered with the DoD Chief Information Officer (CIO) before Milestone B approval. IT intended for use by non-military users shall be accessible to people with disabilities (reference (v)).

4.7.3.2.3.1.5. The tables in enclosure 3 identify the statutory and regulatory requirements that must be met at this milestone. Note that these cannot be deferred to a follow-on interim progress review or future milestone.

4.7.3.2.3.2. <u>AIS-Specific Considerations</u>

4.7.3.2.3.2.1. For MAISs, the MDA shall not grant a Milestone B approval until the Component Head or designee certifies to the DoD CIO that the system is being developed in accordance with the Clinger-Cohen Act (CCA) (reference (k)). The DoD CIO shall issue guidance describing minimum criteria for CCA compliance, but at a minimum, the Head of the Component or designee shall certify that:

4.7.3.2.3.2.1.1. There is a validated and approved requirement.

4.7.3.2.3.2.1.2. The program is fully funded.

4.7.3.2.3.2.1.3. There is an approved acquisition program baseline.

4.7.3.2.3.2.1.4. Business process reengineering has been conducted.

4.7.3.2.3.2.1.5. An analysis of alternatives has been conducted.

4.7.3.2.3.2.1.6. Measurable performance measures have been established to track progress in achieving predetermined goals.

4.7.3.2.3.2.1.7. An economic analysis has been conducted that includes a calculation of the return on investment.

4.7.3.2.3.2.1.8. Mission-related, outcome-based performance measures have been established.

4.7.3.2.3.2.1.9. The program has an information assurance strategy and it is consistent with DoD policies, standards, and architectures.

4.7.3.2.3.2.2. The ASD(C3I) shall require a similar certification before granting subsequent milestone approvals. The certification should be made at least 3 months before the milestone approval is needed.

4.7.3.2.3.3. Acquisition Strategy Considerations

4.7.3.2.3.3.1. The acquisition strategy shall define not only the approach to be followed in System Development and Demonstration, but also how the program is structured to achieve full capability. There are two such approaches, evolutionary and single step to full capability. An evolutionary approach is preferred. Evolutionary acquisition is an approach that fields an operationally useful and supportable capability in as short a time as possible. This approach is particularly useful if software is a key component of the system, and the software is required for the system to achieve its intended mission. Evolutionary acquisition delivers an initial capability with the explicit intent of delivering improved or updated capability in the future.

4.7.3.2.3.3.2. The approach to be followed depends on the availability of time-phased requirements in the ORD, the maturity of technologies, the relative costs and benefits of executing the program in blocks versus a single step, including consideration of how best to support each block when fielded (e.g., whether to retrofit earlier blocks, the cost of multiple configurations, how best to conduct new equipment training, etc.). The rationale for choosing a single step to full capability, when given an ORD with time-phased requirements, shall be addressed in the acquisition strategy. Similarly, the rationale for choosing an evolutionary approach, when given an ORD with no time-phased requirements, shall be addressed in the acquisition strategy. For both the evolutionary and single-step approaches, software development and integration shall follow an iterative spiral development process in which continually expanding software versions are based on learning from earlier development.

4.7.3.2.3.3.3. In an evolutionary approach, the ultimate capability delivered to the user is divided into two or more blocks, with increasing increments of capability.

Deliveries for each block may extend over months or years. Block 1 provides the initial deployment capability (a usable increment of capability called for in the ORD). There are two approaches to treatment of subsequent blocks:

4.7.3.2.3.3.3.1. The ORD includes a firm definition of full capability, as well as a firm definition of requirements to be satisfied by each block, including an IOC date for each block. In this case, each block shall be baselined and the acquisition strategy shall define each block of capability and how it will be funded, developed, tested, produced, and operationally supported.

4.7.3.2.3.3.3.2. The ORD includes a firm definition of the first block, but does not allocate to specific subsequent blocks the remaining requirements that must be met to achieve full capability. In an evolutionary acquisition, the specific requirements for Block 2 are defined in the ORD, based on the user's increased understanding of the delivered capability, the evolving threat, and available technology, lead-time-away from beginning work on Block 2, and so on, until full capability is achieved. Requirements that cannot be fulfilled during a specific block development, with the approval of the requirements authority, may be delayed to the next block development. The first block, and each subsequent block, is baselined in conjunction with the MDA authorizing work to proceed on that block. The acquisition strategy shall define the first block, of capability, and how it will be funded, developed, tested, produced, and supported; the full capability the evolutionary acquisition is intended to satisfy, and the funding and schedule planned to achieve the full capability to the extent it can be described; and the management approach to be used to define the requirements for each subsequent block and the acquisition strategy applicable to each block, including whether end items delivered under earlier blocks will be retrofitted with later block improvements.

4.7.3.2.3.3.4. In a single step to full capability approach, the full system capability is developed and demonstrated prior to Milestone C. Under this approach, any modification that is of sufficient cost and complexity that it could itself qualify as an MDAP or MAIS shall be considered for management purpose as a separate acquisition effort. Modifications that do not cross the MDAP or MAIS threshold shall be considered part of the program being modified, unless the program is no longer in production. In that case, the modification shall be considered a separate acquisition effort. Modifications may cause a program baseline deviation. Deviations shall be reported using the criteria and procedures in DoD 5000.2-R (reference (h)).

4.7.3.2.3.4. Entry into System Development and Demonstration

4.7.3.2.3.4.1. Milestone B approval can lead to System Integration or System Demonstration. Regardless of the approach recommended, PMs and other acquisition managers shall continually assess program risks. Risks must be well understood, and risk management approaches developed, before decision authorities can authorize a program to proceed into the next phase of the acquisition process. Risk management is an organized method of identifying and measuring risk and developing, selecting, and managing options for handling these risks. The types of risk include, but are not limited to, schedule, cost, technical feasibility, risk of technical obsolescence, software management, dependencies between a new program and other programs, and risk of creating a monopoly for future procurements.

4.7.3.2.3.4.2. The nature of software-intensive system development, characterized by a spiral build-test-fix-test-deploy process, may lend itself to a combined system integration and system demonstration, rather than serial efforts more typical of hardware-intensive systems.

4.7.3.2.4. System Integration

4.7.3.2.4.1. The program shall enter System Integration when the PM has an architecture for the system, but has not yet integrated the subsystems into a complete system. The program shall exit System Integration when the integration of the system has been demonstrated in a relevant environment using prototypes (e.g., first flight, interoperable data flow across systems), a system configuration has been documented, the MDA determines a factor other than technology justifies forward progress, or the MDA decides to end this effort.

4.7.3.2.4.2. This effort is intended to integrate the subsystems and reduce system-level risk. The work effort will be guided by a validated ORD. The work effort will be followed by System Demonstration after a successful Interim Progress Review by the MDA (or the person designated by the MDA).

4.7.3.2.5. Interim Progress Review. The purpose of an interim progress review is to confirm that the program is progressing within the phase as planned or to adjust the plan to better accommodate progress made to date, changed circumstances, or both. If the adjustment involves changing the acquisition strategy, the change must be approved by the MDA. There is no required information necessary for this review other than the information specifically requested by the decision-maker.

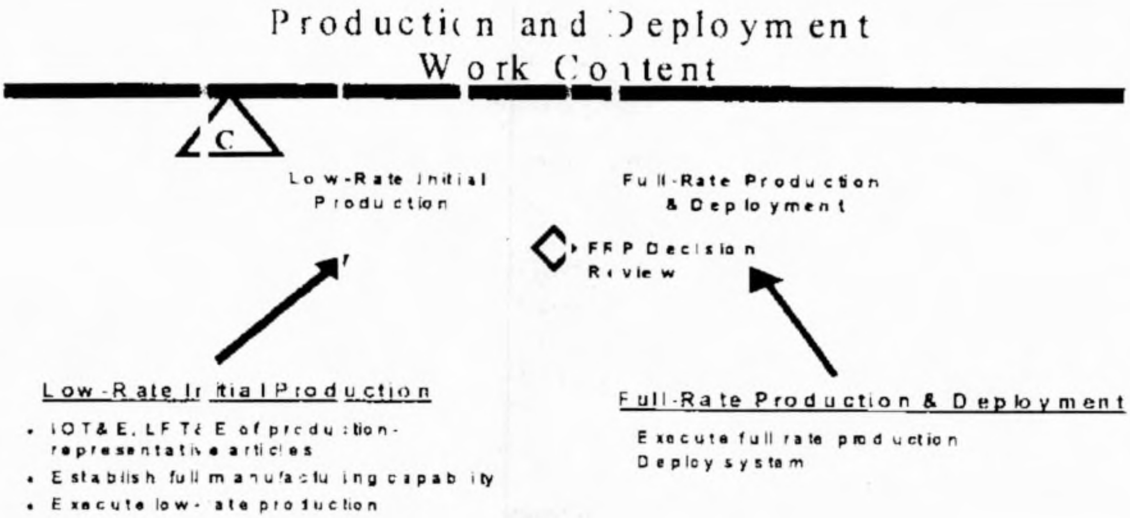
4.7.3.2.6. System Demonstration

4.7.3.2.6.1. The program shall enter System Demonstration when the PM has demonstrated the system in prototype articles. This effort is intended to demonstrate the ability of the system to operate in a useful way consistent with the validated ORD.

4.7.3.2.6.2. This phase ends when a system is demonstrated in its intended environment, using engineering development models or integrated commercial items; meets validated requirements; industrial capabilities are reasonably available; and the system meets or exceeds exit criteria and Milestone C entrance requirements. Preference shall be given to the use of modeling and simulation as the primary method for assessing product maturity where proven capabilities exist, with the use of test to validate modeling and simulation results. The completion of this phase is dependent on a decision by the MDA to commit to the program at Milestone C or a decision to end this effort.

4.7.3.3. Commitment to Low-Rate Production and Produce and Deploy Systems

Figure F5.



4.7.3.3.1. General

4.7.3.3.1.1 The purpose of the Production and Deployment phase is to achieve an operational capability that satisfies mission needs. The production requirement of this phase does not apply to MAISs. However, software has to prove its maturity level prior to deploying to the operational environment. Once maturity has been proven, the system or block is baselined, and a methodical and synchronized deployment plan is implemented to all applicable locations.

4.7.3.3.1.2 A system must be demonstrated before the Department of Defense will commit to production (or procurement) and deployment. For DOT&E Oversight programs, a system can not be produced at full-rate until a Beyond Low-Rate Initial Production Report has been completed and sent to Congress, the Secretary of Defense, and the USD(AT&L). The MDA shall make the commitment decision at Milestone C. Milestone C can be reached directly from pre-systems acquisition (e.g., a commercial product) or from System Development and Demonstration phase

4.7.3.3.2. Entrance Criteria. Regardless of the entry point, approval at Milestone C is dependent on the following criteria being met (or a decision by the MDA to proceed):

4.7.3.3.2.1. Technology maturity (with an independent technology readiness assessment), system and relevant mission area (operational) architectures, mature software capability, demonstrated system integration or demonstrated commercial products in a relevant environment, and no significant manufacturing risks

4.7.3.3.2.2. An approved ORD.

4.7.3.3.2.3. Acceptable interoperability.

4.7.3.3.2.4. Acceptable operational supportability.

4.7.3.3.2.5. Compliance with the DoD Strategic Plan (reference (w)).

4.7.3.3.2.6. Demonstration that the system is affordable throughout the life cycle, optimally funded, and properly phased for rapid acquisition.

4.7.3.3.2.7. Acceptable information assurance to include information assurance detection and recovery.

4.7.3.3.3. Milestone C. The purpose of this milestone is to authorize entry into low-rate initial production (for MDAPs and major systems), into production or procurement (for non-major systems that do not require low-rate production) or into limited deployment for MAIS or software-intensive systems with no production components.

4.7.3.3.3.1. Milestone Approval Considerations

4.7.3.3.3.1.1. Prior to making the milestone decision, the MDA shall consider the independent cost estimate, and, for MAISs, the component cost analysis and economic analysis , the manpower estimate, compliance with the CCA (reference (k)), whether an application for frequency allocation has been approved (for systems that require utilization of the electromagnetic spectrum), System Threat Assessment, and an established completion schedule for National Environmental Policy Act (NEPA) (reference (x)) compliance covering testing, training, basing, and operational support.

4.7.3.3.3.1.2. At this milestone, the MDA shall confirm the acquisition strategy approved prior to the release of the final Request for Proposal and approve an updated development acquisition program baseline, exit criteria for low-rate initial production (LRIP) (if needed) or limited deployment, and the acquisition decision memorandum.

4.7.3.3.3.1.3. The DOT&E and cognizant OIPT Leader shall approve the TEMP for all OSD test and evaluation oversight programs. IT acquisition programs (regardless of ACAT) that entered system acquisition at Milestone C shall be registered with the DoD CIO before Milestone C approval. For MDAPs, a milestone decision shall be the occasion for submission of a revised Selected Acquisition Report (reference (e)).

4.7.3.3.3.1.4. A favorable Milestone C decision authorizes the PM to commence LRIP or limited deployment for MDAPs and major systems. The PM is only authorized to commence full-rate production with further approval of the MDA. There shall be normally no more than one decision (i.e., either low-rate or full-rate) at the Defense Acquisition Executive (DAE)-level for MDAPs.

4.7.3.3.3.1.5. The tables at enclosure 3 identify the statutory and regulatory requirements that must be met at this decision point.

4.7.3.3.3.2. AIS-Specific Considerations

4.7.3.3.2.1. For MAIS, the MDA shall approve, in coordination with DOT&E, the quantity and location of sites for a limited deployment for IOT&E.

4.7.3.3.2.2. MAISs shall complete a CCA compliance certification at Milestone C (see subparagraph 4.7.3.2.3.2., above).

4.7.3.3.4. Low-Rate Initial Production (LRIP)

4.7.3.3.4.1 This work effort is intended to result in completion of manufacturing development in order to ensure adequate and efficient manufacturing capability and to produce the minimum quantity necessary to provide production configured or representative articles for initial operational test and evaluation (IOT&E), establish an initial production base for the system; and permit an orderly increase in the production rate for the system, sufficient to lead to full-rate production upon successful completion of operational (and live-fire, where applicable) testing. The work shall be guided by the ORD.

4.7.3.3.4.2 Deficiencies encountered in testing prior to Milestone C shall be resolved prior to proceeding beyond LRIP (at the Full-Rate Production Decision Review) and any fixes verified in IOT&E. Operational test plans shall be provided to the DOT&E for oversight programs in advance of the start of operational test and evaluation.

4.7.3.3.4.3 LRIP may be funded by either research, development, test and evaluation appropriation (RDT&E) or by procurement appropriations, depending on the intended usage of the LRIP assets. The DoD Financial Management Regulation (reference (y)) provides specific guidance for determining whether LRIP should be budgeted in RDT&E or in procurement appropriations.

4.7.3.3.4.4. LRIP quantities shall be minimized. The MDA shall determine the LRIP quantity for MDAPs and major systems at Milestone B. The LRIP quantity (with rationale for quantities exceeding 10 percent of the total production quantity documented in the acquisition strategy) shall be included in the first Selected Acquisition Report (reference (c)) after its determination. Any increase in quantity after the initial determination shall be approved by the MDA. The LRIP quantity shall not be less than one unit. When approved LRIP quantities are expected to be exceeded because the program has not yet demonstrated readiness to proceed to full-rate production, the MDA shall assess the cost and benefits of a break in production versus continuing annual buys.

4.7.3.3.4.5. DOT&E shall determine the number of LRIP articles required for LFT&E and IOT&E of DOT&E Oversight Programs (MDAPs as defined in paragraph a(2)(B) of 10 U.S.C. 139 (reference (z)). For a system that is not a DOT&E Oversight Program, the Operational Test and Evaluation Agency shall determine the number of LRIP articles required for IOT&E.

4.7.3.3.4.6. LRIP is not applicable to AISs or software intensive systems with no developmental hardware. However, a limited deployment phase may be applicable.

4.7.3.3.4.7. LRIP for ships and satellites is production of items at the minimum quantity and rate that is feasible and that preserves the mobilization production base for that system (reference (aa)).

4.7.3.3.5. Full-Rate Production Decision Review

4.7.3.3.5.1. Before making the full-rate production and deployment decision, the MDA shall consider:

4.7.3.3.5.1.1. The independent cost estimate, and for MAISs, the component cost analysis and economic analysis.

4.7.3.3.5.1.2. The manpower estimate (if applicable).

4.7.3.3.5.1.3. The results of operational and live fire test and evaluation (if applicable).

4.7.3.3.5.1.4. CCA compliance certification (reference (k)) and certification for MAISs (reference (r)).

4.7.3.3.5.1.5. C4I supportability certification.

4.7.3.3.5.1.6. Interoperability certification.

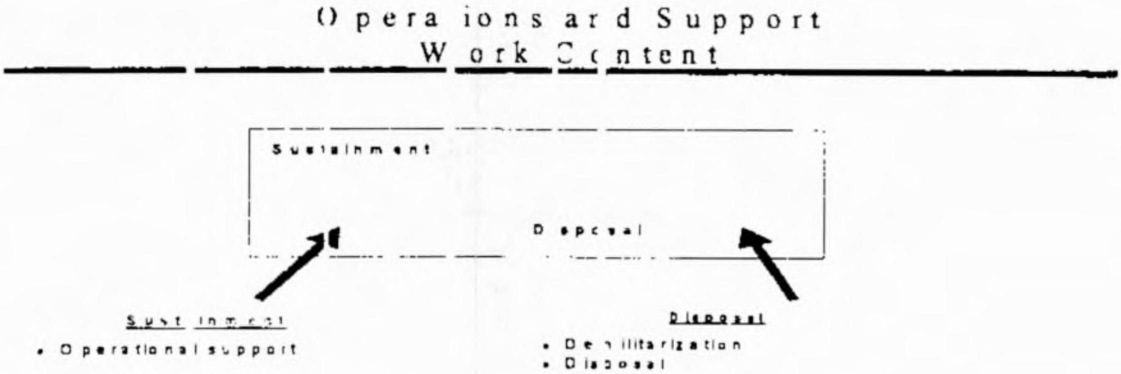
4.7.3.3.5.2. The MDA shall confirm the acquisition strategy approved prior to the release of the final Request for Proposal, the production acquisition program baseline, provisions for evaluation of post-deployment performance (in accordance with GPRA (reference (t)), CCA (reference (k)), and the Paperwork Reduction Act (reference (bb)), and the acquisition decision memorandum.

4.7.3.3.5.3. A full-rate production and deployment decision shall be the occasion for an update of the Selected Acquisition Report (reference (c)).

4.7.3.3.6. Full-Rate Production and Deployment. Following IOT&E, the submission of the Beyond LRIP and LFT&E Reports (where applicable) to Congress, the Secretary of Defense, and the USD(AT&L), and the completion of a Full-Rate Production Decision Review by the MDA (or by the person designated by the MDA), the program shall enter Full-Rate Production (or procurement) and Deployment.

4.7.4. Sustainment. The objectives of this activity are the execution of a support program that meets operational support performance requirements and sustainment of systems in the most cost-effective manner for the life cycle of the system. When the system has reached the end of its useful life, it must be disposed of in an appropriate manner.

Figure F5.



4.7.4.1. Sustain Systems

4.7.4.1.1. The sustainment program includes all elements necessary to maintain the readiness and operational capability of deployed systems. The scope of support varies among programs but generally includes supply, maintenance, transportation, sustaining engineering, data management, configuration management, manpower, personnel, training, habitability, survivability, safety, occupational health, IT (including NSS) supportability and interoperability, and environmental management functions. This activity also includes the execution of operational support plans.

4.7.4.1.2. Programs with software components must be capable of responding to emerging requirements that will require software modification or periodic enhancements after a system is deployed.

4.7.4.1.3. A follow-on operational test and evaluation program that evaluates operational effectiveness, survivability, suitability, and interoperability, and that identifies deficiencies shall be conducted, as appropriate (reference (c)).

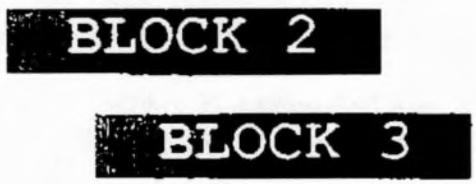
4.7.4.1.4. The Department must develop a system to assess customer confidence at each step of the requirement and distribution chain. The primary metric of confidence shall be customer wait time. In order to achieve customer confidence, the system shall use a simplified priority system driven by user need date, be integrated to allow total asset visibility, and use a fully integrated data environment to ensure the joint users' ability to make timely and confident logistics decisions.

4.7.4.2 Evolutionary Sustainment. Supporting the tenets of evolutionary acquisition, sustainment strategies must evolve and be refined throughout the life cycle, particularly during development of subsequent blocks of an evolutionary strategy, modifications, upgrades, and reprocurement. The PM shall ensure that a flexible, performance-oriented strategy to sustain systems is developed and executed. This strategy will include consideration of the full scope of operational support, such as maintenance, supply, transportation, sustaining engineering, spectrum supportability, configuration and data management, manpower, training, environmental, health, safety, disposal and security factors. The use of performance requirements or conversion to performance requirements shall be emphasized during reprocurement of systems, subsystems, components, spares, and services after the initial production contract.

4.7.4.3. Dispose of Systems. At the end of its useful life, a system must be demilitarized and disposed. The PM shall address in the acquisition strategy demilitarization and disposal requirements and shall ensure that sufficient information exists so that disposal can be carried out in a way that is in accordance with all legal and regulatory requirements relating to safety, security, and the environment. The Defense Reutilization and Marketing Office shall execute the PM's strategy and demilitarize and dispose of items assigned to the Office.

4.7.5. Follow-on Blocks for Evolutionary Acquisition

Figure F7.



4.7.5.1. Evolutionary acquisition strategies are the preferred approach to satisfying operational needs. Evolutionary acquisition strategies define, develop, test, and produce/deploy an initial, militarily useful capability ("Block 1") and plan for subsequent definition, development, test and production/deployment of increments beyond the initial capability over time (Blocks 2, 3, and beyond). The scope, performance capabilities, and timing of subsequent increments shall be based on continuous communications among the requirements, acquisition, intelligence, logistics, and budget communities. Acquisition strategy considerations for evolutionary acquisition are described in subparagraph 4.7.3.2.3.3., above.

4.7.5.2. The requirements community shall ensure that user requirements are prioritized (and constrained, if necessary) for both the capability in the initial block and the increasing functionality in subsequent blocks.

4.7.5.3. The PM shall balance the need to meet evolving user requirements (responsiveness) against the ability of the users to support continued training and repeated deployments for new blocks (turbulence). The PM shall also consider the ability of the system contractor(s) to develop/integrate, test, and deploy multiple concurrent blocks.

4.8. Acquisition Categories and Milestone Decision Authority. A technology project or acquisition program shall be categorized based on its location in the acquisition process, dollar value, and complexity.

4.8.1. Pre-ACAT Technology Projects. Advanced Technology Demonstrations, Joint Warfighting Experiments, Advanced Concept and Technology Demonstrations, Concept Exploration are efforts that occur prior to acquisition program initiation. Component Advanced Development projects may occur before or after acquisition program initiation. If they occur after program initiation, they will be acquisition programs. The USD(AT&L) shall be the MDA for those projects that, if successful, will likely result in an MDAP. The ASD(C3I) shall be the MDA for those projects that, if successful, will result in a MAIS.

4.8.2. ACAT I

4.8.2.1. ACAT I programs are those programs that are MDAPs or that are designated ACAT I by the MDA as a result of the MDA's special interest.

4.8.2.2. In some cases, an ACAT IA program, as defined below, also meets the definition of a MDAP. The USD(AT&L) and the ASD(C3I)/DoD Chief Information Officer (CIO) shall decide who will be the MDA for such AIS programs. Regardless of who is the MDA, the statutory requirements that apply to MDAPs shall apply to such AIS programs.

4.8.2.3. ACAT I programs have two sub categories: ACAT ID, for which the MDA is USD(AT&L) (the "D" refers to the Defense Acquisition Board (DAB), which advises the USD(AT&L) at major decision points) or ACAT IC for which the MDA is the DoD Component Head or, if delegated, the DoD Component Acquisition Executive (CAE) (the "C" refers to Component).

4.8.2.4. Initially, all programs are treated as ACAT ID until formally designated ACAT IC by the USD(AT&L). At any time, the USD(AT&L) may delegate Milestone Decision Authority of an ACAT I program to the Head of the DoD Component who may redelegate to the CAE.

4.8.2.5. If the USD(AT&L) redesignates a formerly ACAT ID program as an ACAT IC program, the following direction shall apply:

4.8.2.5.1. Exit criteria established by the USD(AT&L) prior to the delegation of decision authority shall be maintained in effect unless the USD(AT&L) concurs with any changes.

4.8.2.5.2. The CAE shall approve Acquisition Program Baseline (APB) changes (references (c) and (i)), including updates for threshold breaches, and provide a copy of the new APB to USD(AT&L).

4.8.2.5.3. Acquisition strategies, including CAIV objectives and LRIP quantities, established by the USD(AT&L) prior to the delegation of decision authority shall be maintained in effect during the phase for which approval was given, unless the USD(AT&L) concurs with any changes. When the next milestone approaches and an updated acquisition strategy is prepared for the next phase of the ACAT IC program, it shall not be subject to USD(AT&L) approval.

4.8.2.5.4. The OSD Cost Analysis Improvement Group (CAIG) shall not conduct Independent Cost Estimates for ACAT IC programs unless specifically requested by USD(AT&L). This request usually accompanies the designation of the program as ACAT IC. If the CAIG does not conduct an independent cost estimate, the Component cost analysis office shall provide a component cost analysis to the CAE for consideration at the appropriate decision point.

4.8.3. ACAT IA

4.8.3.1. ACAT IA programs are those programs that are MAISs or that are designated as ACAT IA by the MDA as a result of the MDA's special interest.

4.8.3.2. ACAT IA programs have two sub-categories: ACAT IAM for which the MDA is the Chief Information Officer (CIO) of the Department of Defense (DoD), the ASD(C3I) (the "M" (in ACAT IAM) refers to Major Automated Information System (MAIS)) or ACAT IAC, for which the DoD CIO has delegated milestone decision authority to the CAE or Component CIO (the "C" (in ACAT IAC) refers to Component).

4.8.3.3. The ASD(C3I) designates programs as ACAT IAM or ACAT IAC.

4.8.3.4. If the ASD(C3I) redesignates a formerly ACAT IAM program as an ACAT IAC program, the following direction shall apply:

4.8.3.4.1. Exit criteria established by the ASD(C3I) prior to the delegation of decision authority shall be maintained in effect unless the ASD(C3I) concurs with any changes.

4.8.3.4.2. The CAE or Component CIO shall approve Acquisition Program Baseline (APB) changes, including updates for threshold breaches, and provide a copy of the new APB to ASD(C3I).

4.8.3.4.3. Acquisition strategies, including CAIV objectives, established prior to the delegation of decision authority shall be maintained in effect during the phase for which approval was given, unless the ASD(C3I) concurs with any changes. When the next milestone approaches and an updated acquisition strategy is prepared for the next phase of the ACAT IAC program, it shall not be subject to ASD(C3I) approval.

4.8.4. ACAT II. ACAT II programs are those programs that do not meet the criteria for an ACAT I program, but that are Major Systems or that are designated as ACAT II by the MDA as a result of the MDA's special interest. Because of the dollar values of MAISs, no AIS programs are ACAT II. The MDA is the CAE.

4.8.5. ACAT III. ACAT III programs are defined as those acquisition programs that do not meet the criteria for an ACAT I, an ACAT IA, or an ACAT II. The MDA is designated by the CAE and shall be at the lowest appropriate level. This category includes less-than-major AISs.

4.8.6. Changes in ACAT Level

4.8.6.1. The DoD Component is responsible for notifying the USD(AT&L) or ASD(C3I) when cost growth or a change in acquisition strategy results in reclassifying a formerly lower ACAT program as an ACAT I or IA program. ACAT-level changes will be reported as soon as the Component suspects, within reasonable confidence, that the program is within 10 percent encroachment of the next ACAT level. ACAT-level reclassification will occur upon designation of the USD(AT&L) or the ASD(C3I).

4.8.6.2. The CAE shall request in writing a reclassification of an ACAT I or IA program to a lower acquisition category. The request shall identify the reasons for the reduction in category. The category reduction will become effective upon approval of the request by the USD(AT&L) or ASD(C3I).

4.8.6.3. The USD(AT&L) or ASD(C3I) may reclassify an acquisition program as ACAT ID or IAM at any time.

4.9. Program Management and Assessment. Acquisition programs require dedicated management. This part describes assignment of Program Managers, assignment of Program Executive Officers and the use of Integrated Product Teams.

4.9.1. Assignment of Program Managers. A PM shall be designated for each acquisition program. This designation shall be made no later than program initiation. It is essential that the PM have an understanding of user needs and constraints, familiarity with development principles, and requisite management skills and experience. If the acquisition is for services, the PM shall be familiar with DoD guidance on acquisition of services. A PM and a deputy PM of an ACAT I or II program shall be assigned to the position at least until completion of the major milestone that occurs closest in time to the date on which the person has served in the position for four years in accordance with the Defense Acquisition Workforce Improvement Act (DAWIA) (reference (cc)). Upon designation, the program manager shall be given budget guidance and a written charter of his or her authority, responsibility, and accountability for accomplishing approved program objectives.

4.9.2. Assignment of Program Executive Responsibility. Unless a waiver is granted for a particular program by the USD(AT&L) or the ASD(C3I), CAEs shall assign acquisition program responsibilities to a PEO for all ACAT I, ACAT IA, and sensitive classified programs, or for any other program determined by the CAE to require dedicated executive management. The PEO shall be dedicated to executive management and shall not have other command responsibilities. The CAE shall make this assignment no later than program initiation; or within three months of estimated total program cost reaching the appropriate dollar threshold for ACAT I and ACAT IA programs. CAEs may determine that a specific PM shall report directly, without being assigned to a PEO, whenever such direct reporting is appropriate. The CAE shall notify the USD(AT&L) or the ASD(C3I) of the decision to have a PM report directly to the CAE. Acquisition program responsibilities for programs not assigned to a PEO or a direct-reporting PM shall be assigned to a commander of a systems, logistics, or materiel command. In order to transition from a PEO to a commander of a systems, logistics, or materiel command, a program or block of capability shall, at a minimum, have passed Initial Operating Capability (IOC), have achieved full-rate production, be certified as interoperable within the intended operational environment, and be supportable as planned.

4.9.3. Integrated Product Teams in the Oversight and Review Process. Defense acquisition works best when all of the DoD Components work together cooperatively to share data and information of all types, and the workforce is empowered. Each DoD Component shall implement the concepts of Integrated Product and Process Development (IPPD) and Integrated Product Teams (IPTs) as extensively as possible. All appropriate functional disciplines and the DoD Components shall participate in IPTs to the maximum extent practical and useful.

4.9.4. Decision Reviews. At each milestone and other points in the process where desired by the MDA, the Milestone Decision Authority shall review each technology project or acquisition program. The MDA shall review the Program Manager's program, as informed by the IPT process, and the independent assessments required by law or the MDA's judgment.

5. EFFECTIVE DATE

This Instruction is effective immediately.

Under Secretary of Defense (Acquisition, Technology, & Logistics)

Assistant Secretary of Defense (Command, Control, Communications, and Intelligence)

Director Operational Test & Evaluation

Enclosures - 3

E1. References, continued
E2. Definitions
E3. Statutory and Regulatory Information

E1. ENCLOSURE 1

REFERENCES, continued

(e) Under Secretary of Defense (AT&L), Assistant Secretary of Defense (C3I), and Director, Operational Test and Evaluation, "Defense Acquisition Policy Steering Group and Defense Acquisition Policy Working Group Charter," August 5, 1999
(f) Defense Acquisition Deskbook, www.deskbook.osd.mil
(g) DoD Directive 5000.1, "Defense Acquisition," March 15, 1996 (canceled)
(h) DoD 5000.2-R "Mandatory Procedures for Major Defense Acquisition Programs and Major Automated Information Systems," March 1996 (canceled)
(i) CJCS Instruction 3170.01A, "Requirements Generation System," August 10, 1999
(j) DoD 7000.14-R, "DoD Financial Management Regulation," Volumes 2A and 2B, "Budget Presentation and Formation," July 1998
(k) Section 1401 et seq. of title 40, United States Code, "Clinger-Cohen Act of 1996"
(l) DoD Directive 8000.1, "Defense Information Management (IM) Program," October 27, 1992
(m) DoD Directive 8320.1, "DoD Data Administration," September 26, 1991
(n) DoD Directive 4630.5, "Compatibility, Interoperability, and Integration of Command, Control, Communications and Intelligence (C3I) Systems," November 12, 1992
(o) DoD Instruction 4630.8, "Procedures for Compatibility, Interoperability, and Integration of Command, Control, Communications, and Intelligence (C3I) Systems," November 18, 1992
(p) CJCS Instruction 6212.01B, "Interoperability and Supportability on National Security Systems, and Information Technology Systems," May 14, 2000
(q) Federal Acquisition Regulation, Par. 15.404-1, "Proposal Analysis Techniques"
(r) Fiscal Year 2000 DoD Appropriations Act, Section 8121(b) (Pub. L. 106-79)
(s) Section 2364 of title 10, United States Code, "Coordination and Communication of Defense Research Activities"
(t) Government Performance and Results Act (Pub. L. 103-62)
(u) Section 2366 of title 10, United States Code "Major Systems and Munitions Programs: Survivability and Lethality Testing Required Before Full-scale Production"
(v) Section 794 of title 29, United States Code, "Rehabilitation Act"
(w) Section 306 of title 5, United States Code, "Strategic Plans" (part of the Government Performance and Results Act)
(x) Section 4321 et seq. of title 42, United States Code, "National Environmental Policy Act"
(y) DoD 7000.14-R, "DoD Financial Management Regulation," Volume 2A, "Budget Presentation and Formation," Chapter 1, "General Information," Section 010212, "Research, Development, Test, and Evaluation-Selection and Criteria"
(z) Section 139 of title 10, United States Code, "Director of Operational Test and Evaluation"
(aa) Section 2400 of title 10, United States Code, "Low-rate Initial Production of New Systems"
(bb) Section 3501 et seq. of title 44, United States Code, "Paperwork Reduction Act of 1980"
(cc) Section 1734 of title 10, United States Code, "Career Development"
(dd) Section 2430 of title 10, United States Code, "Major Defense Acquisition Program Defined"
(ee) Section 2302d of title 10, United States Code, "Major System: Definitional Threshold Amounts"

(ff) DoD 5000.4-M, "Cost Analysis Guidance and Procedures." December 1992
(gg) Section 2377 of title 10, United States Code, "Preference for Acquisition of Commercial Items"
(hh) Section 2435 of title 10, United States Code, "Baseline Description"
(ii) Section 2432 of title 10, United States Code, "Selected Acquisition Reports"
(jj) Section 2433 of title 10, United States Code, "Unit Cost Reports"
(kk) Section 2440 of title 10, United States Code. "Technology and Industrial Base Plans"
(ll) Section 2434 of title 10, United States Code, "Independent Cost Estimates; Operational Manpower Requirements"
(mm) Section 2399 of title 10, United States Code. "Operational Test and Evaluation of Defense Acquisition Programs"
(nn) Section 2350a of title 10, United States Code, "Cooperative Research and Development Programs: Allied Countries"
(oo) Section 305 of title 47, United States Code, "Government-Owned Stations"
(pp) Section 104 of the National Telecommunications and Information Organization Act, "Spectrum Management Activities" (Pub. L. 102-538)
(qq) Sections 901, 902, 903, and 904 of title 47, United States Code
(rr) Section 2464 of title 10, United States Code, "Core "Logistics Functions"
(ss) Section 2460 of title 10, United States Code, "Definition of Depot-Level Maintenance and Repair"
(tt) Section 2466 of title 10, United States Code, "Limitations on the Performance of Depot-Level Maintenance of Material"
(uu) Section 2469 of title 10, United States Code, "Contracts to Perform Workloads Previously Performed by Depot-Level Activities of the Department of Defense: Requirement of Competition"
(vv) DoD Directive 5105.21, "Defense Intelligence Agency," February 18, 1997
(ww) DoD 5200.1-M, "Acquisition System Program Protection," March 16, 1994

E2. ENCLOSURE 2

DEFINITIONS

E2.1.1. Acquisition Executive. The individual within the Department and Components charged with overall acquisition management responsibilities within his or her respective organization. The Under Secretary of Defense for Acquisition, Technology, and Logistics is the Defense Acquisition Executive (DAE) responsible for all acquisition matters within the Department of Defense. The Component Acquisition Executives (CAEs) for each of the Components are the Secretary of the Military Departments or the Heads of Agencies with power of redelegation. The CAEs are responsible for all acquisition matters within their respective Component.

E2.1.2. Acquisition Program. A directed, funded effort designed to provide a new, improved, or continuing materiel, weapon, or information system or service capability in response to a validated operational or business need. Acquisition programs are divided into different categories that are established to facilitate decentralized decision-making, execution, and compliance with statutory requirements. Technology projects are not acquisition programs.

E2.1.3. Automated Information System (AIS). An acquisition program that acquires Information Technology (IT), except IT that:

E2.1.3.1. Involves equipment that is an integral part of a weapon or weapons system; or

E2.1.3.2. Is a tactical communication system.

E2.1.4. Information Technology (IT). Any equipment, or interconnected system or subsystem of equipment, that is used in the automatic acquisition, storage, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of data or information.

E2.1.4.1. The term "equipment" means any equipment used by a Component directly or used by a contractor under a contract with the Component that requires the use of such equipment, or the use, to a significant extent, of such equipment in the performance of a service or the furnishing of a product.

E2.1.4.2. The term "IT" includes computers, ancillary equipment, software, firmware and similar procedures, services (including support services), and related resources. The term "IT" also includes National Security Systems (NSSs). It does not include any equipment that is acquired by a Federal contractor incidental to a Federal contract.

E2.1.4.3. This definition is from the CCA (reference (k)).

E2.1.5. Integrated Product and Process Development (IPPD). A management process that integrates all activities from product concept through production and support, using a multifunctional team, to simultaneously optimize the product and its manufacturing and sustainment processes to meet cost, schedule, and performance objectives.

E2.1.6. Integrated Product Team (IPT). A multifunctional team assembled around a product or service, and responsible for advising the project leader, Program Manager, or MDA on cost, schedule, and performance of that product. There are three types of IPTs: Program IPTs, Working-level IPTs, and Overarching IPTs.

E2.1.7. Major Automated Information System (MAIS)

E2.1.7.1. An AIS that is designated by ASD(C3I) as a MAIS, or estimated to require program costs in any single year in excess of $32 million in fiscal year (FY) 2000 constant dollars, total program costs in excess of $126 million in FY 2000 constant dollars, or total life-cycle costs in excess of $378 million in FY 2000 constant dollars.

E2.1.7.2. MAISs do not include highly sensitive classified programs (as determined by the Secretary of Defense) or tactical communication systems.

E2.1.7.3. For the purpose of determining whether an AIS is a MAIS, the following shall be aggregated and considered a single AIS:

E2.1.7.3.1. The separate AISs that constitute a multi-element program.

E2.1.7.3.2. The separate AISs that make up an evolutionary or incrementally developed program.

E2.1.7.3.3. The separate AISs that make up a multi-DoD Component AIS program.

E2.1.8. Major Defense Acquisition Program (MDAP)

E2.1.8.1. An acquisition program that is not a highly sensitive classified program (as determined by the Secretary of Defense) and that is designated by the Under Secretary of Defense (Acquisition, Technology, and Logistics) (USD(AT&L)) as an MDAP, or estimated by the USD(AT&L) to require an eventual total expenditure for research, development, test and evaluation of more than $365 million in fiscal year (FY) 2000 constant dollars or, for procurement, of more than $2.190 billion in FY 2000 constant dollars.

E2.1.8.2. The estimate shall consider all blocks that will make up an evolutionary acquisition program (to the extent that subsequent blocks can be defined).

E2.1.8.3. This definition is from 10 U.S.C. 2430 (reference (dd)). The dollar requirements are established in statute in FY 1990 dollars. The dollar amounts have been updated in accordance with procedures identified in the statute.

E2.1.9. Major System. A combination of elements that shall function together to produce the capabilities required to fulfill a mission need, including hardware, equipment, software, or any combination thereof, but excluding construction or other improvements to real property.

E2.1.9.1. A system shall be considered a major system if it is estimated by the DoD Component Head to require an eventual total expenditure for RDT&E of more than $140 million in FY 2000 constant dollars, or for procurement of more than $660 million in FY 2000 constant dollars, or if designated as major by the DoD Component Head (10 U.S.C. §2302d, reference (ee)).

E2.1.9.2. The estimate shall consider all blocks that will make up an evolutionary acquisition program (to the extent subsequent blocks can be defined).

E2.1.9.3. The dollar requirements are established in statute in FY 1990 dollars. The dollar amounts have been updated in accordance with procedures identified in the statute.

E2.1.10. Milestone Decision Authority (MDA). The individual designated in accordance with criteria established by the USD(AT&L), or by the ASD(C3I) for AIS acquisition programs, to approve entry of an acquisition program into the next phase of the acquisition process.

E2.1.11. National Security System (NSS). Any telecommunications or information system operated by the U.S. Government, the function, operation, or use of which:

E2.1.11.1. Involves intelligence activities;

E2.1.11.2. Involves cryptologic activities related to national security;

E2.1.11.3. Involves command and control of military forces;

E2.1.11.4. Involves equipment that is an integral part of a weapon or weapons system; or,

E2.1.11.5. Subject to the limitation below, is critical to the direct fulfillment of military or intelligence missions. This does not include a system that is to be used for routine administrative and business applications (including payroll, finance, logistics, and personnel management applications).

E2.1.11.6. This definition is from the Clinger-Cohen Act (reference (k)).

E2.1.12. Overarching Integrated Product Team (OIPT) Leader. The person in the Office of the Secretary of Defense who leads the Overarching Integrated Product Team and is responsible for providing an assessment of each assigned program. The OIPT Leader is not in the decision-making line of authority for programs.

E2.1.13. Program Executive Officer (PEO). A military or civilian official who has primary responsibility for directing several MDAPs and for assigned major system and non-major system acquisition programs. A PEO has no other command or staff responsibilities within the Component, and only reports to and receives guidance and direction from the DoD Component Acquisition Executive.

E2.1.14. Program Manager (PM). The individual designated in accordance with criteria established by the appropriate Component Acquisition Executive to manage an acquisition program and is appropriately certified under the provisions of the DAWIA (reference (cc)). A PM has no other command or staff responsibilities within the Component.

E2.1.15. Requirements Authority. The individual within the DoD Components charged with overall requirements definition and validation. The Vice-Chairman of the Joint Chiefs of Staff, in the role as Chairman of the JROC, is the requirements authority for all potential major defense acquisition programs and is responsible for all requirements policy and procedures, including MNSs, CRDs, and ORDs. The Requirements Authority for other acquisition category programs is specified in reference (i).

E2.1.16. Technology Project. A directed, incrementally funded effort designed to provide new capability in response to technological opportunities or an operational or business (e.g., accounting, inventory cataloging, etc.) need. Technology projects are "pre-systems acquisition," do not have an acquisition category, and precede program initiation. Technology is the output of the science and technology program that is used in systems acquisition. The decision authority and information necessary for decision-making on each project shall be specified by the appropriate S&T Executive (for projects not yet approved for Milestone A) or by the MDA (for projects past Milestone A).

E2.1.17. Total Ownership Cost (TOC). The sum of financial resources to organize, equip, sustain, and operate military forces to meet national goals, policies, and standards of readiness, environmental compliance, safety, and quality of life concerns. The TOC for Defense systems consists of the costs to research, develop, acquire, own, operate, and dispose of weapon and support systems. It includes direct costs and indirect costs attributable to the systems and infrastructure costs not directly attributable to the system. Product support mainly concerns the portion of TOC that occurs after the system is deployed (the sustainment and disposal phase of a system's life cycle). For purposes of costing, the PM shall use life-cycle costs as defined in DoD 5000.4-M (reference (ff)).

E2.1.18. Weapon System. An item or set of items that can be used directly by warfighters to carry out combat or combat support missions to include tactical communication systems.

E3. ENCLOSURE 3

STATUTORY AND REGULATORY INFORMATION

E3.1.1. Tables 1 and 2, below, show the information requirements for all milestones, both statutory and regulatory.

For AIS programs, the information in this table except for CCA compliance is regulatory, not statutory, unless otherwise stated or the AIS is a MDAP. Acquisition Program Baselines and Industrial Capabilities, below, for MDAPs are required by the statute cited. For non-MDAPs, they are required by this Instruction.

E3.T1. Table 1. Statutory Information Requirements

INFORMATION REQUIRED	APPLICABLE STATUTE	WHEN REQUIRED
Consideration of Technology Issues	10 U.S.C. § 2364 (reference (s))	Milestone (MS) A MS B MS C
Market Research	10 U.S.C. §2377 (reference (gg))	Technology Opportunities User Needs MS A MS B
Acquisition Program Baseline (APB)	10 U.S.C. §2435 (reference (hh))	Component Advanced Development (if Program Initiation) MS B MS C (updated, as necessary) Full-Rate Production Decision Review (DR)
Compliance with Strategic Plan (as part of the analysis of alternatives, whenever practical)	5 U.S.C. 306 (reference (k))	MS B MS C
Selected Acquisition Report (SAR) (MDAPs only) Unit Cost Report (UCR) (MDAPs only)	10 U.S.C. §2432 (reference (ii)) 10 U.S.C. §2433 (reference (jj))	Component Advanced Development (if Program Initiation) MS B MS C Full-Rate Production DR
Live Fire Waiver & alternate LFT&E Plan (Covered Systems only)	10 U.S.C. §2366 (reference (u))	MS B
Industrial Capabilities (part of acquisition strategy) (N/A for AISs)	10 U.S.C. §2440 (reference (kk))	MS B MS C
LRIP Quantities (N/A for AISs)	10 U.S.C. §2400 (reference (aa))	MS B
Independent Cost Estimate and Manpower Estimate (N/A for AISs) (MDAPs Only)	10 U.S.C. §2434 (reference (ll)) DoDI 5000.2 (this instruction) 10 U.S.C. §2434 (reference (ll))	MS B MS C (ICE only) Full-Rate Production DR
Operational Test Plan (DOT&E Oversight Programs only)	10 U.S.C. §2399 (reference (mm))	Prior to start of operational test and evaluation
Cooperative Opportunities (part of acquisition strategy)	10 U.S.C. §2350a (reference (nn))	MS B MS C
Post-Deployment Performance Review	5 U.S.C. §306 (reference (w)) 40 U.S.C. §1401 et seq. (reference (x))	Full-Rate Production DR

E3.T1. Table 1. Statutory Information Requirements, continued

INFORMATION REQUIRED	APPLICABLE STATUTE	WHEN REQUIRED
Beyond-LRIP Report (OSD T&E Oversight programs only)	10 U.S.C.§2399 (reference (mm))	Full-Rate Production DR
LFT&E Report OSD-covered programs only)	10 U.S.C.§2366 (reference (u))	Full-Rate Production DR
Clinger-Cohen Act (CCA) Compliance (All IT – including NSS)	40 U.S.C.§1401 et seq. (reference (k))	MS B MS C Full-Rate Production DR
CCA Certification (requirement for certification prior to milestone approval for MAISs only)	Pub. L. 106-79, Section 8121(b) (reference (r))	Component Advanced Development (if Program Initiation) MS B MS C Full-Rate Production DR
Application for Frequency Allocation (DD Form 1494) (applicable to all systems/equipment that require utilization of the electromagnetic spectrum)	47 U.S.C. §305 (reference (oo)) Pub. L. 102-538, §104 (reference (pp)) 47 U.S.C. §901-904 (reference (pp))	MS B or C
National Environmental, Policy Act Schedule	42 U.S.C.§4321 (reference (x))	Component Advance Development (if Program Initiation) MS B MS C Full-Rate Production DR
Core Logistics Analysis/Source of Repair Analysis (part of acquisition strategy)	10 U.S.C. §2464 (reference (rr)) 10 U.S.C. §2460 (reference (ss)) 10 U.S.C. §2466 (reference (tt))	MS B or C
Competition Analysis ($3M rule) (part of acquisition strategy)	10 U.S.C. §2469 (reference (uu))	MS B or C

E3.1.2. All requirements are from this Instruction or DoD 5000.2-R (reference (h)), unless otherwise noted.

E3.T2. Table 2. Regulatory Information Requirements

INFORMATION REQUIRED	WHEN REQUIRED
Validated Mission Need Statement (MNS) (source: CJCS Instruction 3170.01A, reference (i))	MS A
Validated Operational Requirements Document (ORD) (source: CJCS Instruction 3170.01A, reference (i))	MS B MS C
Acquisition Strategy	Component Advanced Development (if Program Initiation) MS B MS C Full-Rate Production DR
Analysis of Multiple Concepts	MS A
Analysis of Alternatives (AoA)	MS B or C (if no B)
System Threat Assessment (N/A for AISs) (validated by DIA for ACAT ID programs) (source: DoD Directive 5105.21 (reference (vv)))	MS B MS C
Independent Technology Assessment	MS B MS C
C4ISP (also summarized in the acquisition strategy)	MS B MS C

E3.T2. Table 2. Regulatory Information Requirements, continued

INFORMATION REQUIRED	WHEN REQUIRED
C4I Supportability Certification	Full-Rate Production DR
Interoperability Certification	Full-Rate Production DR
Affordability Assessment	MS B MS C
Economic Analysis (MAISs only)	MS B
Component Cost Analysis (mandatory for MAIS; as requested by CAE for MDAP)	MS B (for MAIS, each time the MDA requests an Economic Analysis Full-Rate Production DR (MDAPs only)
Cost Analysis Requirements Description (MDAPs only)	MS B MS C Full-Rate Production DR
Test and Evaluation Master Plan (TEMP)	MS A (evaluation strategy only) MS B MS C (update, if necessary) Full Rate Production DR
Operational Test Activity Report of Operational Test and Evaluation Results	MS B MS C Full-Rate Production DR
Component Live Fire Test and Evaluation Report (Covered Systems Only)	Completion of Live Fire Test and Evaluation
Program Protection Plan (PPP) (also summarized in the acquisition strategy) (source: DoD 5200.1-M, reference (ww))	MS B (based on validated requirements in ORD) MS C
Exit Criteria	MS A MS B MS C Each Review
ADM	MS A MS B MS C Each DR/IPR

C

Department of Defense
DIRECTIVE

NUMBER 5141.2
May 25, 2000

DA&M

SUBJECT: Director of Operational Test and Evaluation (DOT&E)

References: (a) Title 10, United States Code
(b) DoD Directive 5141.2, "Director of Operational Test and Evaluation," April 2, 1984 (hereby canceled)
(c) DoD Directive 3200.11, "Major Range and Test Facility Base," January 26, 1998
(d) DoD 5025.1-M, "DoD Directives System Procedures," August 1994
(e) through (g), see enclosure 1

1. REISSUANCE AND PURPOSE

Pursuant to the authorities provided in reference (a), this Directive reissues reference (b) to update the responsibilities, functions, relationships, and authorities of the DOT&E.

2. APPLICABILITY

This Directive applies to the Office of the Secretary of Defense, the Military Departments, the Chairman of the Joint Chiefs of Staff, the Combatant Commands, the Office of the Inspector General of the Department of Defense, the Defense Agencies, and the DoD Field Activities, and all other organizational entities within the Department of Defense (hereafter referred to collectively as "the DoD Components").

3. DEFINITIONS

3.1. Operational Test and Evaluation (OT&E). The field test, under realistic operational conditions, of any item (or key component) of weapons, equipment, or munitions for the purpose of determining the operational effectiveness and operational suitability of the weapons, equipment, or munitions for operational use, including combat, by typical military users, and the evaluation of the results of such test.

3.2. Live Fire Test and Evaluation (LFT&E). A test that involves the firing of actual munitions at targets to examine user casualty, vulnerability and/or lethality issues, and the evaluation of the results of such tests.

3.3. Operational Test Agency (OTA). The Army Test and Evaluation Command, the Navy Operational Test and Evaluation Force, the Air Force Operational Test and Evaluation Center, the Marine Corps Operational Test and Evaluation Activity, and the Joint Interoperability Test Command.

3.4. Test and Evaluation (T&E) Infrastructure. Test ranges, facilities, test beds, instrumentation and communications systems, targets, threat representations, vehicles, modeling and simulation, personnel, base support activities, air space, land space, sea space, and other resources in the Department of Defense used to support the conduct of test and evaluation.

3.5. Major Range and Test Facility Base (MRTFB). Specific test ranges and facilities within the Department of Defense test and evaluation infrastructure governed by reference (c)

4. RESPONSIBILITIES AND FUNCTIONS

4.1. The Director of Operational Test and Evaluation is the Principal Staff Assistant and advisor to the Secretary and Deputy Secretary of Defense for the responsibilities and functions described herein. The DOT&E shall not exercise responsibility for developmental test and evaluation except to provide advice to officials responsible for such testing.

4.2. The DOT&E shall:

4.2.1. Prescribe policies and procedures for the conduct of OT&E and LFT&E, and for the composition and operations of the MRTFB within the Department of Defense.

4.2.2. Provide advice and make recommendations to the Secretary and Deputy Secretary of Defense and the Under Secretary of Defense (Acquisition, Technology, and Logistics) (USD(AT&L)). Issue guidance to and consult with the

Heads of the DoD Components with respect to OT&E, LFT&E and the T&E infrastructure in the Department of Defense in general, and with respect to specific OT&E and LFT&E to be conducted in connection with programs under DOT&E oversight and to specific issues regarding the MRTFB.

4.2.3. Designate as appropriate, selected special interest weapons, equipment, or munitions, for DOT&E oversight in accordance with section 139 of title 10, United States Code (reference (a)), and this Directive. Such designation will be identified annually, and does not extend to other purposes for which the term may be used outside of this context.

4.2.4. Monitor and review all OT&E and LFT&E in the Department of Defense, and activities of the MRTFB, to ensure adherence to approved policies and standards.

4.2.5. Analyze the results of OT&E and LFT&E conducted on programs under DOT&E T&E oversight, and submit reports as follows:

4.2.5.1. For OT&E, prior to a decision to proceed beyond low-rate initial production, submit a report to the Secretary of Defense, the USD(AT&L), and the congressional defense committees that addresses:

4.2.5.1.1. The adequacy of the test and evaluation performed.

4.2.5.1.2. Whether the results confirm the operational effectiveness, operational suitability, lethality, and survivability of the items or components actually tested.

4.2.5.2. For LFT&E, prior to a decision to proceed beyond low-rate initial production, submit a report to the Secretary of Defense and congressional defense committees that describes the results of the testing and provides an overall assessment.

4.2.5.3. Report annually to the Secretary of Defense, the USD(AT&L), and the Congress summarizing the OT&E and LFT&E activities and the condition of the test and evaluation infrastructure and resources of the Department of Defense during the preceding fiscal year. The report shall include comments and recommendations on resources and facilities available for T&E and levels of funding made available for OT&E and LFT&E activities.

4.2.5.4. Provide evaluation reports as requested by the Secretary of

Defense or USD(AT&L) in support of system acquistion reviews and the Defense Acquistion Executive Summary preparation

4.2.6. Coordinate Joint Operational Testing.

4.2.7. Ascertain the status of interoperability of information technology and national security systems by assisting the Commanders in Chief of the Combatant Commands and DoD Components in planning exercises, experiments, and training activities which will verify proposed solutions to identified shortfalls.

4.2.8. Oversee Joint Operational Test and Evaluation programs, including chartering and test plan approval, to obtain information pertinent to joint operational doctrine, tactics, and procedures.

4.2.9. Manage the Joint Live Fire program to obtain information pertinent to improving system design, operational doctrine, tactics, and procedures relative to survivability and lethality.

4.2.10 Oversee and direct the activities of the Central Test and Evaluation Investment Program, the Joint Technical Coordinating Groups on Aircraft Survivability and for Munitions Effectiveness, DoD Threat Systems Office, the Precision Guided Weapons Countermeasures Test and Evaluation Directorate, and the Defense Test and Evaluation Professional Institute.

4.2.11 Promote coordination, cooperation, and mutual understanding within the Department of Defense and between the Department of Defense and other Federal Agencies, State, local, and foreign governments and the civilian community with regard to T&E matters.

4.2.12 Co-oversee Joint Test and Evaluation (JT&E) projects and jointly approve JT&E test plans with the USD(AT&L) to ensure an operational test focus.

4.2.13 Establish DoD-wide investment strategies, business processes, policies, for improving the realism, responsiveness and productivity of the test and evaluation infrastructure. Review the DoD Component budget submissions to determine the adequacy of OT&E and LFT&E funding, and the adequacy of funding, for all test investments and recapitalization of ranges and facilities and other resources used for T&E.

4.2.14 Perform such other responsibilities as the Secretary or Deputy Secretary of Defense may prescribe

5. RELATIONSHIPS

5.1. In the performance of assigned functions and responsibilities, the DOT&E shall:

5.1.1. Report directly to the Secretary and Deputy Secretary of Defense.

5.1.2. Serve as a permanent member to the T&E Executive Agent Board of Directors and co-chair the Senior Advisory Group for JT&E.

5.1.3. Require, as appropriate, that observers designated by the DOT&E, be present during the preparation for, and the conduct of, the test part of any OT&E conducted by the DoD Components.

5.1.4. Monitor and review the activities of the Operational Test Agencies.

5.1.5. Use existing systems, facilities, and services of the Department of Defense and other Federal Agencies whenever practicable, to achieve maximum efficiency.

5.2. Other OSD officials and Heads of the DoD Components shall coordinate with the DOT&E on all OT&E and LFT&E, independent test and evaluation programs, test resources, the MRTFB and test and evaluation infrastructure matters as prescribed herein.

5.3. The Secretaries of the Military Departments shall report promptly to the Director, OT&E, the results of all OT&E and LFT&E events conducted by the Military Departments and on all studies conducted by the Military Departments in connection with their OT&E and LFT&E activities.

5.4. The DoD Components, as appropriate shall report promptly to the DOT&E all activities affecting the composition, capabilities, capacity, resources, activity missions, and funding of the MRTFB and the remainder of the test and evaluation infrastructure, operational training ranges, and modeling and simulation facilities and capabilities used for test and evaluation.

6. AUTHORITIES

6.1. The DOT&E is hereby granted authority to:

6.1.1. Co-approve the DoD Test and Evaluation Master Plan (TEMP) and T&E portions of integrated program management documents with the USD(AT&L) for major and other designated defense acquisition programs, and with the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence for major and other designated automated information systems. Approve the TEMP or T&E portions of the integrated program management documents for programs that are solely under DOT&E oversight.

6.1.2. Approve alternative LFT&E strategies in support of waivers of full-up system-level live fire testing.

6.1.3. Chair and re-charter the Defense Test and Training Steering Group (DTTSG) in conjunction with the Under Secretary of Defense (Personnel and Readiness).

6.1.4. Issue DoD Instructions, DoD publications, and one-time directive-type memoranda, consistent with DoD 5025.1-M (reference (d)), that implement policies approved by the Secretary of Defense in order to carry out the functions assigned to the Director, OT&E. Instructions to the Military Departments and other DoD Components shall be issued through the Secretaries or Heads of those Components or their designees. Instructions to Combatant Commands shall be issued through the Chairman of the Joint Chiefs of Staff.

6.1.5. Serve as a permanent member of the Defense Acquisition Board, Program Review Group, and Information Technology Overarching Integrated Product Team for the purpose of carrying out the principles and policies of DoD Directive 5000.1 (reference (e)), DoD 5000.2-R (reference (f)), and DoD Directives System issuances pertaining to test and evaluation activities.

6.1.6. Obtain reports, information, advice, and assistance, consistent with DoD Directive 8910.1 (reference (g)), as necessary in carrying out assigned functions.

6.1.7. Establish arrangements for DoD participation in non-defense governmental programs for which the DOT&E is assigned primary cognizance.

6.1.8. Communicate with other Government officials, representatives of the Legislative Branch, and members of the public, as appropriate, in carrying out assigned responsibilities and functions.

6.1.9. Coordinate and exchange information with other DoD officials exercising collateral or related responsibilities.

7. EFFECTIVE DATE

This Directive is effective immediately.

Rudy de Leon
Deputy Secretary of Defense

Enclosures - 1
E1. References, continued

E1. ENCLOSURE 1

REFERENCES, continued

(e) DoD Directive 5000.1, "Defense Acquisition," March 15, 1996

(f) DoD Regulation 5000 2-R, "Mandatory Procedures for Major Defense Acquisition Programs (MDAPS) and Major Automated Information System (MAIS) Acquisition Programs," March 15, 1996

(g) DoD Directive 8910.1, "Management and Control of Information Requirements," June 11, 1993

D

3200.11 UPDATE

Background:

The Department of Defense Directive 3200.11 establishes policy and responsibilities for the management and operation of specific Department of Defense test and evaluation activities, collectively referred to as the Major Range and Test Facility Base. The Secretary of Defense approved the "Transfer and Streamlining of Test and Evaluation," on June 7, 1999, which, among other things, transferred oversight of the Department of Defense Major Range and Test Facility Base from the Under Secretary of Defense (Acquisition, Logistics and Technology) to the Director, Operational Test and Evaluation. This transfer was further solidified by the reissuance of the Department of Defense Directive 5141.2, "Director of Operational Test and Evaluation," on May 25, 2000. The governing directive for the Major Range and Test Facility Base, Department of Defense Directive 3200.11, required updating to reflect these actions. No changes were included that will affect the current operation or management of Major Range and Test Facility Base activities owned by the military departments or defense agencies.

Current Initiative:

The revised directive is currently in the Deputy Secretary of Defense's office for signature. The draft directive has been coordinated in accordance with Department of Defense Directive 5025.1. No issues resulted from the coordination process.

Department of Defense

DIRECTIVE

NUMBER 3200.11
DOT&E

SUBJECT: Major Range and Test Facility Base (MRTFB)

References:
- (a) DoD Directive 3200.11, "Major Range and Test Facility Base," January 26, 1998 (hereby canceled)
- (b) DoD Directive 5141.2, "Director of Operational Test and Evaluation," May 25, 2000
- (c) DoD 3200.11-D, "Major Range and Test Facility Base Summary of Capabilities," June 1, 1983
- (d) DoD 5025.1-M, "DoD Directives System Procedures," August 1994
- (e) through (o), see enclosure 1

1. REISSUANCE AND PURPOSE

This Directive:

1.1. Reissues reference (a) to update policy and responsibilities for the management and operation of specific DoD test and evaluation (T&E) activities (enclosure 2) (hereafter collectively referred to as the MRTFB), and realigns responsibilities for the MRTFB in accordance with reference (b).

1.2. Continues to authorize publication of DoD 3200.11-D (reference (c)), consistent with DoD 5025.1-M (reference (d))

2. APPLICABILITY

This Directive applies to the Office of the Secretary of Defense, the Military Departments, the Chairman of the Joint Chiefs of Staff, the Combatant Commands, the Inspector General of the Department of Defense, the Defense Agencies, the DoD Field Activities, and all other organizational entities within the Department of Defense (hereafter referred to collectively as "the DoD Components").

3. POLICY

3.1. General. The MRTFB is a national asset that shall be sized, operated, and maintained primarily for DoD T&E support missions, but also may, in accordance with this directive, be available to all users having a valid requirement for its capabilities.

3.1.1. The MRTFB consists of a broad base of T&E activities managed and operated under uniform guidelines to provide T&E support to the DoD Components responsible for developing or operating materiel and weapon systems.

3.1.2. In accordance with DoD 5000.2-R (reference (e)), T&E programs shall be structured to integrate all developmental T&E, operational T&E, live-fire T&E, and modeling and simulation activities conducted by different agencies as an efficient continuum. All such activities shall be part of a strategy to provide information on risk and risk mitigation, to provide empirical data for validation of models and simulations, to permit an assessment of the attainment of technical performance specifications and system maturity, and to determine whether systems are operationally effective, suitable, and survivable for the intended use. The MRTFB is a national asset that exists primarily to provide T&E information for DoD decision-makers and to support T&E needs of DoD research programs and weapon system development programs.

3.1.3. Other U.S. Government Agencies, state and local governments, allied foreign governments, and defense contractors may be permitted to use the MRTFB. Commercial entities may use the MRTFB in accordance with 10 U.S.C. 2681 (reference (f)) and DoD policy guidance. MRTFB commanders are to ensure that they are not competing with U.S. private industry in providing services to commercial entities. The use of MRTFB facilities by non-DoD entities shall not increase the cost to the Department to operate the MRTFB and shall not be factored into the decision-making process for sizing and maintaining the T&E infrastructure.

3.1.4. All users shall reimburse the MRTFB activities in accordance with the appropriate provisions of DoD 7000.14-R, "DoD Financial Management Regulation" per Paragraph 3.6.2. herein.

3.2. <u>Scheduling of Test Resources</u>. Test resources shall be scheduled on the basis of a priority system that gives equitable consideration to all DoD Components. Use of existing Military Department priority and precedence rating systems is encouraged, but such systems must accommodate DoD priorities, and not discriminate among DoD programs on the basis of DoD Component sponsorship.

3.2.1. While priorities and precedence ratings are a primary consideration, test support schedules shall also recognize specific time restrictions (such as launch windows and Defense Acquisition Board schedule milestones), and minimize delays to lower priority projects.

3.2.2. Scheduling conflicts that cannot be resolved at the installation and/or activity, or at the DoD Component level, shall be referred to the Director of Operational Test and Evaluation.

3.2.3. MRTFB commanders shall assure equitable access for commercial entities and non-DoD Government users at their installations.

3.2.3.1. Commanders shall establish workable guidelines for their installations to provide some schedule stability and assurance to commercial entities and non-DoD Government users without compromising primary responsibility to DoD customers. The MRTFB commanders are responsible for resolving conflicts among all competing entities. Commanders' decisions on all such conflicts involving commercial and non-DoD Government entities shall be final. Every effort shall be made to meet all valid customer requirements.

3.2.3.2. The MRTFB commanders are authorized to terminate, prohibit, or suspend immediately any commercial test or evaluation activity if the installation commander determines in writing that the test or evaluation activity is or would be detrimental to:

3.2.3.2.1. The public health and safety

3.2.3.2.2. Property (either public or private)

3.2.3.2.3. Any national security interest of the United States

3.3. Capabilities. Major MRTFB T&E support capabilities shall be based on a combination of DoD user requirements, future technology drivers, and the mission of the activity, and shall not be duplicated elsewhere within the Department of Defense. As the core set of T&E facilities within the Department of Defense, the MRTFB shall be configured and operated to provide adequate support to the DoD Components.

3.4. Multiple-Site Testing. When a test requires the support of more than one MRTFB activity, a lead MRTFB activity concept shall be used. The lead MRTFB activity usually provides major support or originates the test.

3.4.1. The lead activity serves as the principal point of contact with the user for planning, execution, and reimbursements, and coordinates with other activities to obtain total support.

3.4.2. Scheduling and coordinating groups (such as the Southeastern Test and Training Area Coordinating Agency, the Joint Pacific Area Scheduling Office, and the R-2508 Restricted Area Complex Control Board) shall be established when inter-activity coordination and scheduling must routinely occur.

3.5. Defense Test and Training Steering Group (DTTSG). The DTTSG shall act as a permanent organization to coordinate planning and actions with respect to the MRTFB. The Director of Operational Test and Evaluation chairs the DTTSG. Membership consists of representatives of the T&E and training communities of OSD and the Military Components. The DTTSG shall meet at the call of the chair who, in addition to other duties, will have an advisory and coordination responsibility to ensure present and future adequacy of the MRTFB and to avoid unnecessary duplication.

3.6. Financial.

3.6.1. Funding of the MRTFB is designed to ensure the most effective development and testing of material and to provide for inter-Service compatibility, efficiency, and equity without influencing technical testing decisions or inhibiting legitimate and valid testing.

3.6.2. The activities listed in enclosure 2 shall be funded in a uniform manner. All costs incurred by MRTFB activities in support of T&E shall be billed in accordance with DoD 7000.14-R as follows:

3.6.2.1. Volume 11A, "Reimbursable Operations, Policy and Procedures," (reference (g)) provides overall guidance on reimbursable operations, policy and procedures.

3.6.2.1.1. Chapter 12 of reference (g) provides policy on MRTFB test customers that are DoD Component, non-DoD Component users (including Federal, State, and local governments); allied foreign governments; defense contractors; and U. S. commercial entities, when authorized.

3.6.2.1.2. Chapter 13 of reference (g) provides policy on U.S. Commercial Space Activities and their launch support customers covered in reference (f).

3.6.2.2. MRTFB activities that are Working Capital Fund activities are also subject to Volume 11B (reference (h)).

3.6.2.3. Foreign Military Sales customers are covered in Chapter 7, Volume 15 (reference ([illegible])).

4. RESPONSIBILITIES

4.1. The Director of Operational Test and Evaluation, shall:

4.1.1. Establish policy for the MRTFB, including composition, use, and test program assignment.

4.1.2. Monitor and evaluate the MRTFB to ensure its adequacy to meet requirements and to prevent unnecessary duplication of capabilities.

4.1.3. Alter the composition of the MRTFB, if necessary, in coordination with the cognizant DoD Component.

4.1.4. Coordinate all appropriate range and resource decisions that impact developmental test and evaluation with Under Secretary of Defense (Acquisition, Technology & Logistics) (USD(AT&L)). The USD(AT&L) or designee will be a member of all appropriate range and resource committees that affect developmental test and evaluation.

4.1.5. Coordinate all decisions affecting financial policy and all decisions containing a monetary value (financial and non-financial) with the Under Secretary of Defense (Comptroller).

4.1.6. Develop, in coordination with the Military Departments, and issue DoD 3200.11-D (reference (c)), in accordance with DoD 5025.1-M (reference (d)).

4.1.7. Plan, program, and budget for the Central Test and Evaluation Investment Program. This program shall be used to fund high priority and critical multi-service test and evaluation investment programs

4.2. The Secretaries of the Military Departments and the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence shall:

4.2.1. Manage and operate their assigned MRTFB installations and activities, as designated in enclosure 2.

4.2.2. Structure their installations or activities to support specific kinds of DoD tests and programs and, within available resources, any other user requirements considered to be within the mission of each installation or activity.

4.2.3. Plan, program, and budget for institutional costs and implement a reimbursement system to define and collect user charges. Institutional costs are those costs budgeted as part of the appropriation that funds the MRTFB facilities.

4.2.4. Modernize test support capabilities, and replace or repair general-purpose instrumentation, equipment, and facilities.

4.2.5. Ensure early MRTFB participation in the T&E planning process of new defense material and systems (DoD 5000.2-R, reference (e)) to maximize use of existing test support capabilities, avoid unnecessary new acquisition, prevent duplication, and permit development of new capabilities.

4.2.6. Assess the environmental consequences of proposed actions within the United States (DoD Instruction 4715.9, reference (j)), and outside the United States (DoD Directive 6050.7, reference (k)), as prescribed in these DoD issuances.

4.2.7. Establish and maintain an intergovernmental coordination management process to achieve full consultation of MRTFB land and facility development programs and facilities (DoD Directive 4165.61, reference (l)).

4.2.8. When changes to the composition of the MRTFB are needed or desired, request the DOT&E to alter the MRTFB composition under subparagraph 4.1.3. above.

Provide to DOT&E information on the facility affected, timeframe of the action under consideration, the known impact to affected acquisition programs, and the expected effect on the DoD Component's budget. Coordinate with other DoD Components any plan to close or significantly reduce the capacity and capability of a MRTFB installation or activity.

4.2.9. Ensure that each commander of an MRTFB installation or activity shall:

4.2.9.1. Develop and maintain a master plan for developing and operating the MRTFB installation and/or activity.

4.2.9.2. Develop and disseminate an installation and/or activity users' guide that provides capability summaries and procedures for introducing a test program. The capability summaries may reference a generally available electronic database.

4.2.9.3. Coordinate and cooperate with prospective users to assist in T&E planning, including trade-off analyses and optimization of test scenarios based on the test objectives and test support capabilities.

4.2.9.4. Support the planning, programming, and budgeting process by providing estimates of operations, maintenance, and modernization requirements to accomplish projected workloads and maintain the activity.

4.2.9.5. Manage the activity, administer the operating program, and ensure that collections are made for all amounts owed for services of the MRTFB in accordance Paragraph 3.6 herein.

4.2.9.6. Provide or arrange for test support and resources, including, as appropriate, tracking and data acquisition, data reduction, communications, meteorology, targets, utilities, photography, calibration, security, recovery, maintenance and repair, frequency management and control, and base support services relevant to the facility mission. This includes other ranges when range support is required beyond the nominal boundaries or capabilities of the lead activity

4.2.9.7. Ensure that military use of offshore areas shall conform to the policies in DoD Directive 3100.5 (reference (m))

4.2.9.8. Ensure safety is consistent with operational requirements, which includes the prevention of test objects from violating established limits through impact for vehicles with suborbital trajectories and through orbital injection or escape velocity for space vehicles. When more than one activity is involved in a test, the lead activity shall be responsible for safety. For earth recovery or impact of orbiting space vehicles, the safety responsibility rests with the activity controlling the recovery portion of the flight. Specific responsibilities are:

4.2.9.8.1. Determine policies and enforce safety procedures.

4.2.9.8.2. Coordinate safety plans and procedures with other agencies within potentially affected areas and issue notices within the United States and to foreign governments on anticipated hazards from test activities.

4.2.9.8.3. Coordinate on public affairs plans and assist in disseminating appropriate information.

4.2.9.8.4. Establish allowable ground and flight safety conditions and take appropriate action to ensure that test articles do not violate the conditions.

4.2.9.8.5. Notify the National Military Command Center if an accident or errant trajectory occurs that may have international implications.

4.2.9.9. Measure and recognize in accordance with DoD 7000.14-R, Volume 4, "Accounting Policy and Procedures" (reference (n)), accrued environmental and non-environmental disposal cost liabilities per Chapter 13, and accrued environmental restoration (cleanup) liabilities per Chapter 14.

4.2.10. Ensure that MRTFB users shall:

4.2.10.1. Provide timely and complete notification of support requirements, using documentation formats prescribed by the installation activity. The system manager concerned shall certify the initial requirements to the installation and/or activity commander.

4.2.10.2. Plan, budget, and reimburse the MRTFB installations and activities for support costs, as specified by the installation or activity, based on the guidance in paragraph 3.6.

4.2.10.3. Obtain prior concurrence from the installation or activity before entering into any contractual commitment containing activity use provisions.

4.2.10.4. Obtain prior approval from the activity for use of user-furnished instrumentation and ground support equipment to ensure compatibility and prevent duplication. Operate and maintain ground equipment and support facilities assigned for their exclusive use.

4.2.10.5. Provide timely notification of test system performance characteristics, such as planned flight trajectories, in accordance with established activity requirements.

4.2.10.6. Document unique test support capabilities needed beyond those presently available or planned by the activity in Part 5 of the T&E Master Plan (DoD 5000.2-R, reference (e)).

4.2.10.7 Ensure that tests comply with international treaties and other agreements.

4.2.10.8. Coordinate system safety and environmental matters with the activity under reference (e).

5. INFORMATION REQUIREMENTS

The reporting of recommendations for changes to the composition of the MRTFB required by this Directive is exempt from licensing in accordance with subparagraph C4.4.4. of DoD 8910.1-M (reference (o)).

6. EFFECTIVE DATE

This Directive is effective immediately.

Enclosures - 2
E1. References, continued
E2. Major Range and Test Facility Base

E1. ENCLOSURE 1

REFERENCES, continued

(e) DoD 5000.2-R, "Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) Acquisition Programs," March 15, 1996

(f) 10 U.S. Code 2681, "Use of Test and Evaluation Installations by Commercial Entities"

(g) DoD 7000.14-R, "Financial Management Regulation," Volume 11A, "Reimbursable Operations, Policy and Procedures," April 2000

(h) DoD 7000.14-R, "Financial Management Regulation," Volume 11B, "Reimbursable Operations, Policy and Procedures - Defense Business Operations Fund," December 1994

(i) DoD 7000.14-R, "Financial Management Regulation," Volume 15, "Security Assistance Policy and Procedures," February 2000

(j) DoD Instruction 4715.9, "Environmental Planning and Analysis," May 3, 1996

(k) DoD Directive 6050.7, "Environmental Effects Abroad of Major Department of Defense Actions," March 31, 1979

(l) DoD Directive 4165.61, "Intergovernmental Coordination of Department of Defense Federal Development Programs and Activities," August 9, 1983

(m) DoD Directive 3100.5, "Department of Defense Offshore Military Activities Program," March 16, 1987

(n) DoD 7000.14-R, "DoD Financial Management Regulation," Volume 4, "Accounting Policy and Procedures," August 2000.

(o) DoD 8910.1-M, "DoD Procedures for Management of Information Requirements," June 1998

E2. ENCLOSURE 2
MAJOR RANGE AND TEST FACILITY BASE

E2.1. Army Activities

E2.1.1. White Sands Missile Range, including Electronic Proving Ground at Ft Huachuca, AZ

E2.1.2. High Energy Laser Systems Test Facility

E2.1.3. U.S. Army Kwajalein Atoll

E2.1.4. Yuma Proving Ground

E2.1.5. Dugway Proving Ground

E2.1.6. Aberdeen Test Center

E2.2. Navy Activities

E2.2.1. Naval Air Warfare Center-Weapons Division, Point Mugu

E2.2.2. Naval Air Warfare Center-Weapons Division, China Lake

E2.2.3. Naval Air Warfare Center-Aircraft Division, Patuxent River

E2.2.4. Atlantic Undersea Test and Evaluation Center

E2.2.5. Pacific Missile Range Facility

E2.3. Air Force Activities

E2.3.1. 45th Space Wing

E2.3.2. 30th Space Wing

E2.3.3. Arnold Engineering Development Center

E2.3.4. Nevada Test and Training Range (NTTR)

E2.3.5. Air Force Flight Test Center

E2.3.6. Utah Test and Training Range

E2.3.7. Air Armament Center (AAC) 46th Test Wing

E2.4. Defense Information Systems Agency Activity.

E2.4.1. Joint Interoperability Test Command

E

Department of Defense Directive 5129.47
Center for Countermeasures

Background

The Secretary of Defense approved the "Transfer and Streamlining of Test and Evaluation," on June 7, 1999, which, among other things, transferred Office of the Secretary of Defense responsibilities for the Precision Guided Weapons Countermeasures Test Directorate from the Under Secretary of Defense (Acquisition, Logistics and Technology) to the Director, Operational Test and Evaluation. This transfer was further solidified by the reissuance of the Department of Defense Directive 5141.2, "Director of Operational Test and Evaluation," on May 25, 2000. The governing directive for the Precision Guided Weapons Countermeasures Test Directorate requires updating to reflect these actions. The changes to the Directive are administrative in nature, with the exception of the name change from "Precision Guided Weapons Countermeasures Test Directorate" to "Center for Countermeasures."

Current Initiative

The revised directive is currently in the Deputy Secretary of Defense's office for signature. The draft directive has been coordinated in accordance with Department of Defense Directive 5025.1. No issues resulted from the coordination process.

Department of Defense
DIRECTIVE

NUMBER 5129.47

DOT&E

SUBJECT: Center for Countermeasures

References: (a) DoD Directive 5129.47, "Precision Guided Weapons Countermeasures Test and Evaluation Directorate," August 2, 1989 (hereby canceled)

(b) Title 10, United States Code

(c) Title 42, United States Code

(d) DoD 8910.1-M, "DoD Procedures for Management of Information Requirements," June 30, 1998, authorized by DoD Directive 8910.1, "Management and Control of Information Requirements," February 11, 1993

1. REISSUANCE AND PURPOSE

1.1. This Directive supersedes reference (a).

1.2. Pursuant to the authority vested in the Secretary of Defense under reference (b), this Directive renames the Precision Guided Weapons Countermeasures (PGWCM) Test and Evaluation (T&E) Directorate, as the Center for Countermeasures and prescribes its organization, mission, objectives, functions, responsibilities, administration, authority, and funding.

2. APPLICABILITY

This Directive applies to the Office of the Secretary of Defense, the Military Departments, the Chairman of the Joint Chiefs of Staff, the Combatant Commands, the Office of the Inspector General of the Department of Defense, the Defense Agencies, the DoD Field Activities, and all other organizational entities within the Department of Defense (hereafter referred to collectively as "the DoD Components").

3. DEFINITIONS

3.1. Precision Guided Weapon Systems. Those systems operating in all frequency bands, particularly those in the electro-optical and millimeterwave regimes.

Executive Summary

The Defense Science Board task force on Test and Evaluation was chartered to conduct a broad review of the entire range of activities relating to test and evaluation (T&E). This included examining new and innovative ways that the T&E community can better support its users and to find better ways to integrate operational test into the overall systems development process. The task force was asked to consider the special problem of "systems of systems" testing. In addition, the task force was to identify and quantify the current and future needs of the Department's T&E capability and resources, and recommend specific and quantified changes to those capabilities and resources.

To perform this review the task force examined facilities, processes, policies, contractor testing, government development testing, joint T&E, and operational T&E, both before and after full production and in the continuing evolution of force capability. The focus of the task force examination was on the T&E part of the acquisition process.

The task force formed sub-panels to focus on particular subjects related to T&E. These sub-panels studied requirements determination in the T&E process, the developmental testing and operational testing (DT/OT) process, the role of modeling and simulation in T&E, and facility reengineering. The task force also looked at special issues affecting T&E including T&E for Advanced Concept Technology Demonstrations (ACTDs), T&E of Commercial Off the Shelf (COTS) software, T&E of Software, and T&E of Systems of Systems.

Each of these sub-panels developed a set of findings and recommendations to improve the T&E process.

Findings

- **The focus of T&E should be on how to best support the acquisition process.** The focus of T&E should be on optimizing support to the development/acquisition process, not on minimizing (or even "optimizing") T&E capacity. T&E is an integral part of system design, development and acquisition. The two crucial aspects of T&E in supporting acquisition are testing to learn and testing to confirm. For large projects, as investments of funds and time grow, and more is at stake, the need for testing to confirm increases.
- **T&E planning with operational test personnel should start early in the acquisition cycle.** Testing must contribute earlier in the development process. The early involvement of testers and users, especially through the Service Operational Test Agencies is key to this optimization. Early testing to learn about new systems is equally important and requires early tester involvement. Early involvement of testers (and also users), who are independent of the development, provide the feedback essential for the design refinements that lead to truly excellent procurements.
- **Distrust remains between the development and test communities.** There has been reluctance to involve the test and evaluation community early by some program

offices hoping to maintain control of early test results. There has also been reluctance in some testing organizations to be involved early out of fear of losing their independence. In addition, the operational test organizations have not had the resources for early involvement. This has led to polarization within what should be an integrated venture. The resulting tensions have reduced the effectiveness of both T&E and acquisition by interfering with the potential contributions from early involvement. Recapturing the early involvement of testers, while preserving independence of evaluation is a critical objective.

- **Contractor Testing, Developmental Testing, and Operational Testing have some overlapping functions.** A key element in improved support to the users of test and evaluation is improved integration of operational testing into the overall system development process. The current system forces program managers to minimize the learning function of test and evaluation – in both developmental and operational contexts. The Integrated Product Teams that the department uses do not go far enough, and do not start early enough.
- **Independence of evaluation of test data is the essential element, not the taking of the data itself.** The concept of independence of test and evaluation is an important principle. However, is has been interpreted in such a way as to separate T&E from the development and acquisition process of which it is an integral part.
- **Response to perceived test "failures" is often inappropriate and counterproductive.** A test failure often uncovers important information that allows major steps of progress in system design but is too often accompanied by withholding funding, costly rescheduling and threats of cancellation. Test "failures", especially in the early phases of system development, should be received as important learning opportunities and chances to solve problems as they are uncovered.

Recommendations

TEST AND EVALUATION AND THE REQUIREMENTS DETERMINATION PROCESS

1. **Establish a stable team made up of users, developers, testers and appropriate contractors called a Combined Acquisition Force (CAF) to streamline the acquisition process for Acquisition Category I (ACAT I) programs. The CAF should be formed once a need is identified and remain in place throughout the acquisition process.**

The task force studied the current requirements determination process to identify ways to reduce cost and development time of systems with emphasis on streamlining the testing processes. Early tester involvement in the acquisition process is key to improving testing and reducing cycle time in developing and acquiring defense equipment.

In order to foster a closer relationship among user, developer, and tester, and to capture the benefits of a multidiscipline approach throughout the acquisition cycle, we urge the formation of a Combined Acquisition Force (CAF) for each proposed new start that meets ACAT criteria. We envision that the CAF would be composed of members from the user, the developer, and the tester communities. It could have multi-service representation if appropriate. A contractor representative can be added when a contractor is selected. The duties of the CAF are to assist in the development of the Mission Needs Statement (MNS) and the Operational Requirements Document (ORD). It also assists in the Test and Evaluation Master Plan (TEMP) design. Upon program approval, the CAF continues to act in its role as advisor and reviewer throughout the development process to include Engineering and Manufacturing Development (EMD). For this CAF concept to work the team members must be handpicked by their commands and then remain relatively stabilized on the team. They must have the confidence and the ear of their commanders, and be empowered to speak for their commands in matters relevant to the system being sought. Clearly, the purview of the CAF need not be limited to T&E but should be oriented toward all aspects of improving the efficiency and effectiveness of the acquisition process.

Additional Requirements Determination Process Recommendations:

2. **Change 5000.1 to incorporate the CAF concept.**

3. **Require the development of a Preliminary Test and Evaluation Plan in conjunction with the MNS.**

4. **Conduct an early operational assessment based on the ORD and an operational scenario before milestone I (no actual hardware would be involved).**

5. **Make the CAF a key participant in the Requirements Development Process.**

DEVELOPMENTAL AND OPERATIONAL TEST (DT/OT) PROCESS

1. **Each of the Service DT&OT organizations should be consolidated, to include integrated planning, use of models, simulation, and data reduction. Planning should be totally integrated, and the OSD T&E organizations consolidated. There should be integrated use of models, simulation, and data reduction. Except for limited dedicated Operational Test and Evaluation (OT&E), contractor and government testing should also be integrated.**

Bureaucratic barriers to cooperation and efficiencies are contributors to an increasingly protracted weapons system development process.

Contractor and government developmental testing (DT), government operational testing (OT), government user evaluations, and experiments have become increasingly stratified. Test organizations involved in a typical DoD major acquisition program include the prime contractor (original equipment manufacturer), a Service DT and OT organization, a System Program Office test management activity and two OSD test oversight organizations. All of the above, as well as the Primary Service Command, are involved to some degree in test planning, conduct, analysis and reporting. The Service DT and OT organizations actively participate in the test planning, conduct, analysis and reporting process. In addition, there are a number of government oversight organizations that typically are involved to some degree in test plan review and approval and in test result assessment.

Rigid DT/OT stovepipes are, for the most part, artificial. Barriers, real and perceived, discourage cooperation and in some instances prohibit cooperation. The vast majority of test objectives (80%) provide developmental insights as well as operationally relevant information.

Additional DT/OT Recommendations:

2. **For each development program and its associated test and evaluation effort, special attention should be directed early in the planning cycle (and periodically throughout program development) toward compressing the developmental test schedule wherever practical.**

3. **Facilities within the DOD's Major Range and Test Facility Base should be required to conduct periodic, systematic reviews to determine where data acquisition, reduction and analysis procedures could be improved to increase the efficiency of the T&E process.**

MODELING AND SIMULATION (M&S) IN SUPPORT OF THE TEST AND EVALUATION PROCESS

1. **Establish Oversight and Direction of M&S Development and Employment for T&E.**

   Assign responsibility to Director, Defense Research and Engineering (DDR&E) (at an appropriately high level) for oversight and direction of all aspects of research relevant to M&S, particularly that which supports T&E.

Responsibilities for oversight of M&S research would fit into three broad categories:

- Phenomenology aimed at measurements and basic data collection to support M&S development and employment across the board, to include T&E applications.
- Conceptual model development to include not only the traditional engineering focus or legacy-based improvements, but with more attention to the insertion of revolutionary computational and simulation technology to handle non-linear conditions and uncertainties that influence weapon system effectiveness in realistic combat situations.
- Development and maintenance of a catalog of M&S capabilities and accredited applications, to include categories such as hardware-in-the-loop simulations, man-in-the-loop simulators, physics-based models, and constructive models.

M&S is being used extensively and successfully for training, design trade-offs, and basic engineering work in both the commercial and the defense sectors. Within defense acquisition, and in T&E more specifically, there are scattered areas, such as hardware-in-the-loop testing, with long traditions of high quality work. Opportunities for the use of M&S are most obvious in the developmental testing that is an inherent part of engineering development. Advancing technology also permits M&S to be used in the technical and operational evaluation of weapons systems at various stages in their development, and there have been some exceptionally well-run programs in this regard.

Overall, however, opportunities for M&S in support of T&E have not been well exploited. For the most part M&S techniques have been developed not to support T&E, but for use in training and in engineering and design efforts in the pursuit of excellence and improved product quality. Interest in the use of M&S to support T&E is a more recent phenomenon. This recent, high level interest in M&S for T&E specifically, and for acquisition more generally, appears to be in pursuit of reductions in acquisition times and attendant cost savings.

2. Needed investment in M&S for T&E.

> ***Modify the directives governing the acquisition process to require identification and funding of an M&S plan for evaluating a program's progress and operational effectiveness/suitability at the earliest practical point in the program.***

Substantial early investment is often needed to capitalize on the potential M&S benefits in the T&E process. A comprehensive M&S plan should be required as part of the Request for Proposal (RFP) process for development of a new system and should be considered as a major evaluation criterion for each contractor's proposal.

3. Understanding of where M&S can contribute to T&E and where it cannot contribute.

> ***Require the users of M&S in their evaluations to state model assumptions, limitations, and uncertainties explicitly, as well as sources for input data in the presentations of results to decision makers.***

The disciplined accreditation process called for in the recommendation above would accommodate this problem, which has contributed to the perception that the benefits of M&S are oversold.

4. Near-Term Priority on M&S Development and Use in Reliability, Availability, and Maintainability (RAM) Evaluations

> ***Give near-term priority, with required funding, to the development of more state-of-the-art RAM models, and to the update of existing models with legacy data from our vast experience with weapon systems in the field.***

These efforts should be aimed not only at an ability to credibly evaluate the suitability of systems in development, but at reducing the cost of ownership of both existing and planned systems. The emphasis on reducing life cycle costs of systems should be translated into increased attention to predicting the reliability, maintainability, and availability of systems in development.

NOTE: A much more detailed examination of M&S in support of T&E is located in the body of this report.

TEST AND EVALUATION FACILITY REENGINEERING

1. **The task force was briefed on concepts for bringing together the management of T&E resources. OSD and the Services should work together to develop a plan whereby T&E resource management is strengthened and brought under coherent control.**

Physical T&E of weapon systems requires large, sophisticated facilities, such as those at Edwards Air Force Base, Patuxent River Naval Air Station and Aberdeen Proving Grounds. In the course of this study, the task force reviewed the overall management of these facilities and visited a cross-section of DoD's T&E facilities to assess their readiness to meet current and future defense requirements. The task force views these facilities as indispensable to continued development of new weapons systems; however, it concludes that management of T&E facilities must adapt to the changing test and evaluation environment to retain their vitality and capability. Broadly stated, the task force concludes that the operation of the Defense-wide system of T&E facilities should be carefully rethought in the light of changing defense procurement and management practices, advancing technology, budget constraints, and an ability to represent actual and potential enemy capabilities in some circumstances.

2. **Apply the reengineering process, employed at Arnold Engineering and Development Center (AEDC), to all test ranges in order to update operations and maintenance and capability investment plans and strategy.**

DoD should undertake a thorough inventory of the Department's T&E facilities and skills and those of other government and non-governmental organizations. This inventory should look beyond DoD needs and capabilities to take into account those facilities elsewhere in government and in the private sector. The inventory should clearly identify DoD facilities needed to meet future near and long term needs, both for test and evaluation capacity and for unique capabilities.

Additional Facility Reengineering Recommendations:

3. **Military departments responsible for acquiring specific weapons systems should continue to test those systems and be responsible for evaluating and reporting results of these tests.**

4. **DoD should develop a T&E facility investment strategy, based on the inventory and future needs, to assure ability to meet DoD T&E needs through the most effective and efficient combination of all national facilities.**

5. **DoD should establish a set of figures of merit to assess, compare and contrast reengineering progress of each of its major T&E facilities.**

6. **A searching examination of management practices should be undertaken by all test and evaluation centers to address changing test and evaluation technical and business practices, aging facilities, cost and test cycle time reduction and customer service.**

7. **This study limited itself to DoD owned and operated facilities but would observe that a serious look at the T&E facilities should include NASA, DOE, and other agencies test facilities.**

SPECIAL ISSUES

T&E for Advanced Concept Technology Demonstrations (ACTDs)

1. **Direct the participation of a tester in the ACTD process to maximize the value of this concept.**

The purpose of the ACTD process is to introduce new technological capability to the warfighter for their evaluation and development of appropriate tactics. In particular, the technical community gets feedback from the warfighter, while the warfighter gets to check out new technologies and their attendant operational concepts without an upfront commitment to buy. This provides for the possibility of introducing technologies, especially for joint capabilities or other "out-of-the-box" programs that might otherwise not get examined. The requirement of JROC review and CINC sponsorship favors capabilities that have a real, near term mission to perform.

The most useful role for the T&E community in the ACTD program is helping with transition to acquisition status. "Leave behind" products of ACTDs should have adequate operational testing to understand the operational effectiveness before fielding.

Systems of Systems T&E

1. **Create a systems of systems design authority (system designer) with a joint T&E component that uses the Service T&E resources for joint testing.**

"Systems of systems" is a contemporary phrase that can mean anything from a relatively simple integration task that attempts to make components work together to a land, air, sea and space multi-platform, and multi-service joint campaign level interdependent system. For this report systems of systems is defined as those systems that require interoperability or interdependency between functional entities for mission success.

There is currently concern about integrating the information systems of the services and agencies, many of which are not well integrated within themselves, into a joint system which can serve the CINC's effectively in joint operations. There is, at this time, no overall architect of the joint system although many efforts are being made to cope with the resulting problems. Since the joint systems of systems problem is so large and complex and involves so many organizations and so many components of all ages and origins it will be difficult to exercise control over the systems of systems design and test process. And yet, the joint system must be made to work.

Information Systems Software T&E

1. **Insist on Capability Maturity Model levels appropriate to the size and complexity of the system**

2. **Employ alpha and beta testing as employed in the private sector to the extent possible**

3. **Consider machine testing of non-real time software**

4. **Ask DARPA to look into developing machine testing technology for real-time and non real-time software**

There is no exact definition of what constitutes an information system. In general, any information system is made up of a number of subsystems or components and, in turn, is a component of a still larger system sometimes called a system of systems. Furthermore, many military information systems already exist in some form and rarely provide an opportunity for starting over. They are made up of a number of different components, built at different times by different people who may belong to different agencies. The problem is one of upgrade and modification with occasional replacement of a component. There is rarely a central design authority for the system as a whole.

Nonetheless, new components must be built to protocols or standards that permit them to be integrated with already existing systems. T&E plays an important role in the process. The fundamental need is for a well disciplined engineering process for designing, building and testing information systems.

Test and Evaluation of Commercial Off-the-Shelf Software (COTS)

1. **Conduct functional and interface testing of COTS software as a prerequisite to its use in DoD programs.**

The functional requirements for systems in the commercial world have moved closer to the requirements for military systems. This has led to more extensive use of COTS products, including hardware and software, in military systems. The DOD, in policy and practice, has stated a strong preference for COTS products and for a reduction in custom-built software and hardware. However, the use of COTS products can significantly change the process by which systems are built.

Except in trivial cases (such as a word processing or e-mail system), military systems include many software packages. Even if these are COTS products, they will probably come from different vendors and may use different languages, different interfaces and other standards. Even if the individual packages are carefully chosen by the system designers for performance and quality, integration of the software into a working whole may not be easy and may require building substantial amounts of interface software, drivers, etc. This is true for commercial systems as well.

Presumably the COTS software will already have been extensively tested by commercial users and should work well as long as the military application is similar to the usual commercial application and is well within the performance limits of the package. In some cases, however, the military application may stress the COTS software in unusual ways, a problem that may not appear until the system has been completely assembled and tested under realistic conditions.

In Summary

- **Start T&E planning early — very early**
- **Make T&E part of the acquisition process — not adversarial to it**
- **Consolidate DT and OT**
- **Provide joint test leadership**
- **Fund M&S support of T&E in Program Budgets**
- **Maintain independence of evaluation process while integrating all other activities**
- **Establish range ownership and operation structure separate from the Service DT/OT organizations**

INTRODUCTION

The Defense Science Board task force on Test and Evaluation (T&E) was formed by the Under Secretary of Defense (Acquisition and Technology) (USD(A&T)) to undertake a broad review of all activities relating to T&E. The task force is co-sponsored by the Director of Operational Test and Evaluation and the USD(A&T)'s Director of Test, Systems Engineering and Evaluation.

The T&E Structure of the DoD has been built up over a number of years, and today two-thirds of the T&E structure of DoD is over 30 years old. Now, under the guidance of the QDR, procurement is planned to increase 50% by 2003 from a low point in 1996. These procurements will encompass major systems and "systems of systems," upgrades to existing systems, and commercial and non-developmental items. Further, a number of new acquisition techniques have increased early and extensive involvement of the warfighter in acquisition activities. Inclusion of the warfighter as a user will affect future T&E by providing the opportunity to address operational issues early in the development process. Additionally, the variety and ever-changing nature of threat systems that the U.S. and its coalition partners will face in the future requires a new look at the role of T&E in the rapid and responsive acquisition cycles that will be needed to meet these threats.

The task force was asked to:

- Examine new and innovative ways that the T&E community can better support its users.
- Find new ways to integrate operational testing into the overall system development process (follow selected industrial principles and practices).
- Consider the special problems associated with T&E of the "systems of systems" which are increasingly comprising critical parts of our military capability.
- Identify and quantify the current and future needs of the Department's T&E capabilities and resources.
- Recommend specific and quantified changes.

To perform this review the task force examined facilities, processes, policies, contractor testing, government development testing, joint T&E, and operational T&E, both before and after full production and in the continuing evolution of force capability.

The task force formed sub-panels to focus on particular subjects related to T&E. These sub-panels studied requirements determination in the T&E process, the developmental testing and operational testing (DT/OT) process, the role of modeling and simulation in T&E, and facility reengineering. The task force also looked at special issues affecting T&E of Advanced Concept Technology Demonstrations (ACTDs), Commercial Off the Shelf (COTS) products (especially software), and Systems of Systems.

This is a particularly opportune time for such a review. Acquisition reform has been underway for several years to identify opportunities for improving the way we develop and field weapons and support systems. In the forefront of such initiatives are actions that reduce the system development and acquisition cycle time. This is critical because reduced cycle time can reduce costs and put improved capabilities into the hands of our warfighters earlier—thereby providing greater military advantage. T&E tends to be viewed as a "pacing item" in the cycle time for most military systems. We perform developmental tests first, complete system design, and then use operational tests to determine the military utility of the system. That is the perception—and while it is not fully valid, there is clearly a division of focus that probably causes T&E to yield less knowledge early in the program and to take longer than may be necessary. Our DSB review of Integrated Test and Evaluation is clearly timely from the perspective of acquisition reform.

There are other considerations that make this review timely. Joint Vision 2010 is the Department's conceptual framework for how U.S. forces will fight in the future. According to the Secretary's Defense Reform Initiative Report, the ability to achieve the capabilities envisioned in Joint Vision 2010 is contingent upon a Revolution in Military Affairs, to enable our forces to attack enemy weaknesses directly throughout the battlespace with great precision; to better protect themselves from enemy attack; and to receive the right supplies in the right place at the right time. Reducing overhead and support structures will be critical to achieving the Revolution in Military Affairs.

Test and evaluation ranges and facilities are among the major elements of the Department's acquisition infrastructure. They are viewed in many circles as still sized for the Cold War and resistant to downsizing. While this infrastructure has in fact reduced its facilities this review gives us an opportunity to assess the potential improvements to the T&E support structure that might be available through better integration of DT and OT. Improved integration of operational tests into the system development process will not only provide earlier information regarding system effectiveness and suitability, but will also achieve improved efficiency from the infrastructure.

BACKGROUND

The feasibility of reducing acquisition process time through improving the efficiency of T&E was an important consideration of the task force. The role of T&E in DoD acquisition is described in DoD Regulation 5000.2-R under the section of Program Structure, as "part of a strategy to provide information regarding risk and risk mitigation, to provide empirical data to validate models and simulations, to permit an assessment of the attainment of technical performance specifications and system maturity, and to determine whether systems are operationally effective, suitable, and survivable for intended use."

Current DoD policy is that "test and evaluation objectives for each phase of an Acquisition Category (ACAT) I and ACAT IA program shall be designed to allow assessment of system performance appropriate to each phase and milestone. For ACAT I and II programs for conventional weapons systems designed for use in combat, a beyond low-rate initial production decision shall be supported by completed independent initial operational test and evaluation and by completed live fire test and evaluation." Additionally, "operational test and evaluation does not include an operational assessment based exclusively on computer modeling, simulation, or an analysis of system requirements, engineering proposals, design specification, or any other information contained in program documents." The DSB task force reviewed this guidance to determine if any changes are appropriate, and in particular the value of using modeling and simulation.

The task force looked at the roles of both government and contractors in performing test and evaluation, as well as the role of systems engineering and test and evaluation. The task force reviewed how DoD 5000.2R is being followed, how it would apply to ACTD programs, and whether T&E personnel should be involved in the requirements development process.

The DSB task force reviewed constraints by and on the test and evaluation community and the T&E infrastructure that, if removed, might result in reducing acquisition cycle time. We reviewed several acquisition and systems of systems programs to determine how T&E contributed to the acquisition cycle time and to the costs of the programs. The task force looked at commercial and defense industry T&E practices in support of both their development and acquisition programs.

THE TEST AND EVALUATION PROCESS

T&E results are essential information for acquisition decision-makers. The process, depicted in the following figure, is based on defining the information needed, designing an approach to collecting the information required and predicting the results, collecting the data, and then comparing outcomes with predictions, and providing the information back to the acquisition decision-maker. This process applies to DT&E and OT&E, regardless if it is performed by the government or by contractors. The acquisition decision-makers may use this information to assess program risks for costs and schedule, whether the program will reach threshold performance criteria, or as early warning for whether the program will achieve required effectiveness, suitability, and survivability requirements. However T&E data is used, it is integral to the DoD acquisition process.

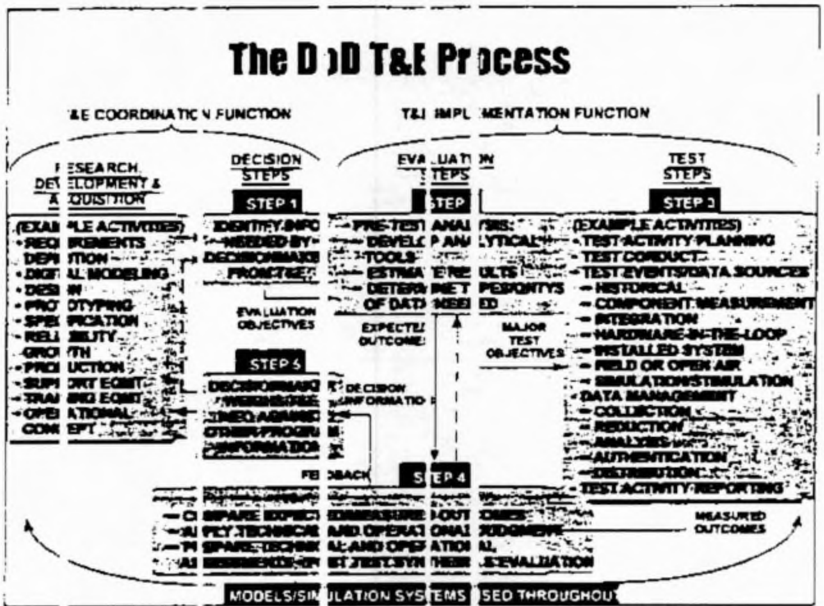


Figure 1

The T&E process, Figure 1, is usually depicted as a parallel process to the acquisition cycle, with emphasis on Developmental Test and Evaluation (DT&E) during the early phases of a program, then gradually shifting to OT&E during later phases. This idea apparently reflects the notion that DT&E is used to select from alternative designs, refine design performance, and to provide information to help assess and manage the risks of the program. In the systems engineering process, it is normally DT&E that is associated with providing the design verification feedback. Emphasis on OT&E is normally associated with preparation for an Initial Operational Test and Evaluation (IOT&E) to seek a Low Rate Initial Production (LRIP) decision, and it is during this period when concerns about effectiveness, suitability, and survivability tend to get the most attention. Figure 2, on the following page, depicts the usual process and the relative emphasis of DT&E and OT&E.

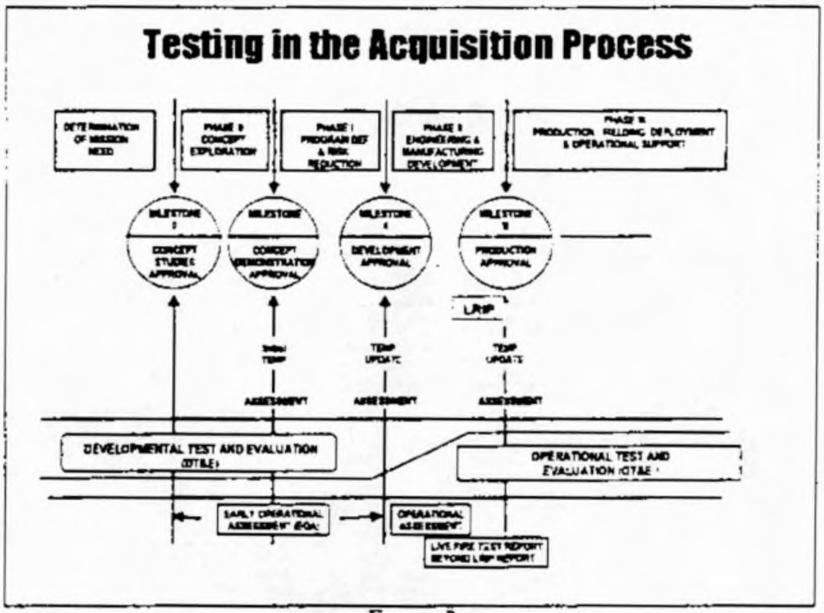


Figure 2

The government, its contractors, and subcontractors all have had responsibilities for performing DT&E, which might also include qualification and acceptance tests as well. Traditionally, DT&E in an acquisition program has been performed by both the government and the contractor. There appears to be a desire to increase contractor responsibility for DT&E. Figure 3, on the following page, depicts the usual involvement of government and contractor personnel.

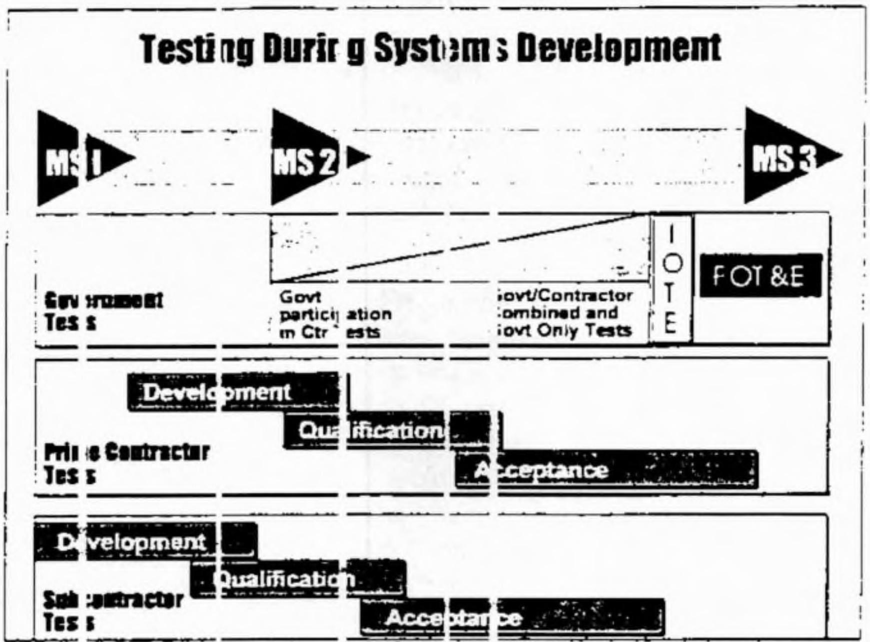


Figure 3

Depending on the type of program, T&E may not follow the process described above. For example, space platform programs vary vastly from the approach for an airframe program with DT&E and OT&E being performed by the contractor in a ground-based space-simulated environment. No directive prescribes OT&E of ACTD programs, therefore, some ACTD programs may have no OT&E involvement. Software-intensive systems and systems of systems programs may call for other non-traditional approaches.

THE IMPACT OF T&E ON STREAMLINING THE ACQUISITION OF MAJOR DEFENSE PROGRAMS

The department's efforts to streamline the acquisition process derive from a long history of attempts to procure modern military hardware faster and at lower cost. This ongoing concern has merged with a much broader desire to make government more efficient. The desire for streamlining has many elements, and there are many reasons why it has become prominent again recently. One factor has been the technology-driven revolution in commercial business affairs. Growing awareness of how American business has become more efficient has fueled the desire to make government more efficient. To some, this means incorporating best business practices into government operations, while to others it means making government operate more like commercial enterprises in more fundamental ways. Acquisition streamlining seeks both to capitalize on better business practices, and to eliminate selected regulations that have accreted over time, but might no longer be useful.

The challenges of introducing new state of the art materiel into the U.S. inventory are daunting. In most cases a new military capability rests on a new technology – or at least great advances in established technology. This implies high technical risk and an associated uncertainty in meeting schedules, especially given limited resources. If maturation of new technologies of a system take longer than expected, other aspects of system design can be put on hold, causing the "technology in hand" to obsolesce as the technology being developed is delayed. Schedules that are technically feasible might not be executable because of funding constraints or other uncertainties. Stretching the program for budgetary reasons can exacerbate total program costs and uncertainties that were high to start with. The long development times that result mean that concepts of operations and threat assessments will change, which in turn forces an evolution of essential requirements.

Test and evaluation can play two important roles in these situations. First, an early DT&E program can identify high-risk technical areas at the outset. Second, what is discovered can be linked to operational assessments of the concept or the design. Mapping technical risk early in a program, and determining the operational impact of not achieving particular technical goals, can have great influence on shrinking the acquisition cycle. In addition, specific assessments of the linkages between technical risk and operational performance can support the execution of Cost as An Independent Variable (CAIV) in a disciplined, rational fashion. Test and evaluation that is both technically and operationally oriented is an essential part of any well-run program. High value comes from learning as early as possible, in as much detail as possible, how the technical challenges and the operational effectiveness are linked.

The key element in acquisition streamlining so far as T&E is concerned is increased early involvement of the T&E community. This involvement needs to include thorough developmental test programs focused on identifying and characterizing the technical risks. These need not be government-conducted tests; contractor tests that aggressively pursue technical risk, with program management office (PMO) and oversight office visibility, would be fine. Also needed are early operational assessments of the system under development. These assessments should not be unrelated but should be closely linked to the testing to identify technical risk. Such a combined program is essential if the PMO is to concentrate on the operationally critical but technically challenging features and appeal for relief on the technically challenging features that promise little operational pay-off.

In short, what is needed is a T&E program that is comprehensive enough to relate operational capability and technical risk, early enough to eliminate low pay-off risk, and focused enough to concentrate on the high pay-off technical challenges.

TEST AND EVALUATION AND THE REQUIREMENTS DETERMINATION PROCESS

The task force studied the current requirements determination process to identify ways to reduce cost and development time of systems with emphasis on streamlining the testing processes. The Secretary of Defense asked for a determination of how further improvements could be made in the testing process to reduce cycle time in developing and acquiring defense equipment. As one of five themes to reform the acquisition process, the Secretary called for "early tester involvement" in system development.

TESTER INVOLVEMENT IN THE ACQUISITION PROCESS

To understand where and how testers are currently involved in the acquisition cycle, depicted in figure 2 on page 14, is helpful to show the DoD scheme as portrayed by today's regulations.

The first tester benchmark is the publishing of an initial test plan, the Test and Evaluation Master Plan (TEMP), at milestone I. In practice, testers are brought into the concept exploration phase too late to properly formulate the initial TEMP. By this time in the acquisition cycle, the performance parameters and the formal user requirements have been through several reviews and hard fought staffing. The late arriving testers are forced into a reactive mode to understand the operational concept, how it will fit into the future warfighting doctrine of the users, decide which of the performance parameters should be tested, and, of these, which are even capable of being tested. It is a steep "learning curve" for the testers, and it fosters the beginning of an adversarial relationship between developers and testers. The initial TEMP, therefore, becomes a negotiated compromise between testers and developers. Moreover, this late inclusion of testers tends to put them in the role of disrupters rather than helpers whose insights could have served to anticipate problem areas and seek remedies to avoid them.

The fundamental purpose for testing is to discover and to learn. The testers as well as the developers and users are the learners in this process. In order to build mutual trust and confidence, and to focus on system operating characteristics that can be tested in a way that makes sense, the expertise of the testers should be sought by the users and developers as the system requirements are being formulated. This means that the testing community should be a part of the *requirements development process*. It is not too early to bring in testers during the "determination of mission needs" sequence and make them full members at this phase. The Army's document titled "Requirements Determination" is a case in point. It directs the formation of an Integrated Concept Team (ICT) which is charged with developing formal requirements for new hardware through the synergy of a multidiscipline team. It falls short of calling for testers to be mandatory team members, however. Nevertheless, the concept is valid. If the Army follows its own directive and adds a tester to the ICTs that it forms, then it will have established a model that could serve DoD wide.

These streams of activity apply not only to major new systems but also to the evolutionary improvement in small steps of the joint military capability.

Three changes to the process are recommended:

1. Bring testers (DT and OT) into the requirements generation process as early as the initiation of Mission Need Statement (MNS).
2. Keep the user (both service and joint) and testers involved throughout system developments.
3. Relate DT and OT in time, space, data, and test criteria. User exercises can produce data useful in both DT and OT without having to do separate exercises.

Any modifications in the current acquisition process (to include the operational requirements development/documentation process) will not significantly improve the process unless the individuals involved are exposed to each other on essentially a daily basis. The challenge to be met is elimination of the isolation of the individuals representing the different organizations involved in the acquisition process.

In order to foster a closer relationship among user, developer, and tester, and to capture the benefits of a multidiscipline approach throughout the acquisition cycle, we urge the formation of a Combined Acquisition Force (CAF) for each proposed new start that meets ACAT I criteria. We envision that the CAF would be composed of members from the user, the developer, and the tester communities. It could have multi-service representation if appropriate, and a contractor representative is added after a contractor is selected. The duties of the CAF are to assist in the development of the Mission Needs Statement (MNS) and the Operational Requirements Document (ORD). It also assists in the TEMP design. Upon program approval, the CAF continues to act in its role as advisor and reviewer throughout the development process to include Engineering and Manufacturing Development (EMD). For this CAF concept to work, the team members must be handpicked by their commands and then remain relatively stabilized on the team. They must have the confidence and the ear of their commanders, and be empowered to speak for their commands in matters relevant to the system being sought.

The matter of chain of command for a CAF is critical to its success. As we see it, the CAF reports to the service commander responsible for each phase of the development. For example, a CAF appointed to assist in the development of a shoulder fired anti-tank weapon for the Army would report to the Army's Training and Doctrine Command (TRADOC) commander until Milestone I. At Milestone I, the CAF would then report to the acquisition executive. In all phases, the CAF will keep appropriate commanders abreast of developments, and be a sounding board for the staffs and commands who play a role in funding and guiding the acquisition system. Although it is not envisioned that membership on a CAF will be a full-time duty, it is clear that such duty must be a number one priority for each of its members.

How the "System" Should Work

Figure 4 below displays the process as the task force sees it — a continuous stream of activity leading to improvements in joint military capability.

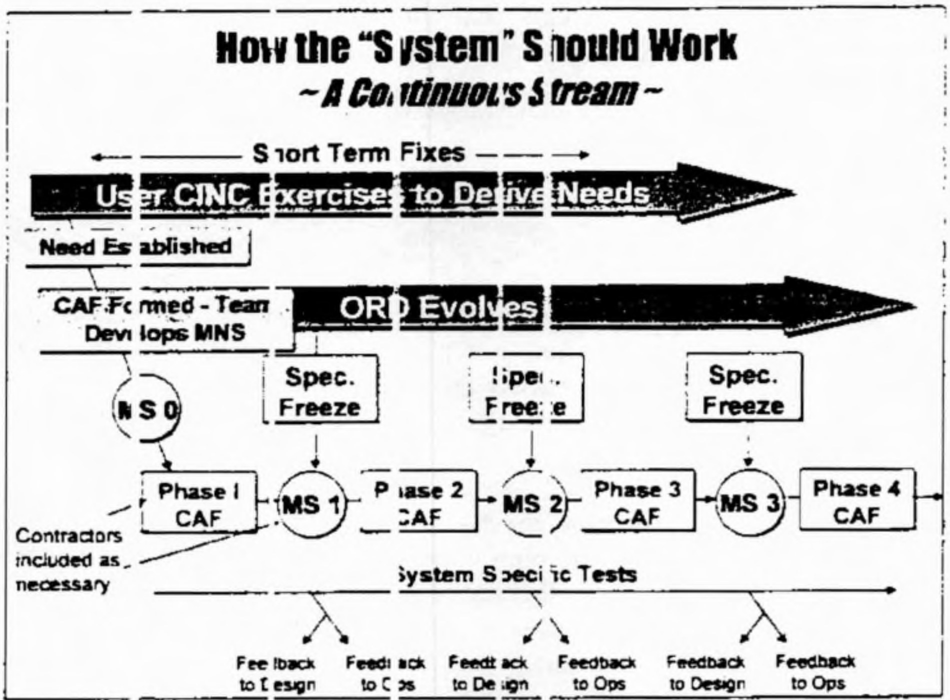


Figure 4

The first stream is one of CINC or user exercises that lead both to short-term fixes and to recognized needs for improvement. The developers and testers participate in these exercises in order to derive common understanding of the needs.

Once a need is recognized, a CAF is formed to assist in the MNS and subsequently in the ORD. The team assures that the proposed system is both doable and testable.

As the project proceeds through its various Milestones and Phases, the CAF stays in force. The ORD and system specifications are assumed not to be fixed but to evolve as information about the need, the development, and the testing warrant changes. The CAF is there to participate in this process.

Associated with the project is a continuous stream of system tests. In the beginning these are largely analysis, simulation, component, and breadboard tests. As the project proceeds and the system comes into being, testing becomes more formal including DT&E and OT&E. The testing provides continuous feedback both to the users to make sure they know what they are getting, to gain their approval, and to the developers to make sure they are building the right thing and ensure that it works properly.

To complete these modest revisions to the acquisition process and perhaps to have the greatest impact on reaching the goal, we should change the basic philosophy of military hardware and software development. Namely, focus new development on making evolutionary improvements to warfighting systems rather than revolutionary changes to individual parts of warfighting systems. Each of the services has in some stage of R&D today a large number of systems, many more than can be afforded by current and projected procurement funds. Each of the new systems can be shown to be better than the systems they are to replace; however, only some can be afforded. Therefore, the strategy is to refocus R&D on those items that do most for evolving warfighting system improvements, do not start R&D on projects that offer revolutionary gain to a sub system, but offer little total system improvement; and use the resulting cost avoidance to realize shorter procurement times for the evolutionary improvements.

Recommendations

1. **Establish a stable team made up of users, developers, testers, and appropriate contractors called a Combined Acquisition Force (CAF) to streamline the acquisition process for ACAT I programs. The CAF should be formed once a need is identified and remain in place throughout the acquisition process.**

Rather than accepting or rejecting the Solution Option out-of–hand, the construct of a CAF could be tested. Pick an emerging weapon program and mandate collocation of all acquisition representatives. Test the concept for two years and make a cross-DoD decision regarding the utility and benefits of the approach. Such a field 'test' would also provide significant data to either justify, modify, or reject use of the CAF construct in the future and be a source of important 'lessons learned' for its future application.

The Joint Staff should provide a vision of the Acquisition Process for Joint Systems to include how the voids mentioned in the previous section will be addressed. This action should be accomplished before the U.S. Atlantic Command (ACOM) 'experimentation' activity takes final shape. A poorly constructed strategic process could wreak havoc on Acquisition (T&E) budgets across the DoD.

2. **Change 5000.1 to incorporate the CAF concept.**

3. **Require the development of a Preliminary Test and Evaluation Plan in conjunction with the MNS.**

4. **Conduct an early operational assessment based on the ORD and an operational scenario before milestone I (no actual hardware would be involved).**

5. **Make the CAF a key participant in the Requirements Developments Process.**

DEVELOPMENTAL AND OPERATIONAL TEST PROCESS

The task force examined Developmental and Operational T&E processes and recommended improvements and reengineering that will reduce test cycle time and cost.

THE CURRENT DT/OT PROCESS

Over the last 25 years the DoD test management and test oversight organizations have evolved and new organizations have been created. In the early to mid-1970's, DoD created AFOTEC and OPTEC (OPTEVFOR already existed) in response to the President's Blue Ribbon Defense Panel's recommendation that independent operational test agencies be established in all the Services. In addition, an office in OSD was set up with responsibility for oversight of T&E activities throughout the Department. In 1983, Congress passed a statute that established an independent Director of Operational Test and Evaluation reporting directly to the Secretary of Defense.

Contractor and government developmental testing (DT), government operational testing (OT), government user evaluations, and experiments have become increasingly stratified. Test organizations involved in a typical DoD major acquisition program include the prime contractor (original equipment manufacturer), Service DT and OT organizations, a System Program Office test management activity and two OSD test oversight organizations. All of the above, as well as the Lead Service Using Command, are involved to some degree in test planning, conduct, analysis, and reporting. The Service DT and OT organizations actively participate in the test planning, conduct, analysis, and reporting process. In addition, there are a number of government oversight organizations that typically are involved to some degree in test plan review and approval and in test result assessment. These organizations include the SPO, OSD (A&T), DOT&E, and FFRDC's (IDA, MITRE, Aerospace Corporation). The service DT and OT organizations are involved in test conduct, and other government entities play a role in planning, analysis and reporting. With its Title 10 oversight and reporting responsibility, DOT&E plays the dominant role in operational test oversight for major development programs. In addition, there is a large test range infrastructure, managed and operated by the services, that supports system developmental and operational testing and to some degree subsystem development and operational testing.

The Service developmental and operational test organizations work together to varying degrees. The Army is currently in the process of combining the government test management and with some notable exceptions, the test range infrastructure within that service. For aircraft flight test programs, the Air Force employs a combined test force concept, which consolidates some elements of the contractor, government DT and OT organizations that are directly involved with test program planning and execution.

Within the DoD, Developmental Test and Evaluation (DT&E) is defined as that T&E conducted throughout the acquisition process to assist in the engineering design and development process and to verify the attainment of technical performance specifications and supportability objectives. The Government developmental test organization is a part of the Service Acquisition Command. In a typical DoD program, the government and the manufacturer are both heavily involved in developmental testing and analysis. (In contrast, in a typical commercial program there is little, if any, direct customer involvement in the product developmental process.)

Operational Test and Evaluation (OT&E) within DoD is defined as the field test under realistic conditions to determine the tested item's operational effectiveness and suitability for use in combat by typical users. The Service operational test agencies report to the Service Chiefs of Staff and, with the exception of the Army, are not involved in the management of test or training ranges.

Findings

Bureaucratic barriers to cooperation and efficiencies are contributors to an increasingly protracted weapons system development process.

The rigid DT/OT stovepipes previously described are, for the most part, artificial. Barriers, real and perceived, discourage cooperation and in some instances prohibit cooperation. For example, the vast majority of test objectives (80%) provide developmental insights as well as operationally relevant information. The stovepipes create a climate that fosters separate, duplicative testing, separate data bases, isolated development and use of models and simulations, and data processing beyond first-generation engineering units. The separation of governmental test organizations and duplication of management overhead is counterproductive. In addition, the government acquisition community needs to focus on evaluation and not use a high percentage of its declining resources on detailed test planning and test conduct.

More emphasis is needed on reducing time required for DoD test programs.

DoD test programs undergo extensive technical and safety reviews, but little attention is paid explicitly to test cycle-time reduction. There is the direct benefit to be realized in completing testing earlier or compressing the test schedule. There are several basic mechanisms by which test cycle-time can be reduced:

- Reduce test program content
- Accomplish testing more effectively/efficiently
- Use test facilities and resources more intensively (e.g., multiple shifts, seven-day weeks, etc.)
- Eliminate duplicative testing
- Budget and fund testing and test planning earlier in the program

In most DoD test programs the content is already at or near a minimum. It could be argued that, for some programs, test content has been reduced below an acceptable minimum, and in fact increasing test content could reduce total acquisition cycle time. A 6- or 7-day workweek is the norm on commercial aircraft development test programs, but military aircraft developmental programs usually operate at a more leisurely pace (except for competitive fly-offs). While a review of program content should not be overlooked, more opportunities for cycle-time reduction probably exist in the area of test process effectiveness/efficiency. Efficiencies can be realized by exploiting advances in information processing technology. So-called "fast-track" T&E programs are common in commercial practice, where lengthy "time-to-market" can have an enormous price tag, up to and including survival of the company. Lengthy DoD development programs also result in significant increases in both direct and indirect costs. Under the current management structure there is little if any, incentive on the part of government developmental test personnel to accelerate the developmental test process.

> ***The duplication that exists in many programs between contractor and government developmental and operational testing also adds to system development time.***

The Integrated Product Team (IPT) process has improved the dialog among the numerous agencies involved in the test execution and oversight process, but much more streamlining can be done.

> ***For many major weapon system development programs, the fixed overhead cost of the test support personnel and associated infrastructure can be a greater cost driver than the variable per test or per mission cost.***

This latter cost includes the direct cost associated with such items as range support and data processing. One exception is a test program where a high-cost test asset is destroyed in every full-up test, e.g., most missile flight tests. Adding test support personnel to accelerate a test program can be less expensive over the duration of a development program than conducting a program that is stretched out over several years. More importantly, decreasing the time needed for the test program, particularly during early development, allows for the identification and correction of deficiencies earlier in the development process, and consequently lowers overall development costs.

Recommendations

1. **Each of the Service DT&OT organizations should be consolidated, to include integrated planning use of models, simulation, and data reduction. Planning should be totally integrated, and the OSD T&E organizations consolidated. There should be integrated use of models, simulation, and data reduction. Except for limited dedicated OT&E, contractor and government testing should also be integrated.**

2. For each development program and its associated test and evaluation effort, special attention should be directed early in the planning cycle (and periodically throughout program development) toward compressing the developmental test schedule wherever practical.

3. Facilities within the DoD's Major Range and Test Facility Base should be required to conduct periodic, systematic reviews to determine where data acquisition, reduction, and analysis procedures could be improved to increase the efficiency of the T&E process.

Modeling and Simulation in Support of the Test and Evaluation Process

For decades, Modeling and Simulation (M&S) has been used in various forms to predict and evaluate the performance of weapon systems. Many of the simulation tools most often used today—computer-based models of complex weapon functions and the even more complex human interactions with those weapons and the surrounding environment—evolved from models used in the early 1960s. Currently, the large number of simulations in use includes very complex models, known as physics-based or engineering models, that attempt to capture the basic physics and engineering inherent in the design of a system and its operating environment, to include materials, structure, aerodynamics, propulsion, sensors, electronics, and so forth. They also include so-called higher order models or constructive simulations, which are digital computer models that attempt to represent combat elements and their functions in force-on-force engagements, along with the environment in which they operate.

Other important and widely used simulations known as hardware-in-the-loop involve actual hardware as an integral part of the simulation itself. Sometimes the hardware includes a complete system such as a missile, but more typically included are weapon subsystem elements such as sensors, guidance and control units, aerodynamic surfaces, propulsion systems, etc. Finally, there are the man-in-the-loop simulations that use displays and sensory stimulants for feedback, some with actual hardware-in-the-loop, including both fixed and motion-based simulators.

Models and simulations are being used extensively and successfully for training, design trade-offs, and basic engineering work in both the commercial and the defense sectors. Within defense acquisition, and in T&E more specifically, there are scattered areas, such as hardware-in-the-loop testing, with long traditions of high-quality work. Opportunities for the use of M&S are most obvious in the developmental testing that is an inherent part of engineering development. Advancing technology also permits M&S to be used in the technical and operational evaluation of weapons systems at various stages in their development, and there have been some exceptionally well-run programs in this regard.

Overall, however, opportunities for M&S in support of T&E have not been well exploited. For the most part M&S techniques have been developed not to support T&E, but for use in training and in engineering and design efforts in the pursuit of excellence and improved product quality. Interest in the use of M&S to support T&E is a more recent phenomenon. This recent, high-level interest in M&S for T&E specifically, and for acquisition more generally, appears to be in pursuit of cost savings.

In general, those who trumpet the usefulness and benefits of M&S for defense acquisition programs have been advocates within the M&S community, or acquisition officials under increasing pressure to reduce both development time and costs of their programs. However, several recent studies of the benefits and cost savings to be gained through the use of M&S tools in the T&E process have raised substantial issues about the validity of advocates' claims. For example, the November 1998 Air Force Scientific Advisory Board

(SAB) Review of Air Force Test and Evaluation concluded that "[t]he high and unrealistic expectations for Digital Modeling and Simulation (DMS) contributions to T&E processes are underwriting a rationale that the Air Force and DoD can ignore ongoing and planned T&E infrastructure investments." Also, a 1996 SAIC study funded by OSD, entitled "Study of the Effectiveness of Modeling and Simulation in the Weapon system Acquisition Process," concluded that "cost savings are especially difficult to quantify and reported cost savings are often illusionary."

One problem has been that M&S developments and applications that are "top down" driven frequently focus on eye-catching graphical displays of information and user interfaces rather than on valid representations of the complex physical and human interactive processes inherent in the design and employment of weapon systems. This approach often results in models that are unsupported by data or analytic expertise.

There also appears to be a heavy focus on improving current legacy-based simulation approaches at the expense of inserting advanced computational technologies. For instance, there appears to be no ongoing substantive relationship between DoD agencies and Department of Energy laboratories aimed at employing DOE's new TERAFLOP (trillion operations per second) computer technology. A good example of the enhanced capability provided by this new technology is the Los Alamos Laboratory's Transportation Analysis Simulation System (TRANSIMS) transportation model, which can accommodate an order of magnitude more objects in the simulation than DARPA's Synthetic Theater of War (STOW).

Clearly, a better coordinated and more disciplined process is needed for the development and use of models and simulations, and for their Verification, Validation and Accreditation (VV&A). This more disciplined approach must also be a more visible and transparent process, particularly if use in test and evaluation is planned.

Findings

M&S has been very beneficial and cost effective in many applications, particularly at the engineering design level, and especially when there is a clearly defined application.

Successes that begin at the engineering design level are generally the result of organic developments embedded in a program where both expertise and data are available, and where the developing and using organizations have a common mission. Most often, successful applications of engineering or physics-based models are planned and carried out by contractors who have a clear stake in their validity and accuracy. These models tend to be most useful when their parameter values are based on solid research, experience, or the laws of physics.

The aerospace industry has used sophisticated M&S tools for many years. NASTRAN is used for basic structural design, computational fluid dynamics (CFD) codes are routinely used for aerodynamic and aerophysics analyses, and UNIGRAPHICS and CATIA are used for air vehicle design. Similar M&S tools have been developed and used for other weapon systems. But while there have been many beneficial applications of these tools, especially by industry, not all have been successful.

For example, existing CFD tools failed to predict the vortex problems behind the C-17 that interfered with the airlifter's ability to carry out its airdrop of paratroopers mission. Flight testing eventually uncovered this problem. Likewise, these tools were not capable of predicting the F/A-18E/F wing drop problems, or even of successfully analyzing proposed fixes after the phenomenon was discovered in flight testing. In another case, NASTRAN-based analyses of the C-5A wing resulted in a wing design providing only about one-fourth the required wing durability.

Despite such failures, M&S appears to provide an overall valuable evaluation tool where there is a clearly defined application, an adequate knowledge of required input data and its appropriate use, and a forthright appraisal of the model in question, leading to an understanding of its limitations.

Models and simulations tend to be least useful when the inputs are largely unknown or uncertain

Among the most overrated M&S tools are large-scale constructive force-on-force combat simulations and models used to predict weapon platform contributions to combat outcomes. To a large extent the parameters used in these models are not based on solid experimental data or research. In many cases, the inputs are simply guesses by the model's builders or users, or they have been altered from known values in an attempt to compensate for perceived or known model limitations.

Many of the constructive legacy models used for combat analyses, such as BRAWLER, TACWAR, ESAMS, TRAP, and SUPPRESSOR were developed years ago. Although these have been updated, they are not the comprehensive evaluation tools that today's technology might support if significant funding was available. These models are considered useful only for relative trade-off studies, but not for predicting actual combat outcomes. The few cases where comparisons of weapon system combat capabilities have been attempted have resulted in highly variant outcomes. For example, the F-22 Cost and Operational Effectiveness Analysis (COEA) used the TAC BRAWLER model and displayed F-22 exchange ratio advantages over the F-15 ranging from 8-to-1 to 20-to-1, depending on the combat mission and scenario. In the end, the Air Force agreed at Milestone II to demonstrate a 2-to-1 effectiveness advantage on the part of the F-22 as one of the criteria for entering production. More recently, the use of TACWAR as a force-on-force combat simulation was criticized in the Quadrennial Defense Review (QDR) for its inability to accord adequate consideration to air power contributions to campaign outcomes.

Much of the extensive investment in M&S by DoD seems to emphasize model architecture, interfaces, graphical displays, and code writing at the expense of conceptual model development and basic data collection.

Most of the high profile, force-on-force, constructive modeling efforts lack the underpinnings of basic science and engineering, both physical and behavioral. Interactive, operationally oriented models have not replicated the more complex interactions that are at the core of military combat. The emphasis on animated, high-resolution graphics provides an opportunity for "easy and ready-made analyses," but conveys to the decision-maker no understanding of the basic engineering, physics, or input assumptions. Clearly, more investment is needed in conceptual modeling, phenomenology, and experimentation to gather realistic input data in order to provide decision-makers with confidence in the results of M&S efforts. The application of cutting-edge technology, such as that demonstrated in the TRANSIMS modeling effort, is an area that promises significant payoff.

Much of the emphasis by the Defense Modeling and Simulation Organization (DMSO) and the Simulation Interoperability Standards Organization (SISO) has been on model architecture (for example, the High Level Architecture (HLA) program), and on interfaces, interoperability, and code writing. DMSO has funded a major effort involving many DoD organizations to develop a Conceptual Model of Mission Space (CMMS) describing the air/land/sea environment for use by all model developers. The project is ambitious and expensive. Another Department priority is the ongoing development of the Joint Modeling and Simulation System (JMASS), intended to develop and facilitate interfaces between legacy tools and new models. This latter effort has been underway now for several years but has undergone at least one major restructuring, so that its success is uncertain at this time.

Some progress has been made, however, by the Joint Advanced Distributed Simulation (JADS) test force in demonstrating distributed simulation interfaces. Sponsored by OSD's Joint Test and Evaluation (JT&E) office, the joint test force has carried out several demonstrations in its investigation of the utility of advanced distributed simulation technologies for test and evaluation purposes. For example, the so-called system integration test successfully linked air-to-air missile and fighter aircraft simulators on the ground with instrumented aircraft flying on the test range. Even this modest success, however, has not been rewarded with follow-on use of this simulation technology by any major weapon system acquisition program. Technical issues such as latency, as well as the cost of developing and maintaining such advanced simulation capabilities, no doubt dampen enthusiasm on the part of potential users.

Verification, Validation and Accreditation (VV&A) as presently practiced with respect to M&S techniques in general is not sufficiently disciplined to inspire confidence in their use in the T&E process.

VV&A does not receive the attention or resources needed to provide decision makers with even minimum levels of confidence in M&S tools for most applications. The use of data from tests and operational exercises to evaluate or validate model outputs appears to be minimal. The use of such "real world" data as model inputs appears to be equally rare. A disciplined method to ensure feedback of test and exercise results in the continuous upgrade of M&S tools should be an integral part of any approval process for investing in a model's development or employment in a particular application. This iterative process is often promised but seldom followed. Planned VV&A activities are often cancelled for cost and schedule reasons, just as testing itself often is cancelled or postponed.

A good example of how VV&A can be overlooked was provided in connection with the Army's state-of-the-art computer model, SQuASH (Stochastic Quantitative Analysis of System Hierarchies). SQuASH had been used since the late 1980s to assess the vulnerability of armored vehicles. In 1993, an independent validation effort compared SQuASH predictions of M-1A1 tank vulnerabilities to actual results obtained in earlier live fire tests. This effort was undertaken in response to an Army proposal to use this model as the primary data source for evaluating the M-1A2 tank's vulnerability. The disturbing results indicated gross mismatches between many of the model's predictions and the actual field test data. As a result, the proposal for assessing the new tank's vulnerability was modified to place more reliance on live fire testing. The Army also developed a plan to establish a "Red Team" and to undertake a full-blown VV&A of the model. (Unfortunately, the latter plans never came to fruition, primarily because of funding limitations.)

The Joint Accreditation Support Activity (JASA) can be a potentially significant resource to assist in the VV&A process. This small group has provided VV&A consulting support to several programs, including the F/A-18E/F, Tomahawk, Joint Strike Fighter, and AIM-9X. However, JASA is severely limited in that the organization has no institutional budget and must rely on customer programs for operating funds. This results in fluctuating staff size and reliance on short-term contracting support to accomplish their VV&A tasks, a very inefficient approach for what could be an important M&S resource.

There appears to be no authoritative single catalog or list of available models or simulations that includes descriptions, applications, level of VV&A achieved, limitations, input data requirements, or other information needed to inspire confidence in their use.

Various types of M&S are used in the T&E process, including large constructive force-on-force models, real time missile or projectile trajectories used on test and training ranges, hardware-in-the-loop and man-in-the-loop simulations, engineering or physics-based models, etc. Each has different applicability to test and evaluation activities, different development and maintenance costs, and different VV&A requirements.

Keeping track of this plethora of tools is not easy. Several repositories of information on models and simulations exist, some of which include the VV&A status of models and their uses. For example, DMSO maintains its Modeling and Simulation Resource Repository (MSRR), while Survivability/Vulnerability Information Analysis Center (SURVIAC) maintains a repository for many constructive models. However, most of the existing repositories tend to be quite specialized and oriented to their specific sponsors' needs. What is needed is a comprehensive single repository or catalog maintained and adequately funded at a higher level than is presently the case. The availability of such an authoritative catalog could assist in the VV&A discipline process and could preclude unnecessary duplication of effort by programs requiring M&S techniques.

For some weapon systems and warfare situations, open air testing is not feasible.

Despite the overselling of M&S and the potential for misuse, practically every mission or warfare area appears to be dependent to some degree on M&S techniques for meaningful evaluations of candidate weapon systems. Many situations and/or weapons systems that cannot be fully evaluated through open air testing alone require access to alternative evaluation approaches. In many cases, it isn't cost or schedule considerations alone that create reliance on means other than live testing.

Evaluating the survivability of an aircraft system, to include the effectiveness of its defensive avionics subsystems, is a good example of such a situation. Clearly, we cannot fire live missiles (even with inert warheads) against manned aircraft during testing. We are thus forced to rely on different forms of M&S. These include surface-to-air or air-to-air missile flyout models, often incorporated into the test range's instrumentation or data reduction routines; Hardware-in-the-loop (HWIL) simulations, such as the Air Combat Environment Test and Evaluation Facility (ACETEF) facility at Patuxent or the RFSS (Radio Frequency Simulation System) at Huntsville; and even constructive digital models that extrapolate (or expand) the one-on-one results from open air tests and HWIL simulations to many-on-many or campaign level evaluations.

But even in the case of aircraft survivability tests that depend almost exclusively on missile flyout models, the models should replicate the engineering and physics associated with the specific missile/target combinations and environmental conditions, and/or demonstrate good correlation with key results, such as miss distances, from actual missile firings against live targets. Such live firing data should be collected from both test and training exercises, such as Combat Archer, to include live shots against target drones maneuvering aggressively to simulate piloted aircraft; these results should be folded back into the flyout models as part of a continuous update program.

The F-22 operating in the modern integrated air defense threat environment for which it was designed cannot be tested realistically on any existing range. Nor can we hope to fully test the operational effectiveness of space-based sensor systems, such as the Space-Based Infra-Red Sensor (SBIRS), or sophisticated missile defense systems, such as Theater High Altitude Area Defense (THAAD) or National Missile Defense (NMD), across either the spectrum of operational scenarios or against the numbers or types of threats for which they are being developed. Full system effectiveness and suitability evaluations depend on an array of models and simulations that must be developed and made available to analysts and decision makers to augment data gathered during limited live firings in support of system acquisition milestones.

Likewise, evaluations of the lethality of our weapons and the vulnerability of our weapons platforms as part of the Live Fire Test and Evaluation (LFT&E) program depend on the use of M&S to extrapolate from affordable live firings, component testing, and the use of surrogates. In this context, government agencies as well as industry employ various physics-based models, finite element models, as well as empirical models to assess the complex interactions inherent in the lethality and vulnerability calculations used in LFT&E.

A potentially fruitful area for effective use of M&S in support of T&E is in the test design and planning process.

M&S techniques can be employed at the outset of a program to determine the critical technical characteristics or operational capabilities that a new system must possess and be tested against in order to justify its development and production. These results can then be used to guide technical and operational test designs in order to focus the scenarios, tactics, threat representations, countermeasures, statistical confidence levels, etc., on the critical technical parameters or operational issues during the detailed test planning and execution phases. However, full realization of M&S techniques' potential benefits for scenario and operational concept development will require more capable self-learning ("adaptive") tools not currently in use.

A notable recent successful use of M&S for test design and planning occurred in the Apache Longbow OT&E. The contractor's full-mission simulator was used to train aircrews and to develop tactics prior to field test, while U.S. Army Missile Command's (MICOM) HWIL simulator was used for missile flyout predictions prior to live Longbow Hellfire firings on the test range. VV&A of the simulators was generally successful, with simulator fidelity judged to be adequate for aircrew training and pre-test planning.

Another potentially high payoff area for the application of M&S techniques is the Reliability, Availability, and Maintainability (RAM) field.

Improved forecasting of RAM through M&S applications could build on the successes in the engineering design field. The Defense Department's emphasis on reducing operating and support costs will not bear fruit unless the logistics system can be simulated well enough early in a program to identify problem areas and permit tradeoffs to be carried out before designs are concrete.

Logistics Composite Model (LCOM), developed in the 1960s, is still the primary suitability/logistics analysis model. Although it is a legacy model, LCOM has been updated on a near continuous basis and extensively modified over the years. But in spite of efforts to remain current, there are still some problems associated with the use of such M&S techniques in system design and subsequent RAM evaluations. Typically, these logistics models contain many factors difficult to quantify in algorithms, such as the system's concept of operations (CONOPS), motivation and training maturity of the maintenance personnel, allocated manning and skill levels, and the efficiency of the supply chain. There appears to be no systematic effort to collect data on operational systems in a variety of environments and at different operational tempos for feedback into these models to ensure they accurately reflect real world situations.

Unfortunately, not enough emphasis is placed on logistics analyses early in development. Availability models are too often used to show that weapon systems are supportable and suitable, instead of determining realistic support requirements and attempting to identify and fix support problems.

More credible and accurate forecasting of RAM will allow for improved systems engineering, improved operational testing, and reduced ownership costs for new systems. Credible RAM modeling and simulation capabilities are necessary in that, during the testing phases of a new system, measurements of these parameters are typically made for relatively immature hardware/software, requiring extrapolation to predict the life cycle costs of the system.

It is extremely difficult to measure the cost and time benefits associated with the use of M&S in the T&E process.

Claims of substantial program cost savings attributable to the increased use of M&S, with a concomitant reduction in testing, cannot be verified. In addition to the Air Force SAB and SAIC reports referred to previously, a White Paper prepared by the AIAA Flight Test Technical Committee (FTTC) in late 1998 entitled, "Seeking the Proper Balance between Simulation and Flight Test," states "the members of the FTTC are unaware of any study that has supported the claim of substantial program cost savings realized by a significant expansion of the use of M&S with a concomitant reduction in testing."

The 1996 SAIC report documents numerous claims of cost savings attributed to M&S use, some of which border on the incredible. In many of the cases reported, the so-called cost savings are actually cost avoidances where the use of M&S tools permits a program to forego extensive testing, some of which would not be carried out in any event. Examples of large savings reported to have been achieved (or planned for achievement) include $40 million saved by the F-16 program by using M&S to replace flight testing of new avionics, $673 million saved by the Comanche program, and up to 3 percent of life cycle costs saved for the Joint Strike Fighter, which would equate to $5 billion.

In many cases, large savings forecasts have not been realized, even though budgetary and personnel reductions have been levied on both infrastructure and programs based on these unrealistic forecasts. Unfortunately, not even modest up-front investments have been made to attain savings in software, hardware, and personnel. Credible value analyses of the contributions of M&S to the cost, cycle time, and effectiveness of the system to be tested and evaluated need to be carried out to justify these investments and presented to decision makers early in a program's acquisition.

The lack of up-front funding is often a critical problem for M&S.

The Air Force SAB panel states that it "could find little information on the cost of ongoing Digital Modeling & Simulation (DMS) development programs," but did conclude that funding of DMS projects is substantial and it doesn't appear to have any coordinated focus or central control.

The sizeable costs associated with the development and employment of M&S capabilities can be daunting to the program manager who requires such capabilities as an adjunct to physical testing of his weapon system. This often leads to a promised M&S capability not being available when needed for T&E. A good example of this problem is the F-22 Air Combat Man-in-the-Loop simulator, which early on became a linchpin in the Air Force strategy to minimize open air OT&E. It costs around $140 million, and it has been a frequent target during budget drills, resulting in a challenging schedule in danger of not meeting the OT&E requirement.

There is serious concern about the ability of the Department to attract and maintain the intellectual capital required to achieve the potential benefits M&S appears to offer.

The entertainment industry and its pioneering and innovative applications of simulation tools are apparently far more glamorous than government work, and appear to be attracting many of the best and brightest in the field. Clearly, the government has failed to compete with the commercial world in attracting or maintaining the talent necessary to provide a first class M&S development capability. This concern applies to both industry and in-house government agencies responsible for M&S, and affects the long-term prospects for the development and use of a first-rate, credible M&S capability to support decision making.

At present the center-of-gravity for cutting edge advances in computational and simulation technology currently resides in the Department of Energy (DOE) Defense Program Laboratories. Their TERAFLOP computing capabilities provide the potential for large, adaptive simulations involving millions of objects. Yet there appears to be little, if any, significant DoD involvement on a strategic level aimed at the use of these emerging tools.

Recommendations

1. Oversight and Direction of M&S Development and Employment

Assign responsibility to Director, Defense Research and Engineering (DDR&E) (at an appropriately high level) for oversight and direction of all aspects of research relevant to M&S, particularly that which supports T&E.

Responsibilities for oversight of M&S research would fit into three broad categories:

- Phenomenology aimed at measurements and basic data collection to support M&S development and employment across the board, to include T&E applications.
- Conceptual model development to include not only the traditional engineering focus or legacy-based improvements, but with more attention to the insertion of revolutionary computational and simulation technology to handle non-linear conditions and uncertainties (including the impact of human factors, combat behavior, and environmental factors) that influence weapon system effectiveness in realistic combat situations.
- Development and maintenance of a catalog of M&S capabilities and accredited applications, to include categories such as hardware-in-the-loop simulations, man-in-the-loop simulators, physics-based models, and constructive models.

Critical to the exercise of these responsibilities would be a shift from the current emphasis on "code-writing" and simulation connectivity to conceptual model building and basic data collection and use.

Establish an independent accreditation process for M&S use in support of the acquisition process, to include input data for models.

This process is needed to instill much-needed discipline, as well as to increase the level of confidence in the development and application of M&S as an evaluation tool in the acquisition process. For the specific use of M&S tools in operational assessments or system evaluations, the Joint Chiefs of Staff J-8 office should be assigned the responsibility for accreditation of those tools for particular applications. In a similar vein, the DOT&E should accredit input data for use in these models and simulations.

Encourage the use of M&S techniques to improve the test design and planning process, to rehearse tests, and to predict the outcome of test trials. In the latter case, require the modification of models and simulations to reflect the actual outcome of tests when predictions miss the mark.

Require more balanced cost consciousness, to include independent evaluations, in the cost benefit analyses used to justify the development and use of M&S as a means to reduce open air testing.

2. Up-Front Investment in M&S for T&E Applications

Modify the directives governing the acquisition process to require identification and funding of an M&S plan for evaluating a program's progress and operational effectiveness/suitability at the earliest practical point in the program.

Substantial early investment is often needed to capitalize on the potential M&S benefits in the T&E process. A comprehensive M&S plan should be required as part of the Request for Proposal (RFP) process for development of a new system and should be considered as a major evaluation criterion for each contractor's proposal. Approval and commitment of funding for the M&S plan should occur as early as Milestone I, if possible, and certainly by Milestone II at the latest, and should be a necessary condition for proceeding with the program.

Assign funding responsibility for the development of M&S tools required for the evaluation of acquisition programs to a central agency such as the DDR&E agency discussed in the first recommendation above or a Defense Agency that might be assigned the responsibility for the ranges and test facilities.

Typically, program managers lack the incentive to fully fund the M&S tools required for thorough evaluation of their systems and to protect that funding through the life of the program. This situation is analogous to the overall funding of the T&E infrastructure in general as well as system-specific requirements (e.g., targets, unique instrumentation).

3. Identification of Model/Simulation Assumptions and Limitations

Require the users of M&S in their evaluations to state model assumptions, limitations, and uncertainties explicitly, as well as sources for input data in the presentations of results to decision makers.

The disciplined accreditation process called for in the recommendation above would accommodate this problem, which has contributed to the perception that the benefits of M&S are oversold.

4. Near-Term Priority on M&S Development and Use in RAM Evaluations

Give near-term priority, with required funding, to the development of more state-of-the-art reliability, maintainability, and availability models, and to the update of existing models with legacy data from our vast experience with weapon systems in the field.

These efforts should be aimed not only at an ability to credibly evaluate the suitability of systems in development, but at reducing the cost of ownership of both existing and planned systems. The emphasis on reducing life cycle costs of systems should be translated into increased attention to predicting the reliability, maintainability, and availability of systems in development.

TEST AND EVALUATION FACILITY REENGINEERING

Physical T&E of weapons systems requires large, sophisticated facilities, such as those at Edwards Air Force Base, Patuxent River Naval Air Station and Aberdeen Proving Grounds. In the course of this study, the task force reviewed the overall management of these facilities and visited a cross-section of DoD's T&E facilities to assess their readiness to meet current and future defense requirements. The task force views these facilities as indispensable to continued development of new weapons systems; however, it concludes th nagement of T&E facilities must adapt to the changing test and evaluation e onment to retain their vitality and capability. Broadly stated, the task force co ues that the ration of the Defense-wide system of T&E facilities should be ca ly ret e light of changing defense procurement and management prac ces, adva technology, and budget constraints.

OVER MANAGEMENT

e imp ent the management system. Both investment and atin can be s educed through management reengineering. Initial savin o orde of $1 per year are possible.[1] While this result is welcome, testing vings must not be the primary goal for management changes.

ved testing far exceed what is achievable from concentrating os. current operations. Testing is second only to design in levera rly investmen e total program cost. Finding problems early through testing and inc orating fix w e in development saves precious cycle time, precludes expensive lded systems and provides combat systems to the warfighter much faster. Th h payoff results of better testing. Once initial designs are mpleted, there is ter return on investment than funds and time spent doing comprehensive, well-planned testing.

Findings

> ***The Army has recently consolidated its organizations responsible for evaluat g results obtained during development and operational testing. This ossible model for Department of Defense test and evaluation manage ent consolidation.***

The Army operational test and evaluation agency is now responsible for independent evaluation of all testing results accomplished by the Army throughout the life of a

[1] Major Range and Test Facility Base (MRTFB) operating budgets for FY '99 are listed in Annex C of this report.

program. The ne :t step in the Army's T&E eer gineering process is to create a single management org: nization fc r all Arm; test res our es.

Unnecess ary test facility d. iplication among the Services, defense contracto s, and other gove. nment age ncies could be eliminated by centralizi g T&E m inagemer t in a si igl DoD T&E organization.

Studies conducte l of OSD': T&E or anizations l ave examined alternative management structures. Signif cant impr vements n owne shi and utilization of T&E resources can result from:

- centralize l financial managem nt and : dm nistration
- distribute functiona activitie:
- common : trategic re: ource inv stment la: ning
- integrated data acqui ition, an: lysis, ar hi ing, and processing operations
- common : esearch, d velopmer t, test, a d e valuation initiatives
- T&E com nunity-wi le human esource ma agement
- sharing of best T&E practices . cross th: D partment
- distribute test facili y manage nent and te: t execution.

Outsourc ng without reengin ering, how ver, can only reduce the cost of busine: s as usual

The task force al: o consider d other possible T&E management models. Contracting out represents nearly 73 percen of the t tal R&D T&E budget. Only reengineering of the management, ow iership, and operatic n of T&E resources as shown in the DoD studies can provide "ne v and innovative w ys that th T&E community can better support users."

REENGINEERI G INDIVIDUAL T&E FACIL TIES

The T&E task orce beli ves that a busir ess as usual approach to T&E facility management is nsufficient to main tain the se critical systems development support facilities to mee t future DoD neec s. Copi g with today's technical and business environment req ires mor than s ort-term palliative measures; the management approaches, supp rting busi ess syste ns and t st lesigns must adapt to ensure continued assurance that U.S. weapon: systems meet de en: e needs. The task force concludes that most DoD T&E facilities lack suc essen ial change processes; this short-coming jeopardizes U.S. &E capab lity and affordabi ity.

Findings

Physical space required for flight, vehicle, sea, and live-fire testing and facilities with sophisticated or unusual capabilities are a major consideration for T&E facility reengineering.

Facilities for weapon system physical T&E must often be large (e.g., Edwards AFB), expensive, complex (wind tunnels, rocket and jet engine test stands and flight test facilities), sophisticated (well instrumented, supported by high-performance communications and computing systems) and have unusual capabilities (e.g., anechoic chambers, terrestrial and space environment simulators, vehicle test tracks). These aspects must be taken into account in any T&E facility reengineering effort.

Some major test and evaluation facilities are obsolete and inoperable as a result of cannibalization, whereas other heavily used test facilities are limited by time needed for essential repairs.

Many underlying test capabilities witnessed by the task force are old, some constructed during the 50's and using World War II vintage components, such as some of the wind tunnels at Arnold AFB. In response to declining budgets and demands for less costly testing, preventative maintenance for many facilities has been postponed; remediation of acute facility problems now dominates facility upkeep.

Test and evaluation technology is rapidly advancing, propelled by tight test budgets, short T&E schedules and advancements in sensors, communications and computer technology.

Today's programs budget for fewer live fire test vehicles and less flight test time than earlier efforts. High-fidelity modeling and simulation, combined with sophisticated ground testing of reusable vehicles, must replace some field tests. Remote real time, or near real time, control of tests and data evaluation is changing historical relationships between test operators and system developers.

Test and evaluation business practices are changing, forcing profound changes in the way facilities are managed and costs are accounted.

Increased contractor performance test and evaluation, use of government facilities by commercial developers, activity-based accounting, the requirement that system developers pay test costs, and a substantial drop in institutional funding are forcing profound changes in the way facilities are managed and costs are accounted.

DoD has many unique, irreplaceable test and evaluation facilities, some of which, while not required to meet immediate needs, will be needed for future weapons developments. Comparable capability is not available elsewhere, including in the private sector.

Cost-effective ways must be found to deactivate these unique, irreplaceable facilities in ways that preserve their capabilities to meet future needs.

Duplicate T&E capabilities exist among the Services and between the Department and non-DoD organizations.

Test and evaluation facilities within DoD were developed in response to Service needs. As a result, duplicate T&E capabilities exist among the Services and between the Department and non-DoD organizations such as NASA. Examples of this are seen at Patuxent River and Edwards AFB. Many of these facilities appeal to the same outside customers for business.

The task force found some test and evaluation organizations that are effectively addressing changes in the T&E environment and technology.

Arnold Engineering Development Center's (AEDC) reengineering program is one notable example. The task force examined the Center's process of managing operations to meet the shifting T&E environment and followed up with a site visit to learn more. The task force found a sustained, center-wide top-down driven activity focused on adapting AEDC operations to long-term trends in support, project, and facilities funding and personnel strength. This activity, closely patterned on industrial reengineering successes, places heavy emphasis on measures of cost-effectiveness, response, activity-based costing, and activity-based management. Continuous process improvement, (for both businesses and T&E processes), qualified by metrics, is central to this reengineering program. This commitment to reengineering, which has persisted throughout the tenures if several AEDC commanders, resulted in a 50% reduction in allocated costs in the first year, with additional significant savings coming from improved logistics support and business processes in subsequent years. This has been accomplished while sustaining the center's missions cost structure, organization, and T&E processes.

Such successful efforts have resulted from a thorough rethinking of the test and evaluation process and shifts in business pressures. The need to compete more strongly for test and evaluation customers through cost, cycle time, service and capabilities drives these long-term transformations to ensure organizational survival.

Recommendations

1. **The task force was briefed on concepts for bringing together the management of T&E resources. OSD and the Services should work together to develop a plan whereby T&E resource management is strengthened and brought under coherent control.**

This control organization should be responsible to the Secretary of Defense for planning, budgeting, operations and maintenance of the Department's T&E resources.

2. **Military departments responsible for acquiring specific weapons systems should continue to test those systems and be responsible for evaluating and reporting results of these tests.**

This new management organization should make every effort to outsource activities that can be performed in the private sector. Decisions concerning outsourcing and facility conversion to non-government operation should be made first, on the basis of fielding the best possible weapons systems to warfighters in the most expeditious manner; second, to exploit the best applicable business practices to achieve better, faster, and cheaper test and evaluation; and third, to ensure the preservation of unique facilities needed to meet future defense test and evaluation needs.

3. **Apply the reengineering process, employed at Arnold Engineering and Development Center (AEDC), to all test ranges in order to update operations and maintenance and capability investment plans and strategy.**

DoD should undertake a thorough inventory of the Department's T&E facilities and skills and those of other government and non-governmental organizations similar to that recently completed for radar cross section measurement facilities[2]. This inventory should look beyond DoD capabilities to take into account those facilities elsewhere in government and in the private sector. The inventory should clearly identify DoD facilities needed to meet future near- and long-term needs, both for test and evaluation capacity and for unique capabilities.

4. **DoD should develop a T&E Facility investment strategy, based on the inventory and future needs, to assure ability to meet DoD T&E needs through the most effective and efficient combination of all national facilities.**

Investment alternatives should be formulated using scenario- or statistics-based modeling tools to provide the basis for decisions. Options including increased use of contractors to conduct operations should be considered.

5. **DoD should establish a set of figures of merit to assess, compare, and contrast reengineering progress of each of its major T&E facilities.**

The test and evaluation community as a whole (including both DoD and contractor organizations) must develop more efficient test procedures, based on computer-based modeling and simulation, that achieve more insight into system performance from ground-based tests. The virtual test project at Arnold Engineering Development Center is one good example of creative ways to improve the fidelity and coverage of wind tunnel testing.

Test and evaluation is no longer limited to the later stages of system development and operational deployment. Future test and evaluation planning must reach back to early systems development process. The complexity of modern systems, especially those based on Very Large Scale Integration (VLSI) electronics, are impractical to thoroughly test from outside the system. Design for Test and Evaluation and Built-In Self Test and Evaluation must become a routine part of DoD systems development to assure developmental and operational T&E can be adequately performed.

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[2] National Test Facility Advisory Council, Radar Cross Section (RCS) Measurement Facilities Assessment, December 1998.

6. **A searching examination of management practices should be undertaken by all test and evaluation centers to address changing test and evaluation technical and business practices, aging facilities, cost and test cycle time reduction, and customer service.**

The result of this examination should be a sustained reengineering effort that is disciplined and enterprise-wide. Coping with the future test and evaluation environment requires new thinking about business processes, not merely new computer or business programs. Experience shows that such a change will require dedicated leadership and resources; outside help from groups with proven records of success in planning and facilitating similar changes elsewhere will be needed.

The critical spiral of diversion of scarce preventative maintenance resources to solve short-term operating problems while delaying routine maintenance must be broken. Once started, this spiral leads to operations where all problems are emergencies. The result is inevitably longer test and evaluation schedules and compromised capabilities.

Sustained leadership dedicated to achieving real change is essential to success in the kind of major shift in business and technical practices envisioned by the Panel. Leadership must achieve organization-wide buy-in and enthusiasm for the change. The time required will last throughout the terms of several facility military commanders.

Test and evaluation reengineering will not succeed without incentives to facility management to achieve dramatic long term results. The current financial system actively penalizes improvements by decrementing operating budgets based on forecasted savings at the outset of reengineering. In the near term, facilities should be allowed to reinvest a portion of savings achieved to promote still further test and evaluation improvements.

7. **This study limited itself to DoD owned and operated facilities but would observe that a serious look at the T&E facilities should include NASA, DOE, and other agencies test facilities.**

SPECIAL ISSUES

This special issues section includes discussion and recommendations on topics that are of special interest to the Department and include T&E involvement in advanced concept technology demonstrations (ACTDs), T&E of systems of systems, T&E of information system software, and T&E of commercial off-the-shelf (COTS) software.

To address these issues the task force looked at how each of these areas can benefit from T&E. The task force examined how the transition of ACTDs can be improved by adding a tester to the process and how T&E should be conducted on military systems that are actually systems of systems. Lastly, T&E of software was studied, to include both information systems and COTS software.

ADVANCED CONCEPT TECHNOLOGY DEMONSTRATIONS (ACTDS)

The Advanced Concept Technology Demonstration (ACTD) Program, initiated in 1994, supports a set of the department's programs aimed at quickly capturing technology and getting it into the hands of the warfighter. Through 1998, nine ACTDs had been completed, including the Predator medium altitude Unmanned Aerial Vehicle (UAV), which saw operational use in Bosnia and Kosovo, and the Precision/Rapid Counter Multiple Rocket Launcher System in Korea. Currently, just over 50 ACTDs are underway, including 11 accepted for FY99.

ACTDs are designed to directly foster alliances between technologists and warfighters. In particular, the technical community gets feedback from the warfighter, while the warfighter gets to examine new technologies and their attendant operational concepts without an upfront commitment to buy. This provides for the possibility of introducing technologies, especially for joint capabilities or other "out-of-the-box" programs, that might otherwise not get examined. The requirement of JROC review and CINC sponsorship favors capabilities that have a real, near-term mission to perform.

The intent of the ACTD programs, if successful, is to create and "leave behind" some operational capability when the program concludes in a two- to four-year time period. An operational assessment based on effectiveness in an anticipated operational environment with expected threats must accompany a "leave behind" operational capability. At this point, it should be possible to decide whether or not to convert the effort into an acquisition program to equip more of the force.

The most useful role for the T&E community in the ACTD program is helping with transition to acquisition status. "Leave behind" products of ACTDs should have adequate operational testing against threats to understand the operational effectiveness before fielding. CINCs must know both the capabilities and limitations for combat employment. The T&E community can help by aiming the demonstration and the data collected at a particular milestone. For example, a demonstration that was intended to proceed directly to production would require resolving issues ordinarily settled in a dedicated operational test, whereas a demonstration aimed at MS II insertion would have much more modest learning requirements. In addition, in the spirit of "early involvement" the T&E community can work with and archive the data to minimize the redundancy of information gathered in formal testing later on.

T&E participation has provided early operational insights that have influenced the direction taken by the demonstration. In the case of the Medium Endurance Unmanned Aerial Vehicle (Predator), the testers identified lack of system reliability as a driver preventing the continuous coverage that would become one of the Key Performance Perameters.

However, Predator was one of the first ACTDs, and the testers were added to the demonstration late in the process. Inclusion of testers at the beginning of an ACTD is becoming more common. This will go a long way toward easing transition pain. The adoption of the CAF concept will be the remedy for better integration of testers in ACTDs as well as in the standard acquisition process.

Recommendation

Direct the participation of a tester in the ACTD process to maximize the value of this concept

SYSTEMS OF SYSTEMS T&E

The integration of information systems from Services and Agencies, many of which are not well integrated themselves, into joint systems which can effectively serve the CINCs in joint operations presents difficult T&E challenges. In most instances there is no overall architect of the joint system although efforts are made to cope with the resulting lack of overall concepts. Since the joint systems of systems problem is so large and complex and since it involves so many organizations and so many components of all ages and origins it is difficult to exercise control over the systems of systems design and test process.

The term "Systems of systems" means different things to different people. It covers anything from a simple component integration to a land, air, sea and space multi-platform, multi-service joint campaign-level interdependent system. For this report, systems of systems are defined as those systems that require interoperability or interdependency between functional entities for mission success. In nearly all cases, the systems being integrated do not have a single responsible design agent and extensive coordination is required across Service and agency lines.

There are three classes of components

- Legacy systems
- New systems
- Interoperability/interdependency enabling systems

The joint systems of systems must work. Yet, very large systems tend to evolve; they are not created in a single action. The usual technique is to assemble the system and run it under realistic conditions, learn how to use it, and find out what doesn't work and fix it. This is how very complex civil systems come into being.

Systems of systems T&E differs from the form of T&E where the tests are run to determine whether the system meets specifications. Instead, the idea is to make the best of the situation, to find out how to use what exists, to fix what is possible to fix, and to encourage suppliers to create new and useful components as well as to improve old components. The emphasis is on evaluating the fixes.

Joint learn-and-fix tests and exercises, both real-world and simulated, place new demands on the DoD's T&E resources. Systems of systems testers must have comprehensive knowledge of all the systems of systems components in the joint environment. The tester must have a truly joint perspective. Further, the systems of systems tester must be able to mount a test environment that accurately reflects joint operations. The environment must be able to support interoperability/interdependency testing.

Historically, interoperability/interdependency testing has been optional. Yet system interoperability weaknesses are often first uncovered during operational testing, when component systems are operated together in a field test. Solving problems thus discovered are key to operational mission success. Operating evaluations and innovative work around procedures can overcome many interoperability deficiencies. Today's shift to interdependency will create new systems that have limited autonomous capability, thereby introducing risk to the potential success of these systems and will lead to "dependent" systems that cannot be operationally tested without the presence of the integrated "resource" systems.

The rapidly improving technology that is associated with the systems that provide the "information linking" must deal with both new systems having comparable technology and legacy systems that are often comprised of dated technology

DoD has an organization devoted to the T&E of joint systems of systems. The Joint Interoperability Test Command (JITC), is tasked with assuring joint interoperability, yet JITC involvement in systems of systems development is optional. It has no funds of it's own, Program Managers must bring cross-service budget agreements with them when they enlist JITC's' help, and thus often skip T&E aimed at interoperability issues.

Findings

There is no clear, common, definition of "systems of systems."

Many of the briefings presented to the DSB T&E task force were, in the eyes of the briefer, "systems of systems" programs. Representatives from DOT&E, the Military Services OT&E agencies organizations responsible for modeling and simulation and testing of joint systems and interoperability, presented many views of systems of systems.

There is no single responsible entity that has both the financial and performance responsibility for the operational success of the particular system of systems.

Joint Interoperability Test Command (JITC) should be assigned responsibility for assuring systems of systems interoperability and be provided limited program funds to carry out this mission.

Recommendation

> **Create a systems of systems design authority (system designer) with a joint T&E component that uses the Service T&E and JITC resources for joint testing.**

Joint systems of systems testing will likely be difficult, as it is not well defined.

INFORMATION SYSTEMS SOFTWARE T&E

Information systems are frequently systems of systems, incorporating new as well as legacy hardware and software and lacking an overall systems architect; they often share many of the systems of systems T&E challenges indicated in the previous section. The organization of development into separate hardware and software design activities often gets in the way of achieving efficient marriage of these two major systems aspects.

A well-disciplined engineering process is essential for designing, building and testing information systems to deal with system complexities.

Test and evaluation considerations must be part of the initial system development plan and must be an important consideration at every step of the process. Serious problems not found by conventional T&E until late in the development process can be totally disruptive and compromise the entire development

Although T&E of the integrated hardware and software components of information systems has many challenges, software is a major T&E problem in its own right. Postponing software T&E until late in the development process wastes valuable opportunities to uncover problems at periodic system "builds" and to correct them easily early in the development.

Modular software design that allows incremental testing of pieces of the system as the development proceeds is essential. Even when modules are validated individually, integration testing can uncover major flaws, but at least the elements of the system are understood. Sound software system architecture and rigorous configuration control are essential to assure that interface problems can be identified and tested early. Each module should have built-in test capabilities to assist in diagnosing T&E and operating problems.

Software testing must start early in the program to uncover problems as they arise. Software "inspections" and peer reviews, where a small, independent team of software and applications experts reviews the design, the developed code and documentation are important. Such reviews detect existing flaws and potential problems as well, saving time and money later in the development process. Development organizations themselves, not separate organizations, are responsible for carrying out these early T&E activities.

Effective software design and development hinges on having a competent, experienced software team (contractor or government). The proven Capability Maturity Model (CMM) helps to assess a software organization's capabilities. The process involves a team of 5 or 6 people lead by a certified expert in software appraisal that spends 5- 10 days performing a CMM assessment. A successful assessment qualifies the ability of the organization to carry out disciplined software development and to track software performance to specifications.

Late in the software development process, commercial companies employ alpha and beta testing of their products by sample users to uncover unanticipated problems and assure a robust product at introduction to the general market. DoD should study the private sector practices and employ them in the development of military information system software to the maximum extent possible.

Automated testing of non real-time software that automatically identifies design flaws in developmental software is showing some promise. Automated test technology should be developed and employed by software testers to the maximum extent possible.

Recommendations

1. **Insist on Capability Maturity Model qualification of software development teams appropriate to the size and complexity of the information system.**

2. **Employ alpha and beta testing, as practiced in the private sector, to the fullest extent possible.**

3. **Consider automated testing of non real-time software; ask DARPA to consider developing machine testing technology for both real-time and non real-time software.**

4. **Insist that regular, independent software "inspections" be routinely incorporated into information system development programs.**

TEST AND EVALUATION OF COMMERCIAL OFF-THE-SHELF SOFTWARE (COTS)

The functional requirements for systems in the commercial world have moved closer to the requirements for military systems. For example, both electronic commerce and military systems require network security. This has led to more extensive use of COTS products, including hardware and software, in military systems. The DoD, in policy and practice, has stated a strong preference for COTS products and for a reduction in custom-built software and hardware. However, the use of COTS products can significantly change the process by which systems are built. For example, the system must be designed to use existing COTS products even if they are merely satisfactory and not optimum for the military purpose. One expectation is that the COTS product has been thoroughly tested and proven and that its characteristics have been demonstrated in commercial applications, therefore, testing for military applications can be greatly reduced. This is a reasonable assumption for individual software packages but is less so for systems of packages. In general, it seems likely that the use of COTS software in military systems will not have a major effect on reducing the effort required for system testing, in either DT or OT.

Except in trivial cases (such as a word processing or e-mail system), military systems include many software packages. Even if these are COTS products, they will probably come from different vendors and may use different languages and interfaces and other standards. Even if the individual packages are carefully chosen by the system designers for performance and quality, integration of the software into a working whole may not be easy and may require building substantial amounts of interface software, drivers, etc. This is true for commercial systems as well.

Presumably the COTS software will already have been extensively tested by commercial users and should work well as long as the military application is similar to the usual commercial application and is well within the performance limits of the package. In some cases, however, the military application may stress the COTS software in unusual ways; a problem may not appear until the system has been completely assembled and tested under realistic conditions. The integrating contractor may find that his lack of knowledge of the COTS details, the lack of source code, and the limited leverage he will have on the vendor to make changes and corrections will offset the relative lack of bugs in the COTS software. These problems also exist in system level testing where discovering which package is at fault may be difficult.

COTS software can have many advantages including savings in time and money, fewer bugs, and built-in vendor support and upgrades. At the same time, the frequent new versions of COTS software will create new integration problems. Existing software in the system may have to be changed because the vendors no longer support the old versions while the new versions may require related upgrades in hardware and operating systems which will affect the other packages. Software maintenance is a major problem with all software systems but maintenance of COTS systems presents somewhat different, but not necessarily easier, problem than maintenance of custom systems.

Recommendation

Conduct functional and interface testing of COTS software as a prerequisite to its use in DoD programs.

SUMMARY OF RECOMMENDATIONS

TEST AND EVALUATION REQUIREMENTS DETERMINATION PROCESS

Recommendations

1. **Establish a stable team made up of users, developers, testers, and appropriate contractors called a Combined Acquisition Force (CAF) to streamline the acquisition process for ACAT I programs. The CAF should be formed once a need is identified and remain in place throughout the acquisition process.**

2. **Change 5000.1 to incorporate the CAF concept.**

3. **Require the development of a Preliminary Test and Evaluation Plan in conjunction with the MNS.**

4. **Conduct an early operational assessment based on the ORD and an operational scenario before milestone I (no actual hardware would be involved).**

5. **Make the CAF a key participant in the Requirements Developments Process.**

DEVELOPMENTAL AND OPERATIONAL TEST PROCESS

Recommendations

1. **Each of the Service DT&OT organizations should be consolidated, to include integrated planning, use of models, simulation, and data reduction. Planning should be totally integrated, and the OSD T&E organizations consolidated. There should be integrated use of models, simulation, and data reduction. Except for limited dedicated OT&E, contractor and government testing should also be integrated.**

2. **For each development program and its associated test and evaluation effort, special attention should be directed early in the planning cycle (and periodically throughout program development) toward compressing the developmental test schedule wherever practical.**

3. **Facilities within the DoD's Major Range and Test Facility Base should be required to conduct periodic, systematic reviews to determine where data acquisition, reduction, and analysis procedures could be improved to increase the efficiency of the T&E process.**

Modeling and Simulation in Support of the Test and Evaluation Process

Recommendations

1. **Oversight and Direction of M&S Development and Employment**

   Assign responsibility to DDR&E (at an appropriately high level) for oversight and direction of all aspects of research relevant to M&S, particularly that which supports T&E.

   Establish an independent accreditation process for M&S use in support of the acquisition process, to include input data for models.

   Encourage the use of M&S techniques to improve the test design and planning process, to rehearse tests, and to predict the outcome of test trials. In the latter case, require the modification of models and simulations to reflect the actual outcome of tests when predictions miss the mark.

   Require more balanced cost consciousness, to include independent evaluations, in the cost benefit analyses used to justify the development and use of M&S as a means to reduce open air testing.

2. **Up-Front Investment in M&S for T&E Applications**

   Modify the directives governing the acquisition process to require identification and funding of an M&S plan for evaluating a program's progress and operational effectiveness/suitability at the earliest practical point in the program.

   Assign funding responsibility for the development of M&S tools required for the evaluation of acquisition programs to a central agency such as the DDR&E agency discussed in the first recommendation above or a Defense Agency that might be assigned the responsibility for the ranges and test facilities.

3. **Identification of Model/Simulation Assumptions and Limitations**

   Require the users of M&S in their evaluations to state model assumptions, limitations, and uncertainties explicitly, as well as sources for input data in the presentations of results to decision makers.

4. Near-Term Priority on M&S Development and Use in RAM Evaluations

Give near-term priority, with required funding, to the development of more state-of-the-art reliability, maintainability, and availability models, and to the update of existing models with legacy data from our vast experience with weapon systems in the field.

TEST AND EVALUATION FACILITY REENGINEERING

Recommendations

1. **The task force was briefed on concepts for bringing together the management of T&E resources. OSD and the Services should work together to develop a plan whereby T&E resource management is strengthened and brought under coherent control.**

2. **Military departments responsible for acquiring specific weapons systems should continue to test those systems and be responsible for evaluating and reporting results of these tests.**

3. **Apply the reengineering process, employed at Arnold Engineering and Development Center (AEDC), to all test ranges in order to update operations and maintenance and capability investment plans and strategy.**

4. **DoD should develop a T&E Facility investment strategy, based on the inventory and future needs, to assure ability to meet DoD T&E needs through the most effective and efficient combination of all national facilities.**

5. **DoD should establish a set of figures of merit to assess, compare, and contrast the reengineering progress of each of its major T&E facilities.**

6. **A searching examination of management practices should be undertaken by all test and evaluation centers to address changing test and evaluation technical and business practices, aging facilities, cost and test cycle time reduction, and customer service.**

7. **This study limited itself to DoD owned and operated facilities but would observe that a serious look at the T&E facilities should include NASA, DOE, and other agencies test facilities.**

ANNEX A: TERMS OF REFERENCE

THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, D.C. 20301-3010

ACQUISITION AND
TECHNOLOGY

18 MAY 1998

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Terms of Reference--Defense Science Board Task Force on Test and Evaluation

You are requested to form a Defense Science Board (DSB) Task Force to undertake a broad review of the entire range of activities relating to Test and Evaluation (T&E). The T&E structure of the Department of Defense has been built over a number of years, and today two-thirds of the T&E structure of the Department is over 30 years old. While some new T&E capability has been added, generally T&E did not share in the buildup in the 1980s when both procurement and Defense R&D increased considerably. Now under the guidance of the QDR, procurement is planned to increase 50% by 2003 from its low point in 1996. These procurements encompass major systems as large as any in the history of the Department as well as small upgrades, commercial, and nondevelopmental items. The costs and cycle times of all these defense acquisitions can be reduced, and the T&E structure cannot only be responsive to all these needs, it can help lead the way to positive change. Further, a number of new acquisition techniques, such as the ACTD, have formalized the department's increasing emphasis on early and extensive involvement of the warfighter via CINC participation in acquisition activities. Inclusion of the warfighter as a user will effect future T&E, in part by providing the opportunity to address operational issues and gain operational insights early in the development process.

Your study should include an examination of new and innovative ways that the T&E community can better support these users. For example, the variety and everchanging nature of the threat systems which U.S. and coalition forces face calls for a new look at the role of T&E in rapid and responsive acquisition cycles to meet these threats. There are a number of test processes that merit thoughtful review in light of these new demands and the new technologies with which they are associated. Major advances can be realized by applying selected industrial principles and practices to operational testing and the associated information gathering and evaluation process in the development of military systems. In addition, it is desirable to find new ways to integrate operational testing into the overall system development process to provide as much information as possible as soon as possible on operational effectiveness and suitability so that improvements to the system and decisions about continuing system development or passing to full-rate production can be made in a timely manner.

In view of the above, the DSB Task Force review should be comprehensive, including facilities, processes, policies, contractor testing, government development testing, joint test and evaluation, and operational test and evaluation, both before and after full production and in the continuing evolution of force capability. Further, the Task Force should consider the special problems associated with Test and Evaluation of the "Systems of Systems" which are comprising increasingly critical parts of our military capability. From the information gathered the Task Force should, first, identify and quantify the current and future needs of the Department's T&E capabilities and resources and, second, should recommend specific and quantified changes to those capabilities and resources.

In structuring this Task Force, it is recommended that the DSB bring to bear individuals experienced in T&E, knowledgeable of the weapons system development process as it is evolving, and individuals familiar with the Congressional initiatives which have formed much of the T&E structure over the past years.

This study should provide an interim report to the sponsors by November 1998 and complete its work by April 1999.

The Under Secretary of Defense (Acquisition and Technology) and the Director, Operational Test and Evaluation will co-sponsor this Task Force. Mr. David Heebner will serve as Chairman of the Task Force. Mr. Bill Meyer from the office of the Director, Test Systems Engineering and Evaluation, USD(A&T), and Dr. Dave Sparrow from the office of the Director, Operational Test and Evaluation will serve as co-Executive Secretaries. CDR David Norris, USN, will be the Defense Science Board Secretariat Representative.

The Task Force will operate in accordance with the provisions of P.L. 92-463, the "Federal Advisory Committee Act," and DoD Directive 5105.4, the "DoD Federal Advisory Committee Management Program." It is not anticipated that this Task Force will need to go into any "particular matters" within the meaning of Section 208 of Title 18, U.S. Code, nor will it cause any member to be placed in the position of acting as a procurement official.

J. S. Gansler

ANNEX B: TASK FORCE MEMBERSHIP

CHAIRMAN

Mr. David R. Heebner

MEMBERS

Mr. Charles E. Adolph
Mr. Thomas P. Christie
Mr. Robert E. Everett
Mr. Donald N. Fredericksen
Dr. William G. Howard, Jr.
The Honorable John E. Krings
Mr. Frank Marchilena
Mr. Ken Morrelly
GEN Glenn K. Otis, USA (Ret)
Maj Gen. Cecil W. Powell, USAF (Ret)
MG Richard W. Tragemann, USA (Ret)
RADM Jack Zerr, USN (Ret)

EXECUTIVE SECRETARIES

Dr. David A. Sparrow
Mr. Bill Meyer

ANNEX C: MAJOR RANGE & TEST FACILITY BASE (MRTFB) OPERATIONS FY99

ALL INSTALLATIONS
SOURCE: JUNE 99 MRTFB
($000)

MRTFB	INSTITUTIONAL*	FUNDING USER**	TOTAL
Aberdeen Test Center (ATC), Aberdeen Proving Ground, MD	29,356	70,680	100,036
Dugway Proving Ground (DPG), UT	9,983	22,450	32,433
High Energy Laser Systems Test Facility (HELSTF), NM	14,442	286	14,728
U.S. Army Kwajalein Atoll/Kwajalein Missile Range (KMR)	53,153	70,821	123,974
White Sands Missile Range (WSMR), NM including EPG at Ft Huachuca, AZ	57,143	151,461	208,604
Yuma Proving Ground (YPG), AZ including Tropic and Arctic test center	19,022	58,538	77,560
Sub Total	**183,099**	**374,236**	**557,335**
Atlantic Fleet Weapons Training Facility (AFWTF), Roosevelt Roads, PR	20,533	3,891	24,424
Atlantic Undersea Test and Evaluation Center (AUTEC), Andros Islands, BA	46,134	16,453	62,587
Naval Air Warfare Center-Aircraft Division (NAWC-AD), Patuxent River, MD	71,074	115,790	186,864
Naval Air Warfare Center- Weapons Division (NAWC-WD) Pt Mugu & China Lake	119,931	109,964	229,895
Sub Total	**257,672**	**246,098**	**503,770**
30TH Space Wing, Vandenberg AFB, CA	59,446	63,218	122,664
45TH Space Wing, Patrick AFB, FL	137,048	168,605	305,653
46TH Test Group at Holloman AFB, NM	18,717	34,234	52,951
Arnold Engineering Development Center (AEDC), Arnold AFS, TN	99,053	114,030	213,083
Air Armament Center (AAC), Eglin AFB, FL	61,357	211,456	272,813
Air Force Flight Test Center (AFFTC), Edwards AFB, CA	104,745	232,430	337,175
Air Force Air Warfare Center (AWC) at Nellis Range Complex, NV	37,800	15,200	53,000
Utah Test and Training Range (UTTR), Hill AFB, UT	17,584	8,475	26,059
Sub Total	**535,750**	**847,648**	**1,383,398**
Joint Interoperability Test Command (JITC), Defense Information Systems Agency Activity	7,549	72,110	79,659
GRAND TOTAL	**984,070**	**1,540,092**	**2,524,162**

* Institutional funds to cover indirect cost of Test & Evaluation support.
** User funds charged to the customers for direct cost

ANNEX D: GLOSSARY

ACAT	Acquisition Category
ACETEF	Air Combat Environment Test and Evaluation Facility
ACOM	U.S. Atlantic Command
ACTD	Advanced Concept Technology Demonstration
AEDC	Arnold Engineering and Development Center
BRAWLER	Air Combat Simulation (not an acronym)
CAF	Combined Acquisition Force
CAIV	Cost as An Independent Variable
CFD	Computational Fluid Dynamics
CINC	Commander in-Chief
CMM	Capability Maturity Model
CMMS	Conceptual Model of Mission Space
COEA	Cost and Operational Effectiveness Analysis
CONOPS	Concept of Operations
COTS	Commercial Off-The-Shelf
DARPA	Defense Advanced Research Projects Agency
DDR&E	Director, Defense Research & Engineering
DMS	Digital Modeling and Simulation
DMSO	Defense Modeling and Simulation Organization
DoD	Department of Defense
DOE	Department of Energy
DOT&E	Director, Operational Test and Evaluation
DSB	Defense Science Board
DT	Developmental Test
DT&E	Developmental Test & Evaluation
EMD	Engineering and Manufacturing Development
ESAMS	Enhanced Surface-to-Air Missile Simulation
FFRDC	Federally Funded Research and Development Center
FTTC	Flight Test Technical Committee
HLA	High Level Architecture

HWIL	Hardware-in-the-Loop
ICT	Integrated Concept Team
IDA	Institute for Defense Analysis
IOT&E	Initial Operational Test & Evaluation
IPT	Integrated Product Team
ITF	Integration Task Force
JADS	Joint Advanced Distributed Simulation
JASA	Joint Accreditation Support Activity
JCS	Joint Chiefs of Staff
JMASS	Joint Modeling and Simulation System
JT&E	Joint Test & Evaluation
JTIC	Joint Interoperability Test Command
LCOM	Logistics Composite Model
LFT&E	Live Fire Test & Evaluation
LRIP	Low Rate Initial Production
M&S	Modeling & Simulation
MICOM	U.S. Army Missile Command
MNS	Mission Needs Statement
MSRR	Modeling and Simulation Resource Repository
NMD	National Missile Defense
ORD	Operational Requirements Document
OSD	Office of the Secretary of Defense
OT	Operational Test
OT&E	Operational Test & Evaluation
PMO	Program Management Office
QDR	Quadrennial Defense Review
RAM	Reliability, Availability, and Maintainability
RCS	Radar Cross Section
RFP	Request for Proposal
RFSS	Radio Frequency Simulation System
SUPRESSOR	An air, ground, naval and space combat simulation (not and acronym)

SAB	Scientific Advisory Board
SBIRS	Space-Based Infra-Red Sensor
SISO	Simulation Interoperability Standards Organization
SPO	Sponsored Projects Office
SQuASH	Stochastic Quantitative Analysis of System Hierarchies
STOW	Synthetic Theater of War
SURVIAC	Survivability/Vulnerability Information Analysis Center
T&E	Test & Evaluation
TACWAR	Tactical Warfare Model
TEMP	Test and Evaluation Master Plan
THAAD	Theater High-Altitude Area Defense
TRADOC	U.S. Army Training and Doctrine Command
TRANSIMS	Transportation Analysis Simulation System
TRAP	Trajectory Analysis Program
UAV	Unmanned Aerial Vehicle
USACOM	U.S. Atlantic Command
USD(A&T)	Under Secretary of Defense (Acquisition & Technology)
VLSI	Very Large Scale Integration
VV&A	Verification, Validation and Accreditation

B

Report of the Defense Science Board Task Force
Test and Evaluation Capabilities

The Defense Science Board Task Force conducted a follow-on study of test and evaluation during the past year. The task force was primarily a subset of the previous task force. Their report is not yet published, but the draft was distributed for comment in early December. The recommendations tracked fairly closely with the previous report; however, there were some differences that caused the present Director some concerns, concerns shared by the Services. The issues raised by the present Director fell into three areas: important observations of the Test and Evaluation Task Force, areas that needed greater emphasis, and his concerns.

The four most important observations in the report were as follows:

1. "A consistent theme the Task Force encountered in talking to those who are in the program management side of this endeavor, is that testing is just another hurdle to be overcome in driving their program past its next milestone during their tenure."
2. "During the course of this study, the Task Force learned that the issue of human resources *- how to attract and retain personnel with the motivation and skills to serve and lead in civilian and military capacities –* is one of the most significant concerns of the test and evaluation community."
3. "The fundamental concern of test and evaluation facility managers is how do they get enough money and manpower to continue their operations."
4. "Next to personnel problems, the most common concern found within the test community during our Task Force data gathering was the negative impact of a shift from institutional to programmatic funding for test resources and facilities."

The requirement for new investment in test and evaluation capabilities needed greater emphasis in the findings and recommendations. The report did mention the need for new investment for interoperability testing, for more efficient frequency utilization, for new targets, and for embedded instrumentation. However, the report had no major findings nor recommendations that speak to the need for new investment for the testing of new and advanced technologies in the acquisition systems undergoing test, for modernization of aging instrumentation, for modeling and simulation, or for new investment to reduce operating costs at the Service test ranges. Further, although the report recognized the value of early involvement by the Service Operational Test Agencies, the report made no findings or recommendations about the fact that the Service Operational Test Agencies will not be able to provide early support to acquisition programs without new resources for that purpose.

Finally, the concerns expressed by the present Director were about three areas covered by recommendations. The first concern was about the recommendation regarding the need to determine "the value of testing." For example, the report said, "The Task Force found the most significant capability missing in the test and evaluation community is the ability to measure the 'value of testing.'" The Director did not agree that that was the most significant shortfall. The greatest shortfall is the need for new investment in test and evaluation, about which the report is too silent. Howeve , the value of testing could be be ter articulated to and by the acquisition community. Trying to measure the value of testing i like trying to measure the value of management.

The second concern was about th recommen lations that suggest consolidation of testing in certain geographi areas. Th e report a serted t hat here was unnecessary excess capacity throughout the Dep rtment of Defense te st and evalu ation community at the Service test ranges, but presented no ev dence to su pport this

The final ma jor concern was abou t the recom nendations concerning organizational alternatives. The re port recom nended th e creatio n o "a Department of Defense Test and Evaluation Resourc Enterprise within th e Office of the Director of Operational Test and Evaluation." The T ask Force based this inding c n a study, funded by the Office of the Director of Test, Systems En gineering a nd Evalua ion. Ap par ently the Task Force misunderstood this study. The study di l not devel op "a mod el for optim zing common functional test facilities and potentially assessing the impac of unnec essary te st c pability duplication," as claimed by the Task Force report. The study also did no identify un necessary excess capacity at the test ranges as might be inferred from the Task Force report.

C

OFFICE OF THE DIRECTOR, OPERATIONAL TEST AND EVALUATION STAFFING STUDY

FISCAL YEAR 1998

By the Deputy Director for Resources and Ranges
October 1999

Executive Summary

This report responds to a recommendation derived from Finding D (Test Status Reporting) in the "Audit Report of the DoD Inspector General—Operational Testing Performed on Weapon Systems," Report No. 96-107, May 1996. The essence of the recommendation is:

> *The Director, Operational Test and Evaluation (DOT&E) lacked adequate resources to monitor, review, and report all DoD operational testing; and also lacked internal guidance and training for its action officers. As a result, the Secretary of Defense and the Under Secretary of Defense (Acquisition and Technology), and Congress did not get complete and consistent operational test information for decisionmaking. The DoD-IG recommended that the Director for Operational Test and Evaluation conduct a staffing study to determine the appropriate mix of in-house DoD staffing and contractor support requirements to perform the DOT&E mission.*

This study reviewed the mission of the Director, Operational Test and Evaluation (DOT&E), and the functions, tasks, and initiatives to fulfill the mission. Government in-house civilian and military and contractor support professionals performed the primary mission of the Director, Operational Test and Evaluation during Fiscal Year 1998 (FY98). The results of our analysis confirm the Department of Defense (DoD) Inspector General (DoD-IG) contention that the DOT&E lacked adequate resources for the period FY98 to accomplish all responsibilities and functions required by law and the DoD directive governing the establishment of the office. U.S. Code Title 10, Section 139 (i) requires that the DOT&E "have sufficient professional staff of military and civilian personnel to carry out the duties and responsibilities of the Director prescribed by law." The DOT&E is not resourced to adequately provide operational assessments of all acquisition programs on the OSD T&E Oversight List, or to monitor all operational test and evaluation in the Department.

The methodology used for this study was based on a data call that was issued to all DOT&E action officers to estimate the amount of man-hours expended by them and their contract support for each acquisition program on the OSD T&E Oversight List. Also requested were their estimates of shortfalls in their time and contractor support that should have been expended. The Deputy Directors validated and adjusted the estimates as appropriate. Analysis was performed from these estimates to determine if staffing was adequate and how deficiencies could be accommodated. Additionally, the Deputy Directors provided their assessment of the ratio of each DOT&E task of how much should be performed by in-house government personnel (military and civilian) to contractor to retain a "smart buyer" capability for the DoD.

It is noted that since the DoD-IG audit, the DOT&E mission was increased to include the live-fire test and evaluation program, and the DOT&E incurred manpower losses due to OSD downsizing. The study suggests that while contractors supplement many functions or tasks being worked by the in-house action officers, many of these functions or tasks should be considered inherently governmental tasks and so much dependence on contractors may be inappropriate. The study determines that the Secretary of Defense's integrated test and evaluation initiatives and the actions being required by the DOT&E in FY99 will further exacerbate the workload. The study suggests that in-house personnel should be focused on those tasks that are inherently governmental and try to live within the staffing constraints of DoD to include further the loss of two Action Officer billets during FY99. Other actions by the DOT&E are suggested that could two Action Officer billets during FY99. Other actions by the DOT&E are suggested that could offload workload from the DOT&E action officers, but these would have only marginal benefit – the DOT&E already has prioritized the attention provided to specific programs. Some difference or shortfall in performing all tasks could be made up by increasing the reliance on the Operational Test Agencies (OTAs) in the Services; however, indications are that they, too, are understaffed for their increasing workload. Increasing reliance on contractor support to perform or supplement tasks and functions is a viable alternative, but not desirable. Ideally, the ratio of in-house (government) action officers to contractor personnel should be increased to 0.9 vice the 0.4 of FY 1998.

The study concluded that DOT&E was unable to perform its responsibilities for all of the acquisition programs on the OSD T&E Oversight List; however, prioritization of effort was applied to ensure appropriate attention was provided to those programs most critical within the resources available. Furthermore, with the addition of the SecDef initiatives and the implementation charge by Director, Operational Test and Evaluation to his action officers and contractor support personnel, this shortfall will be exacerbated in coming years. The Director, Operational Test and Evaluation should apply for additional billets and contract support man-years. Unless additional manpower billets and/or contract man-years are provided, this shortfall will continue, and the Department will not have complied with U.S. Code Title 10, Section 139 (i).

CONTENTS

SECTION A
Introduction

1. IG Study Requirement

The purpose of this report is to respond to a recommendation derived from Finding D (Test Status Reporting) in the "Audit Report of the DoD Inspector General—Operational Testing Performed on Weapon Systems," Report No. 96-107, May 1996. This finding and the associated recommendations are found in their entirety in Appendix A, but the information pertinent to this report are summarized as follows:

> *Based on review of the FY94 Annual Report of the Director for Operational Test and Evaluation, the DOT&E lacked adequate resources to monitor, review, and report all DoD operational testing; and also lacked internal guidance and training for its action officers. As a result, the Secretary of Defense and the Under Secretary of Defense (Acquisition and Technology), and Congress did not get complete and consistent operational test information for decisionmaking. The DoD-IG recommended that the Director for Operational Test and Evaluation conduct a staffing study to determine the appropriate mix of in-house DoD staffing and contractor support requirements to perform the Director, Operational Test and Evaluation mission.*

2. Purpose

This report identifies: (1) current and required DOT&E in-house staffing and functions, and (2) the contractor support mix. It recommends changes as needed and suggests further actions.

3. Scope

The scope of this report focuses on the professional staff of DOT&E and the professional contractor support used to accomplish the mission of reporting to Congress on the progress of DoD weapon system acquisition programs. From analysis of these functions, recommendations on the appropriate in-house staffing and level of contractor support are made. The study did not address professional staff personnel that support the Office of the Director, Operational Test and Evaluation in functions such as supervision, resources, administration, personnel actions, training, and legislative reporting.

4. Methodology

A data call was issued to all DOT&E action officers to estimate the amount of man-hours expended by them and their contract support for each acquisition program on the OSD T&E Oversight List. Also requested were their estimates of shortfalls in their time and contractor support that should have been expended. Analysis was performed from these estimates to determine if staffing was adequate and how deficiencies could be accommodated.

SECTION B
DOT&E Mission and Functions

1. Statutory Requirements

The DOT&E was established by an act of Congress in 1983. It grew out of an initiative by Congress to influence the DoD acquisition process in addressing a fundamental concern that weapons were not being tested thoroughly or realistically, and on the premise that complete and accurate information was not being disseminated. The congressional objectives were for the DOT&E to provide independent oversight, coordinate the military Services' planning and execution of operational testing, provide an independent evaluation of the results of operational testing, and provide objective reporting of these results to decisionmakers in Congress and DoD. In 1994, Congress also directed that the live-fire test and evaluation mission be moved under the DOT&E, which was implemented in 1995. The legislative requirements are found in the following:

- U.S. Code Title 10, Section 139—role and responsibilities of DOT&E.
- U.S. Code Title 10, Section 2399—operational test and evaluation.
- U.S. Code Title 10, Section 2400—low-rate initial production (LRIP).
- Federal Acquisition Streamlining Act of 1994—assigns live-fire test and evaluation to DOT&E, and amends Sections 139 and 2366.
- U.S. Code Title 10, Section 2366—live-fire test and evaluation.

Key provisions (relevant to this study) from U.S. Code Title 10, Section 139, are as follows:

> The Director shall—
> (1) prescribe, by authority of the Secretary of Defense, policies and procedures for the conduct of operational test and evaluation in the Department of Defense;
> (2) provide guidance to and consult with the Secretary of Defense and the Under Secretary of Defense for Acquisition and Technology and the Secretaries of the military departments in general and with respect to specific operational test and evaluation to be conducted in connection with a major defense acquisition program;
> (3) monitor and review all operational test and evaluation in the Department of Defense;
> (4) coordinate operational testing conducted jointly by more that one military department or defense agency;
> (5) review and make recommendations to the Secretary of Defense on all budgetary and financial matters...;
> (6) monitor and review the live fire testing activities of the Department of Defense provided for under section 2366 of this title.
>
> There is a Director of Operational Test and Evaluation in the Department of Defense, appointed from civilian life by the President, by and with the advice and consent of the Senate.

The term "operational test and evaluation" means—
(1) the field test, under realistic combat conditions, of any item of (or key component of) weapons, equipment, or munitions for use in combat by typical military users; and
(2) the evaluation of the results of such test.

Title 10 U.S. Code Title 10, Section 2399 (as relevant to this study) states:

> (1) Operational test and evaluation of a major defense acquisition system may not be conducted until the Director of Operational Test and Evaluation approves (in writing) the adequacy of the plans (including the projected level of funding) for operational test and evaluation to be conducted in connection with that program.
> (2) The Director shall analyze the results of the operational test and evaluation conducted for each major defense acquisition program. At the conclusion of such testing, the Director shall prepare a report stating the opinion of the Director as to—
>
> - whether the test and evaluation performed were adequate; and
> - whether the results of such test and evaluation confirm that the item or components actually tested are effective and suitable for combat?
>
> (3) The Director shall submit each report under paragraph (2) to the Secretary of Defense, the Under Secretary of Defense for Acquisition and Technology, and the congressional defense committees. Each such report shall be submitted to those committees in precisely the same form and with precisely the same content as the report originally was submitted to the Secretary and Under Secretary and shall be accompanied by such comments as the Secretary may wish to make on the report.
> (4) A final decision within the Department of Defense to proceed with a major defense acquisition program beyond low-rate production may not be made until the Director has submitted to the Secretary of Defense the report with respect to that program under Paragraph 2 and the congressional defense committees have received that report.

The DOT&E has a role in the Low Rate Initial Production determination per U.S. Code Title 10, Section 2400 (as relevant to this study) to advise on "low-rate initial production with respect to a new system is production of the system in the minimum quantity necessary to provide production-configured or representative articles for operational tests pursuant to section 2399 of this title."

According to the Federal Acquisition Streamlining Act of 1994 Conference Report:

> The House recedes with an amendment that would make clear that the Director would be responsible for monitoring and reviewing the live fire testing activities of the Department, including the Department's responsibilities under 10 U.S.C. 2366. The conferees intend that the Director prepare the report required by 10 U.S.C. 2366(d). The conferees note that the responsibility of the Director to

include live fire testing activities in the annual report does not replace other statutory reporting requirements concerning live fire testing. The conferees direct the Secretary of Defense to review all applicable reporting requirements, and to advise the congressional defense committees, not later than March 1995, as to whether any statutory reporting requirements should be consolidated.

In 1995, the DOT&E assumed the mission for live fire test and evaluation for the SecDef in accordance with U.S.C Title 10, Section 2366, which requires:

(a) Requirements. - (1) The Secretary of Defense shall provide that -

(A) a covered system may not proceed beyond low-rate initial production until realistic survivability testing of the system is completed in accordance with this section and the report required by subsection (d) with respect to that testing is submitted in accordance with that subsection; and

(B) a major munition program or a missile program may not proceed beyond low-rate initial production until realistic lethality testing of the program is completed in accordance with this section and the report required by subsection (d) with respect to that testing is submitted in accordance with that subsection.

(2) The Secretary of Defense shall provide that a covered product improvement program may not proceed beyond low-rate initial production until -

(A) in the case of a product improvement to a covered system, realistic survivability testing is completed in accordance with this section; and

(B) in the case of a product improvement to a major munitions program or a missile program, realistic lethality testing is completed in accordance with this section.

(b) Test Guidelines. - (1) Survivability and lethality tests required under subsection (a) shall be carried out sufficiently early in the development phase of the system or program (including a covered product improvement program) to allow any design deficiency demonstrated by the testing to be corrected in the design of the system, munition, or missile (or in the product modification or upgrade to the system, munition, or missile) before proceeding beyond low-rate initial production.

(2) The costs of all tests required under that subsection shall be paid from funds available for the system being tested.

(c) Waiver Authority. - (1) The Secretary of Defense may waive the application of the survivability and lethality tests of this section to a covered system, munitions program, missile program, or covered product improvement program if the Secretary, before the system or program enters engineering and manufacturing development, certifies to Congress that live-fire testing of such system or program would be unreasonably expensive and impractical.

(2) In the case of a covered system (or covered product improvement program for a covered system), the Secretary may waive the application of the survivability and lethality tests of this section to such system or program and instead allow testing of the system or program in combat by firing munitions likely to be encountered in combat at components, subsystems, and subassemblies, together with performing design analyses, modeling and simulation, and analysis of combat data. Such alternative testing may not be carried out in the case of any covered system (or covered product improvement

program for a covered system) unless the Secretary certifies to Congress, before the system or program enters engineering and manufacturing development, that the survivability and lethality testing of such system or program otherwise required by this section would be unreasonably expensive and impracticable.

(3) The Secretary shall include with any certification under paragraph (1) or (2) a report explaining how the Secretary plans to evaluate the survivability or the lethality of the system or program and assessing possible alternatives to realistic survivability testing of the system or program.

(4) In time of war or mobilization, the President may suspend the operation of any provision of this section.

(d) Reporting to Congress. - At the conclusion of survivability or lethality testing under subsection (a), the Secretary of Defense shall submit a report on the testing to the congressional defense committees. Each such report shall describe the results of the survivability or lethality testing and shall give the Secretary's overall assessment of the testing.

2. DOT&E Responsibilities

The responsibilities of the Director for Operational Test and Evaluation are as follows:

- Member of DAB & MAISRC
- Report annually to Congress on Operational Test and Evaluation.
- Operational Test and Evaluation (OT&E) and Live Fire Test and Evaluation (LFT&E).
- Prescribe OT&E and LFT&E policy.
- Provide guidance on all OT&E and LFT&E matters.
- Monitor and review all OT&E and LFT&E in DoD.
- Approve test plans for operational test and live-fire oversight programs.
- Report on programs, before proceeding beyond LRIP:
  - Adequacy of OT&E & LFT&E.
  - Operational effectiveness, suitability, survivability, and lethality.
  - By statute, to Congress and the Secretary of Defense.

Table 1 lists the detailed responsibilities of the Director for Operational Test and Evaluation identified in DoDD 5141.2. Responsibilities for live fire test and evaluation were added in 1995. Table 2 lists the associated functions of the Director for Operational Test and Evaluation to perform his responsibilities, also as identified in DoDD 5141.2.

TABLE 1

Responsibilities of Director for Operational Test and Evaluation

(DoDD 5141.2)

1. Prescribe policies and procedures for the conduct of OT&E within the Department of Defense.
2. Provide advice and make recommendations to the Secretary of Defense, and issue guidance to and consult with the heads of the DoD Components with respect to OT&E in the Department of Defense in general, and with respect to specific OT&E to be conducted in connection with a major defense acquisition program.
3. Designate selected special interest weapons, equipment, or munitions as major defense acquisition programs, as the Director, OT&E considers appropriate to carry out reference (a) and the responsibilities, functions, and authorities assigned to the Director, OT&E under this Directive. Such a designation applies exclusively to the implementation of reference (a) and this Directive, and does not extend to other purposes for which the term may be used outside of this context.
4. Develop systems and standards for the administration and management of approved OT&E plans for major defense acquisition programs.
5. Monitor and review all OT&E in the Department of Defense to ensure adherence to approved policies and standards.
6. Coordinate operational testing conducted jointly by more than one DoD Component.
7. Coordinate Joint Operational Test and Evaluation (JOT&E) programs to obtain information pertinent to operational doctrine, tactics, and procedures.
8. Initiate plans, programs, actions, and taskings to ensure that OT&E for major defense acquisition programs is designed to evaluate the operational effectiveness and suitability of U.S. military weapon systems.
9. Review and make recommendations to the Secretary of Defense on all budgetary and financial matters relating to OT&E, including operational test facilities and equipment.
10. Review and report to the Secretary of Defense on the adequacy of operational test planning, priorities, support resources, execution, evaluation, and reporting for major defense acquisition programs while avoiding unnecessary duplication.
11. Promote coordination, cooperation, and mutual understanding within the Department of Defense and between the Department of Defense and other federal agencies, state, local, and foreign governments, and the civilian community with regard to OT&E matters.
12. Serve on boards, committees, and other groups pertaining to assigned OT&E, and represent the Secretary of Defense on OT&E matters outside the Department of Defense.
13. Execute such other related responsibilities as the Secretary of Defense may prescribe.

TABLE [illegible]

Functions of the Director for Operational Test and Evaluation

(DoDD 5141.2)

The Director, OT&E, shall carry out the responsibilities described above, for all aspects of OT&E, to include the following functions:
1. OT&E programs of the DoD Components, to include their operational test facilities and resources and the coordination of Military Service OT&E activities.
2. JOT&E programs and Joint Military Service operational testing.
3. Analysis of OT&E results on all major defense acquisition programs.
4. Review of budget submissions to determine the adequacy of OT&E funding.
5. Approval of OT&E sections of the DoD Test and Evaluation Master Plan (TEMP) for major defense acquisition programs.
6. Review of new major system requirements documents, system concept papers, decision coordinating papers and if appropriate, integrated program summaries for OT&E implications.
7. Enhancement of operational test realism.
8. Development and administration of an OT&E data base.

3. <u>DoD OT&E Policy</u>

DoDD 5000.1 established the following DoD policy:

> Test and evaluation programs shall be structured to provide essential information to decision-makers, assess attainment of technical performance parameters, and determine whether systems are operationally effective, suitable, and survivable for intended use. Each Military Department shall establish an independent operational test and evaluation activity, reporting directly to the Service Chief, to plan and conduct operational tests, report results, and provide evaluations of effectiveness and suitability.

4. DoD OT&E Mandatory Procedures

The DoD has established mandatory procedures for all DoD components in DoD 5000.2-R. The DOT&E monitors and ensures compliance with these procedures and performs actions as required for MDAPs and MAIS acquisition programs. The following excerpts from DoD 5000.2-R indicate the scope of effort that must be performed by his office:

3.4.5 -- Operational Test and Evaluation

Operational test and evaluation (OT&E) programs shall be structured to determine the operational effectiveness and suitability of a system under realistic conditions (e.g., combat) and to determine if the minimum acceptable operational performance requirements as specified in the ORD have been satisfied. The following procedures are mandatory:

1. Threat or threat representative forces, targets, and threat countermeasures, validated in coordination with DIA, shall be used.
2. Typical users shall operate and maintain the system or item under conditions simulating combat stress and peacetime conditions.
3. The independent operational test activities shall use production or production representative articles for the dedicated phase of OT&E that supports the full-rate production decision, or for ACAT IA or other acquisition programs, the deployment decision. The use of modeling and simulation shall be considered during test planning. Whenever possible, an operational assessment shall draw upon test results with the actual system, or subsystem, or key components thereof, or with operationally meaningful surrogates. When actual testing is not possible to support an operational assessment, such assessments may rely upon computer modeling, simulations (preferably with real operators in the loop), or an analysis of information contained in key program documents. However, as a condition for proceeding beyond LRIP, initial operational test and evaluation shall not comprise an operational assessment based exclusively on computer modeling; simulation; or, an analysis of system requirements, engineering proposals, design specifications, or any other information contained in program documents (10 USC2399). The extent of modeling and simulation usage in conjunction with operational and test evaluation shall be explained in the Test and Evaluation Master Plan.
4. All hardware and software alterations that materially change system performance (operational effectiveness and suitability) shall be adequately tested and evaluated. This includes system upgrades as well as changes made to correct deficiencies identified during test and evaluation.
5. Naval vessels, the major systems integral to ship construction, and military satellite programs typically have development and construction phases that extend over long periods of time and involve small procurement quantities. To facilitate evaluations and assessments of system performance (operational effectiveness and suitability), the independent operational test activity shall monitor or participate in all relevant testing and use these results to make operational assessments.
6. Conduct an OT&E before full-rate production to evaluate operational effectiveness and suitability as required by 10 USC2399 for ACAT I and II programs.
8. Operational Test Agencies shall participate early in program development to provide operational insights to the program office and to acquisition decisionmakers.

9. Operational testing and evaluation shall be structured to take maximum advantage of training and exercise activities to increase the realism and scope of operational testing and to reduce testing costs.

The Director Operational Test and Evaluation shall:

(1) assess the adequacy of OT&E and LFT&E conducted in support of acquisition program decisions, and

(2) evaluate the operational effectiveness, operational suitability and survivability, as applicable, of systems under OT&E oversight.

-- Operational Test and Evaluation Plans

The DOT&E shall approve, in writing, the adequacy of the OT&E plans (including project funding) for all ACAT I and ACAT IAM programs and other designated programs prior to the initiation of operational testing. Plans for all operational assessments of programs on DOT&E's oversight list being conducted to support acquisition decisions such as LRIP or release of funds for long lead shall be approved by DOT&E prior to their execution.

DoD Components shall brief the DOT&E on the concepts for the test and evaluation or assessment 120 days prior to commencement and submit the test plan to the DOT&E 60 days prior to commencement. Any major revisions to the operational test shall be reported to the DOT&E. Testing shall not proceed in accordance with the major revision until approved by the DOT&E.

These test plans shall include test objectives, measures of effectiveness, planned operational scenarios, threat simulation, resources, test limitations, and methods of data gathering, reduction, and analysis. The planned test events shall be described in sufficient detail to permit an assessment of operational realism.

3.4.7 -- Use of System Contractors in Support of Operational Test and Evaluation

The use of system contractors in support of the OT&E conducted to support a decision to proceed beyond low-rate initial production is restricted by 10 USC2399. In ACAT I and II programs, contractors may participate only to the extent that is planned for them to be involved in the operation, maintenance, and other support of the system being tested when it is deployed in combat.

A contractor that has participated (or is participating) in the development, production, or testing of a system for a DoD Component (or for another contractor of the DoD) may not be involved in any way in the establishment of criteria for data collection, performance assessment, or evaluation activities for the operational test and evaluation. These limitations do not apply to a contractor that has participated in such development production or testing solely in testing for the federal government.

3.4.9. -- Live Fire Test and Evaluation*
*Not applicable to ACAT IA programs.

Live Fire Test and Evaluation (LFT&E), as that term is defined in 10 USC2366 must be conducted on a covered system, major munition program, missile program, or product improvement to a covered system, major munition program, or missile program before it can proceed beyond low-rate initial production. A covered system is any vehicle, weapon platform, or conventional weapon system that includes features designed to provide some degree of protection to users in combat and that is an ACAT I or II program. Depending upon its intended use, a commercial or non-developmental item may be a covered system, or a part of a covered system.

Survivability testing shall begin at the component, subsystem, and subassembly level, culminating with tests of the complete covered system or program, or covered product improvement, configured for combat. A covered system, major munitions, a missile program, or a product improvement to a covered system, major munitions, or missile program may not proceed beyond low-rate initial production until realistic survivability or lethality testing is completed and the report required by statute is submitted to the prescribed congressional committees (10 USC2366). Such testing shall be conducted sufficiently early in the development phase of the system or program (including a covered product improvement program) to allow any design deficiency demonstrated by the testing to be corrected in the design of the system, program, or product improvement before proceeding beyond low-rate initial production. For Commercial and Non-Developmental Items that are covered systems, the Under Secretary of Defense (Acquisition & Technology) shall identify equivalent events for the items that will allow the requirements of statute and this Regulation to be met.

As delegated by the Secretary of Defense, the USD(A&T), for ACAT ID programs, or the CAE, for less than ACAT ID programs, may waive the requirement for realistic survivability (i.e., full-up, system-level tests) and lethality tests if the USD(A&T) or the CAE, before the system or program enters engineering and manufacturing development, certifies to Congress that live fire testing of such system or program would be unreasonably expensive and impractical. Alternatively, in the case of a covered system (or covered product improvement program for a covered system), the USD(A&T) or the CAE may waive the application of the required survivability and lethality tests and instead allow testing of a system or program by firing munitions likely to be encountered in combat at components, subsystems, and subassemblies, together with performing design analyses, modeling and simulation, and analysis of combat data in lieu of testing the complete system configured for combat. The strategy for such alternative testing shall be included within the waiver request, jointly reviewed by DOT&E and DTSE&E, and approved by DOT&E. Such alternative testing may not be carried out unless the USD(A&T) or the CAE certifies to Congress, before the system or program enters engineering and manufacturing development, that the survivability and lethality testing of such system or program otherwise required would be unreasonably expensive and impracticable.

In either case, the USD(A&T) or the CAE shall include, with any such certification, the DOT&E-approved alternative strategy explaining how the USD(A&T) or the CAE plans to evaluate the survivability or lethality of the system or program and assessing possible alternatives to realistic survivability and lethality testing of the system or program. Waiver of the requirement for realistic survivability testing does not remove the requirement for survivability testing of components, subsystems, and subassemblies.

Waivers and the use of alternative survivability and lethality testing shall be addressed in the TEMP for the covered system, program, or covered product improvement program. CAE certifications and reports required under 10 USC2366(c) shall be submitted to Congress through the DOT&E and the USD(A&T).

3.4.11 -- Test and Evaluation Master Plan

The Test and Evaluation Master Plan (TEMP) shall focus on the overall structure, major elements, and objectives of the test and evaluation program that is consistent with the acquisition strategy. It shall include sufficient detail to ensure the timely availability of both existing and planned test resources required to support the test and evaluation program.

A TEMP shall:

1. be prepared for all ACAT I and ACAT IA programs and other acquisition programs designated for DOT&E or Office of the Secretary of Defense test and evaluation oversight (10 USC2399);
2. be approved by the DOT&E and the DTSE&E for all ACAT I and ACAT IAM programs and other designated programs; and,
3. provide a road map for integrated simulation, test, and evaluation plans, schedules, and resource requirements necessary to accomplish the test and evaluation program.

SECTION C
Staffing Analysis

1. DOT&E Staffing Survey

A survey distributed to all weapon system program action officers in the Office of the Director, Operational Test and Evaluation asked for all man-hours consumed in FY98 in support of the Test and Evaluation Oversight List of programs. We realized that emphasis on OT&E events can vary greatly for the various acquisition programs from year to year and that some programs may have no activity whatsoever for a given year. However, the activities and man-hours consumed for acquisition programs in FY98 should be representative when viewed in the aggregate. Likewise, personnel and acquisition program changes that occur throughout a given year will tend to average out.

The action officers were also asked to provide their assessment of how many additional man-hours per acquisition program should have been worked to perform the functions to their fullest if applicable. Shortfalls in both in-house and contractor support man-hours were noted among many of the action officers. The data inputs were then validated by the DOT&E Deputy Directors.

The data from the survey are summarized in Appendix B. Results and observations from this survey follow.

1. Thirty DOT&E individuals (action officers) reported to have expended time on acquisition programs and other DOT&E functions during FY1998. The number of man-years expended during this period by these action officers was 37.5 (where 1,760 hours equals 1 man-year -- 251 maximum number of federal work days minus an average of 31 unavailable work days per year for combined annual, sick, training, and administrative leave). Temporary personnel such as Rotational Training Assignment personnel (RTAs) are not counted as action officers nor in this expenditure. During FY 1998, 29 billets in DOT&E (GM 15s, O-6s, and O-5s) were authorized as dedicated action officers, and a personnel reassignment among the military during this period accounted for the 30 action officers reporting.
2. An action officer commented that assignment to several acquisition programs, especially if they are diverse in operational requirements or technical content, can dilute one's attention to some of the details needed to do an effective job in all. (It is noted that contractor support can alert the DOT&E action officers to any details required for any of his tasks over a wide variety of programs.)
3. Contractor effort expended during FY98 supporting specific programs on the OSD T&E Oversight List was 75.9 man-years (where 1,810 hours equal one IDA man-year). Contractor supervisory and efforts supporting special studies that cut across several programs on the OSD T&E Oversight List were not reported.
4. Many of the action officers felt there was a shortfall in government or contractor man-hours for fulfilling their responsibilities for each of their assigned acquisition programs. These action officers identified a combined shortfall of 33.1 man-years for government in-house and contractor personnel.

2. DOT&E Staffing Trends

Overall, manning of DOT&E has been declining since 1990, as seen in Figure 1. Three more billets are scheduled to be lost in FY99, two of which are action officers. Many of these billets are not direct action officer personnel for working acquisition programs, but perform overhead functions, supervision, resources and administration support.

Authorized Billets	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
EX Level IV	1	1	1	1	1	1	1	1	1	1	1
Senior Executive Service: SES	4	4	3	3	3	3	4	4	4	4	4
Scientific Advisor: ST-1303	1	1	1	1	1	1	1	1	1	1	1
Military: Rank 06	**10**	**10**	**11**	**12**	**12**	**13**	**11**	**12**	**12**	**12**	**12**
Military: Rank 05	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**2**	**2**
GM-15	**16**	**15**	**14**	**14**	**15**	**14**	**18**	**15**	**15**	**15**	**12**
GM-14								**1**	**1**		**1**
Administrative and Support (GS Civ.)	14	14	15	12	11	10	10	10	9	9	8
Action Officers (bold): Sub-total	**28**	**28**	**26**	**27**	**28**	**28**	**31**	**30**	**30**	**29**	**27**
TOTAL (all DOT&E)	48	48	46	44	44	43	47	46	45	44	41

NOTE: The Live-Fire Test and Evaluation (LFT&E) mission was transferred into DOT&E in 1995 with a few billets.

FIGURE 1
DOT&E STAFFING OVER TIME

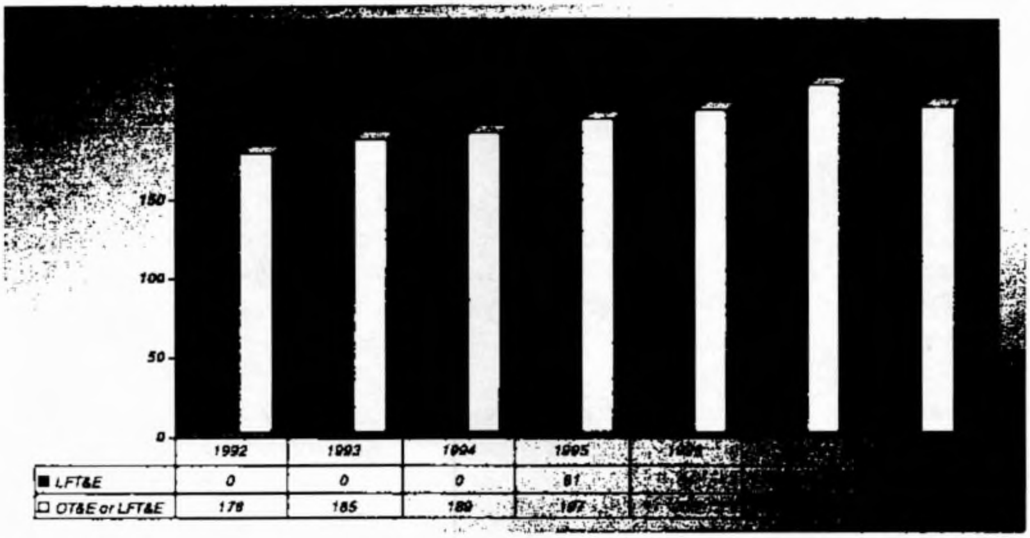
In-house DOT&E action officer staffing has been fairly constant (Figure 1), while the number of acquisition programs on the OSD T&E Oversight List has been slightly increasing over the same period of time. In 1995, the live fire test and evaluation mission was transferred into DOT&E bringing with it some LFT&E only programs to the OSD T&E Oversight List. This trend is depicted in Figure 2 as the number of acquisition programs on the OSD T&E Oversight List since 1986. There were 205 acquisition programs on the OSD T&E Oversight List in FY98, so the number of programs can be expected to be over 200 per year.

2. Contractor Staffing Trends

The number of man hours to be expended by the FFRDC contractor was regulated by a ceiling on the amount of funding provided within his contract(s). Providing more dollars into the contract tasks could have accommodated the contractor shortfalls identified in the DOT&E Action Officer survey.

FIGURE 2

Programs Requiring DOT&E Oversight



NOTE: LFT&E programs added in 1995.

Appendix C identifies the FY98 contract support tasks performed for the Office of the Director, Operational Test and Evaluation by the Institute for Defense Analyses (IDA), a Federally Funded Research and Development Center (FFRDC).

SECTION D
DOT&E Workload

While this study primarily illustrates workload issues using data on man-years expended, both quantity and quality are important issues. DOT&E is responsible for a large number of programs in an evaluative role which is seen as increasingly important for decisionmakers both inside and outside the DoD. This role is far beyond the "oversight" role of most OSD organizations. For DOT&E to play a key role in the OT&E process and the acquisition process, it is imperative that staffing issues be addressed.

1. Tasks Performed by DOT&E

For the primary responsibilities, functions, and roles required by DoD directives and mandatory procedures (Section B) the DOT&E action officers, supported by contractors, are required to perform the tasks in Table 3 as a minimum for each program listed on the OSD T&E Oversight List. These tasks are primarily in support of their over-arching function of performing *systems assessments* of weapon systems' effectiveness, suitability, vulnerability, and lethality. The metrics in Table 3 reflect the time and frequency for which these tasks are to be completed by the action officers and contractor support.

We did not assess the degree to which the metrics in Table 3 were achieved, nor how many of the tasks had to be accomplished during the period. The survey data showed, that out of 205 acquisition programs on the OSD T&E Oversight List, no action officer time was expended on only a few programs, and some of these because the time expended was included on a related sister program. No analysis was performed to determine the level of activity in these programs during this period; however, one has to assume that that some level of oversight should have been performed. But for numerous programs, there was a reported need for additional effort to be expended. And this further verifies that the DoD-IG's finding of inadequate staffing was also true for FY98 for the MDAP and other programs on the OSD T&E Oversight List. The DoD Inspector General went on to recommend that the DOT&E "monitor, review, and report all DoD operational testing." While monitoring all OT&E in the DoD by DOT&E is required by law, reporting (which implies assessing) all OT&E would extend the Director's responsibilities, and existing government and contractor staffing is clearly inadequate for this purpose.

TABLE 3

DOT&E Acquisition Program Tasks with Metrics

Task	Description	Metric
Analysis of Alternatives	Review for information, compare with COIs and mission	Within 1 week of receipt
Annual Report	Review Service reports, test data, conduct analysis, evaluate results, draft report input	Submitted to Congress NLT President's Budget
Audits: GAO and IG	Attend meetings, assemble and provide requested information, review draft and final reports, draft response	Within 30 days
B-LRIP Report	Assemble test data, conduct data analysis and evaluation, draft report, coordinate report through internal and external review, complete ant deliver report.	Submitted 135 days after completion of test
Congressional Data Sheets	Review for accuracy, provide comments to Services	Completed within 2 working days
Congressional Actions	Research the action, develop the response, coordinate response through internal and external review	Within 48 hours for inquiries, or per date specified for reports
Contract Award Reports	Advise on award of weapon system development or production contracts	Within 1 week of announcement in CBD
Central Test and Evaluation Investment Program (CTEIP)	Participate in CTEIP program proposal and execution reviews, advise	Per schedule
Crossbow	Participate in program reviews, advise	Per schedule
Data Automation Standardization	Execute program to develop data standards for archiving test data	Per program milestones
Database	Inputs to maintain	Within 7 days of event
Defense Acquisition Executive Summary	Review for comments, input OT&E assessments, brief Director for review meetings	Quarterly for some programs, annually for others
DOT&E Budget	Prepare, submit, and follow-up	Per PPBS schedule
Education/Training	Participate in DAWIA and DTEPI meetings, advise	Per schedule
Foreign Comparative Test Program	Review, assess, and advise	Within 2 weeks of availability of test data
Independent Test Concepts	Review mission, requirements, AOAs, threat and concept of operation documents, identify test issues and data requirements, outline required operations and events, draft concept document	Within 2 weeks of request
IPTs, TPWGs, Program Reviews	Identify potential discussion items, perform research, attend meeting, provide trip report, perform follow-up actions	Per schedule
Joint Live Fire	Manage and execute	Per schedule
JT&E	Evaluate candidate programs; review, assess, and advise on test plan; and review and assess report for approval	Annually
JT&E Test Plan Approval	Review, assess, and advise	Within 2 weeks of receipt
JT&E Report	Review, assess, and advise	Within 2 weeks of receipt
Live Fire Test Plan	Review and assess for approval	30 days prior to test initiation
Live Fire Test Report	Produce	Prior to MS III
Live Fire Test and Trials	Execute	Per schedule
LRIP Test Articles	Identify or verify number needed	Within POM lead-time
Mission Needs Statement (MNS)	Review for information	Within 1 week of receipt

Task	Description	Metric
Modeling and Simulation	Research to identify appropriate models, characterize model strengths and weaknesses, review VV&A adequacy, determine how models will be used, run models, review modeling results	Per schedule
MRTFB annual review	Attend, participate, and synthesize information for Annual Report; advise	Draft to be completed within 2 weeks of post-MRTFB back-wash with the Director
Office Automation Program	Prepare for approval by Director	Prepared annually within suspense window
Operational field assessments	Develop requirements and operational issues, identify exercise opportunities, perform simulation studies and exercise design, attend, analyze data, produce report	Completed within 6 months of formal request
Operational Requirements Document (ORD)	Review for completeness to support mission, prepare comments as needed, identify areas requiring testing	Completed within 1 week of receipt
OT&E Policy and Procedures	Identify policy voids or problems, draft new or revised policies, conduct internal and external coordination, promulgate through appropriate forums	As needed
Operational Test Plan	Review draft test plans, develop comments, negotiate plan revisions, coordinate internal plan approval	Completed for signature within 30 days
Operational Test Readiness Review	Participate and represent the Director	Per schedule of Program Manager
Operational Test Report (OTA generated)	Review for data analysis and evaluation methodology, identify areas to be incorporated into DOT&E assessments, initiate inquiries to resolve questions	Within 45 days of completion of test
Rapid Enhancement Project	Oversee program execution	Assets available when required
Selected Threat Assessment	Review to identify test scenario threats, contact threat agencies for questions/clarifications, arrange for threat agency personnel to review test scenarios and replication on site	Within five working days of receipt
Special Project	Monitor and assess (special security)	Within 45 days of completion of event
T&E Master Plan (TEMP)	Compare draft test structure to mission need, requirements, threats and independent test concept; identify weaknesses; and negotiate improvements as necessary; coordinate internal review and approval	Within 30 days of receipt
T&E Process Studies	Support study board members (e.g., DSB)	Per schedule
Test Scoring/Failure Review	Participate in review meetings, provide comments, identify situations for different scoring/failure assessment	Per schedule

2. Expanding DOT&E Workload

In the upcoming years, there will be further challenges to maintain the integrity of purpose of the DOT&E and to fulfill its obligations in an environment of streamlining and downsizing throughout the DoD. DOT&E is not able to adequately cover all of the programs on the OSD T&E Oversight List with existing staffing today. Moreover, DOT&E is to lose three billets during the OSD drawdown during FY99.

DOT&E is faced with an even greater challenge: how to implement the new initiatives imposed by the Secretary of Defense (SecDef). These initiatives will require additional and more intensive activities by DOT&E action officers and contractor personnel. According to "Secretary of Defense Report to Congress: Actions to Accelerate the Movement to the New Workforce Vision" dated April 1, 1998:

> Test and evaluation are essential to the development of high-performing weapon systems. I have outlined five themes to reform and improve the test and evaluation process and better support streamlined acquisition. These themes are:
>
> (1) Early tester involvement, especially the operational tester, in the development of a system to identify potential problems early so that they can be addressed as the system is being designed.
> (2) Combining development test (DT) and operational test (OT) activities to enable more efficient use of test resources.
> (3) Combining testing with training or field operations to reduce the cost of testing as well as improve its realism.
> (4) The use of modeling and simulation (M&S) to support resolution of test issues.
> (5) Greater participation in the ACTD process by test personnel and organizations to assist ACTD planning and evaluation and to support ACTD transitions to acquisition at advanced milestones.

To implement the SecDef's themes, the DOT&E, in December 1998, directed his action officers and contractor support personnel to do the following:

- Begin participation in acquisition programs well before Milestone III, preferably in Milestone 0.
- Encourage OTAs to get involved in programs no later than Milestone I, in addition to their increasing number of smaller programs.
- Initiate and participate in test planning meetings.
- Participate in all test events, including visiting factories in early stages of prototypes.
- Act as an "early warning system" for acquisition, users, and design decisions.
- Become involved in requirements and analyses of alternatives (AOAs).
- Determine causality as part of learning (implying greater test design, instrumentation, and analysis requirements during OT&E events).
- Identify opportunities for getting insights from activities other than test events, such as computer exercises, digitization exercises, and ground tests during developmental test and evaluation events.

- Improve Test and Evaluation Master Plans (TEMPs).
- Ensure TEMPs identify helpful tools for the OTAs to gain early involvement, including access to drawings for Early Operational Assessments.
- Start collecting suitability data earlier
- Work to improve developmental test and evaluation (advise).
- Reduce the amount of time it takes for analysis and reports.
- Work with system contractor and program managers to ensure they are aware of OT&E criteria.
- Implement and work to help Congress recognize the importance of the National Research Council's Recommendation 3.1 (Recommendation 3.1 reads as follows: "Congress and the Department of Defense should broaden the objective of operational testing to improve its contribution to the defense acquisition process. The primary mandate of the Director, Operational Test and Evaluation should be to integrate operational testing into the overall system development process to provide as much information as possible on operational effectiveness and suitability. In this way, improvements to the system and decisions about continuing system development or passing to full-rate production can be made in a timely and cost-efficient manner.")
- For OFAs, joint experiments, and joint T&E events, report what was successful as well as what was not; i.e., report *all* that was learned.
- Determine opportunities for early OT&E involvement to contribute to low-rate initial production (LRIP) decisions.
- Write input to the DOT&E's annual report to Congress for the Program Managers (vice Congress) as target audience. Raise the issues that the action officers have concern over.
- Include a frontispiece in each Beyond LRIP Report in which a reader can discern operational issues at a glance
- Get OT&E involvement in contractor conducted developmental test and evaluation.
- Identify needs and new ideas for more capabilities, replacements, improvements, and outright deficiencies in the test and evaluation infrastructure.
- Identify instances of sub-optimization as causes of resource deficiencies and test support delays.
- Identify problems with the decreasing military role in the conduct and management of T&E.
- Determine ways to match users' needs without burdening the user for commercial-off-the-shelf/non-developmental item (COTS/NDI) programs.

Acquisition reform initiatives within DoD are also driving higher levels of participation by DOT&E action officers to participate in Integrated Product Team (IPT) activities. Each acquisition program on the OSD T&E Oversight List (over 200) can be expected to form IPTs on which DOT&E will be expected to participate. This increasing proliferation of IPTs, combined with having to deal with the possibility of conflict of interest between impartiality of DOT&E and involvement in IPTs at all levels, can be expected to increase the burden on DOT&E personnel and contractor support. However, with the acquisition reform initiative of performance-based acquisitions (i.e., acquisitions based on operational requirements), the criticality of early OT&E involvement increases considerably.

In the Senate Appropriations Committee Report for FY99, "weapons system testing" is required to be added to the Government Performance and Results Act Performance Plan for FY00. The DOT&E is responsible for tracking all OT&E events under OSD oversight (not just those on the OSD T&E Oversight List) and to report the percentage of successful ones. The DOT&E action officers will not only be responsible for working to improve this percentage each year, additional workload will be required for each to identify all future OT&E events, to assess whether the events were "successful" when completed, and to input the this information into a database.

SECTION E
Options and Analysis

1. Options

Obviously, the workload of both the DOT&E action officers and their contractor support personnel will increase if DoD is to accomplish the initiatives described in Section D. The findings of the DoD IG still apply and will continue into the foreseeable future due to the scheduled decrease in DOT&E billets, and current shortfalls in available contractor man-years. Options that the DOT&E can consider are:

- **Increase the number of DOT&E in-house billets**. Given current acquisition workforce drawdown initiatives, this is an "uphill battle." DOT&E is scheduled to lose three billets (two action officers directly supporting programs on the OSD T&E Oversight List) in FY99.

- **Rescope and redefine the responsibilities of the Director, Operational Test and Evaluation.** Congress has defined the responsibilities of the office of the Director, Operational Test and Evaluation (and DoD directives have reiterated these responsibilities). Congressional action, at a minimum, would be required to reduce these responsibilities.

- **Prioritize and focus resources on highest priority acquisition programs**. Analysis of the survey data indicates that the DOT&E is already prioritizing attention of the DOT&E action officers on the most critical programs on the OSD T&E Oversight List. The OSD T&E Oversight List includes Major Defense Acquisition Programs (MDAPs), and other programs that are considered special interest. The DOT&E is currently required by law to assess and report on all MDAPs, and to monitor all OT&E in the DoD. The DoD-IG seeks to expand the reporting responsibility to all ACAT categories (includes those reported only by OTAs currently). The Performance Indicator in the Government Performance and Results Act Performance Plan for Fiscal Year 2000 requires tracking OT&E events for all programs on the OSD T&E Oversight List. These counter-prevailing forces limit the usefulness of this option.

- **Restrict activities of government in-house personnel only to those functions that are inherently governmental functions and increase dependence on contractor support personnel for the remaining functions**. Table 4 identifies FY98 tasks that were to be performed, and an assessment by DOT&E management of how much of each should have been performed by government action officers vice contractor support services (1.1 contractor support manyear per each government action officer manyear would have been preferred). Some of these tasks should only be performed by government action officer personnel (inherently governmental functions). Others can be supported by FFRDC contractors somewhat, but still must have government personnel involvement. Increased dependence on contractor personnel to perform these tasks is not desirable.

- **Establish arrangements and procedures that will increase support for and sharing of responsibilities among the OTAs.** The OTAs have all reported significant increases in workload over the next five years, and no additional manpower has been identified for them to accommodate it. Furthermore, no direct chain of command exists between the OTAs and DOT&E. Therefore, while some changes in reporting by the OTAs or more reliance on the OTA analysis might help improve the workload burden in DOT&E, it is unlikely to be significant enough to make much difference as long as the DoD directed responsibilities of the Director, Operational Test and Evaluation remain as written.

TABLE 4

DOT&E Tasks per Recommended Performers

Minimum percentage of DOT&E tasks that should be performed by government action officer personnel (GO) and percentages of those that can be performed by FFRDC contractors (CO).

Task	Description	GO	CO
Analysis of Alternatives	Review for information, compare with COIs and mission	20	80
Annual Report	Review Service reports, test data, conduct analysis, evaluate results, draft report input	30	70
Audits: GAO, IG	Attend meetings, assemble and provide requested information, review draft and final reports, draft response	60	40
B-LRIP Report	Assemble test data, conduct data analysis and evaluation, draft report, coordinate report through internal and external review, complete ant deliver report.	40	60
Congressional Data Sheets	Review for accuracy, provide comments to Services	50	50
Congressional actions	Research the action, develop the response, coordinate response through internal and external review	80	20
Contract Award Reports	Advise on award of weapon system development or production contracts	100	0
Central Test and Evaluation Investment Program (CTEIP)	Participate in CTEIP program proposal and execution reviews	25	75
Crossbow	Participate in program reviews	100	0
Data Automation Standardization	Execute program to develop data standards for archiving test data	10	90
Database	Inputs to maintain	100	0
Defense Acquisition Executive Summary	Review for comments, input OT&E assessment, brief Director for review meetings	25	75
DOT&E Budget	Prepare, submit, and follow-up	100	0
Education/Training	Participate in DAWIA and DTEPI meetings	100	0
Foreign Comparative Test Program	Review, assess, and advise	100	0
Independent Test Concepts	Review mission, requirements, AOAs, threat and concept of operation documents, identify test issues and data requirements, outline required operations and events, draft concept document	20	80
IPTs, TPWGs, Program Reviews	Identify potential discussion items, perform research, attend meeting, provide trip report, perform follow-up actions	30	70

Task	Description	GO	CO
Joint Live Fire	Plan, manage, execute program	20	80
JT&E	Evaluate candidate programs, review, assess, and advise on test plan and review and assess report for approval	60	40
Live Fire Test Plan	Review and assess for approval	20	80
Live Fire Test Report	Prepare report	20	80
LRIP Test Articles	Identify or verify number needed	60	40
Mission Needs Statement (MNS)	Review for information	40	60
Modeling and Simulation	Research to identify appropriate models, characterize model strengths and weaknesses, review VV&A adequacy, determine how models will be used, run models, review modeling results	30	70
Office Automation Program	Prepare for approval by Director	10	90
Operational Field Assessments	Develop requirements and operational issues, identify exercise opportunities, perform simulation studies and exercise design, attend, analyze data, produce report	20	80
Operational Requirements Document (ORD)	Review for completeness to support mission, prepare comments as needed identify areas requiring testing	40	60
OT&E Policy and Procedures	Identify policy voids or problems draft new or revised policies, conduct internal and external coordination, promulgate through appropriate forums	70	30-
Operational Test Plan	Review draft test plans, develop comments, negotiate plan revisions, coordinate internal plan approval	30	70
Operational Test Readiness Review	Participate	75	25
Operational Test Report (OTA generated)	Review for data analysis and evaluation methodology, identify areas to be incorporated into DOT&E assessments, initiate inquiries to resolve questions	30	70
Rapid Enhancement Project	Oversee program execution	90	10
Selected Threat Assessment	Review to identify test scenario threats, contact threat agencies for questions/clarifications, arrange for threat agency personnel to review test scenarios and replication on site	30	70
Special Project	Monitor and assess (special security)	60	40
T&E Master Plan (TEMP)	Compare draft test structure to mission need, requirements, threats and independent test concept; identify weaknesses; and negotiate improvements as necessary; coordinate internal review and approval	30	70
T&E Process Studies	Support study board members (e.g., DSB)	50	50
Test Scoring/Failure Review	Participate in review meetings, provide comments, identify situations for different scoring/failure assessment	20	80
	Resulting Ratio	1.0	1.1

2. Analysis

Unless more government billets become available, the DOT&E should try the following actions to get the most accomplishment out of his mission with the remaining action officers:

- Restrict DOT&E Action Officer duties and travel only to those minimally inherent government actions (as determined from Table 4) and contract for all remaining activities.
- Establish working procedures with the OTAs that will provide minimum overlap and complementary analysis and reporting. Advise OTAs and programs of any additional T&E requirements that DOT&E will require early so that the OTAs can collect and analyze the data.
- There is no statutory requirement for DOT&E to report all DoD operational testing, and this DoD-IG initiative does impose additional workload. This addition was included in the DOT&E Annual Report for FY98 as recommended. The OTAs could supply information to the DOT&E for use in the annual reports for those programs not on the OSD T&E Oversight List if desired, but they should submit them in a publication-ready format.
- Implement the SecDef and the DOT&E initiatives, such as combining DT&E and OT&E events, that can contribute to reducing T&E workload. Rely on data and analyses provided by all sources, rather than recreate. (Overall, these initiatives will have a tendency to require more DOT&E man-hours, government and contractor, but management should be able to minimize the DOT&E involvement.)
- Get more effective and efficient usage of government (including Rotational Training Assignment) and contractor personnel by requiring formal training prior to or at the outset of their assignment. As a minimum, this training should include information on the test and evaluation process and the acquisition process. On-the-job training and learning-by-doing about the basics of these processes should be avoided.
- Transfer to the Deputy for Resources and Administration as many action officer duties as possible that are not related to specific acquisition programs.

3. Government/Contractor Mix

The FY98 expenditure of 37.5 man-years of government and military action officer effort (out of 29 authorized billets) and 75.9 man-years of contractor support was inadequate for performing the functions related to specific OSD T&E Oversight List programs—a shortfall of 33.1 man-years of combined government and contractor man-years was estimated for the workload at that time. It is also noted that the 29 government action officers expended, on the average, over 23% more man-years than the accepted definition of a manyear (1760 man-hours), further suggesting a greater shortfall than reported. In FY99, DOT&E will lose two government action officer billets. All taken together, 146.5 man-years of combined government and contractor support personnel would have been required in FY 1998 to have adequately have performed the DOT&E mission from the 113.4 actually expended; i.e., a shortfall of 33.1 man-years. Table 4 suggests that the ideal in-house/contractor mix would be 1.1 contractors to each in-house action officer to each, or 69.8 in-house and 76.8 contractor man-years to perform the FY 98 workload. Moreover, even if this shortfall was addressed, it will not address the expanding workload identified in Section D. The actions of the analysis (Part 2 above) could contribute to alleviating some of the in-house workload requirements but at the expense of maintaining as good an in-house "smart buyer" capability.

SECTION F
Conclusions

DoD-IG Report No. 96-107 provided a critical assessment of DOT&E performance in the Annual Report and in System Acquisition Reviews (SARs). This deficient performance is attributed, in part, to lack of manpower. This staffing study confirmed that in FY98, shortfalls in in-house government and contractor support personnel persisted. DOT&E was unable to perform its responsibilities and functions for all of the acquisition programs on the OSD T&E Oversight List, let alone monitor all OT&E in the DoD; however, the highest priority programs and tasks were supported adequately. Furthermore, with the addition of the SecDef initiatives and the implementation charge by Director, Operational Test and Evaluation to his action officers and contractor support personnel, this shortfall will be exacerbated in coming years. Unless additional manpower billets or contractor support is provided, this shortfall will continue. U.S. Code Title 10, Section 139 (i) requires that the DOT&E "have sufficient professional staff of military and civilian personnel to carry out the duties and responsibilities of the Director prescribed by law."

It was estimated that to have performed all responsibilities and duties required for all acquisition programs on the OSD T&E Oversight List and the other tasks such as the Y2K Compliance, 146.5man-years of effort by DOT&E would have been required. And, in order that DoD maintain sufficient in-house expertise to remain a "smart buyer" and to bring military experience to the office of the DOT&E, it is advised that the ideal mix of government action officers and contractor personnel supporting the acquisition programs on the OSD T&E Oversight List would be 70 in-house action officers and 76 contractor support man-years. A mix as it is now with contractors outnumbering the in-house action officers by more than two to one is not seen as desirable. But, it is not realistic in today's OSD drawdown environment to consider growth of this magnitude for government billets, but the Director, Operational Test and Evaluation should pursue some increases for both government billets and contractor support, and continue prioritizing which programs are most deserving of attention to live within his resources.

The recommendation of the DoD Inspector General for DOT&E to "report <u>all</u> DoD operational testing" is clearly beyond existing legislative requirements and resources. Delegation of these responsibilities to the OTAs is not practical or desirable; however, some arrangements have been made with the OTAs to offset some of this workload in DOT&E. Compliance with this recommendation was accomplished in the FY98 DOT&E Annual Report.

The functions and the initiatives of the DOT&E are seen as essential to both getting effective and suitable weapons into the hands of warfighters as soon as possible and achieving DoD acquisition goals of reducing acquisition program costs and acquisition cycle time.

Appendices

APPENDIX A
Finding D of DoD-IG Report 96-107

Audit Report

OFFICE OF THE INSPECTOR GENERAL

OPERATIONAL TESTING PERFORMED ON WEAPONS SYSTEMS

Report No. 96-107

May 6, 1996

Department of Defense

Finding D. Test Status Reporting

The FY 1994 Annual Report of the Director, Operational Test and Evaluation (the Annual Report), did not include results of operational testing performed on nonmajor programs that were not selected for oversight. Also for 16 of 65 of the reported systems, the report did not present a complete and consistent assessment of the system's performance demonstrated in operational tests because DOT&E lacks resources to monitor, review, and report all DoD operational testing. The DOT&E also lacked adequate internal guidance and training for its action officers. As a result, the Secretary of Defense, the Under Secretary of Defense for Acquisition and Technology, and Congress did not get complete and consistent operational test information for decisionmaking.

Test Reporting Policy

The DOT&E is to provide the Secretary of Defense and Congress an unbiased insight into the operational effectiveness and suitability of new systems and major modifications to existing systems. Each year, the DOT&E issues his Annual Report to the Secretary of Defense, Under Secretary of Defense for Acquisition and Technology, and Congress summarizing the operational testing performed for DoD oversight programs for the fiscal year. Oversight programs are acquisition category I programs and other programs (nonmajor) selected due to their relative importance and sensitivity.

Statute. The Director is required by 10 U.S.C. 139 to monitor and review all operational test and evaluation in DoD and to summarize the OT&E activities of the DoD during the preceding fiscal year. The law also requires DOT&E to have sufficient professional staff to implement the duties and responsibilities of the Director.

DoD Guidance. DoDI 5000.2 implemented 10 U.S.C. 139 and also stated that the Director will prepare an annual report summarizing all OT&E activities within the DoD during the preceding fiscal year.

Although the guidance stated that DOT&E is to report on all OT&E activities, the FY 1994 Annual Report, February 1995, states that DOT&E is responsible for reporting the operational test results only for major Defense acquisition programs and nonmajor systems with DOT&E oversight.

Annual Test Report

Report Content. The FY 1994 Annual Report omits results of operational testing performed on nonmajor programs not selected for DOT&E oversight. The report summarized the OT&E activity for 59 of the 189 DoD major programs and other designated oversight programs. Neither 10 U.S.C. 139 nor DoDI 5000.2 stated that the DOT&E reports should be limited to an "oversight" listing or exclude nonmajor programs.

Operational testing and evaluation and reporting issues also occur in nonmajor programs that do not have DOT&E operational testing oversight. For example, the AC-130U Special Operation Forces Gunship was on the DOT&E oversight listing for live fire testing, but not operational testing. Major OT&E issues occurred as discussed in Finding B.

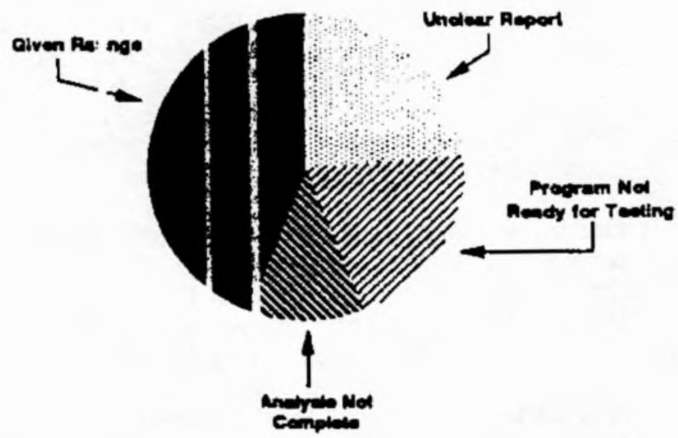
Additionally, the Naval Audit Service reviewed eight nonmajor programs with total projected costs of $2.7 billion. The Navy's subsequent report (Appendix B) concluded that operational tests and test results were not adequately documented and that the test results were not given adequate consideration in production decisions. The Inspector General, DoD, Report 92-079, "Operational Test and Evaluation of Nonmajor Systems," April 17, 1992, concluded that OT&E was inappropriately limited or omitted for 8 of 17 systems that did not have the DOT&E oversight.

Congress has not given DOT&E a waiver or other legislative relief from its OT&E monitoring, reviewing, and reporting responsibilities. A DOT&E official stated that the decision not to monitor, review, and report all operational testing in the Annual Report was a conscious, but informal, decision based on the lack of resources.

Clarity of the Annual Report. The Annual Report does not always completely and consistently assess the systems' operational testing performance. According to 10 U.S.C. 2399, the Annual Report is to describe the status of test and evaluation activities in comparison to the TEMP for the systems covered in the report. The status of the test, the source of the analysis, and the overall rating of the system by DOT&E were not always discernible from the report's systems summaries.

For example, the FY 1994 Annual Report states that the Navy OTA determined that the AN/SQQ-89(V)6 Antisubmarine Warfare Combat System was operationally effective and suitable. However, DOT&E did not state whether the system was operationally effective and suitable. This ambiguity leaves the reader uncertain as to whether DOT&E agreed with the Navy assessment.

Our review of the FY 1994 Annual Report showed that 23.5 percent of the systems' summaries were not clear, as shown in the figure.



Status of Test and Evaluation Reported

Both the report content and clarity issues result from a lack of sufficient resources for the DOT&E to meet the reporting intent of the congressionally directed oversight of OT&E. Current legislation and policy require earlier and continuing operational assessments, more explicit and implicit reporting requirements, and the Live Fire Test responsibilities added to the DOT&E workload.

Oversight Activity and Resources

DOT&E lacked resources to monitor, review, and report on all operational testing performed in the DoD, as required by 10 U.S.C. 139. In addition, the Federal Acquisition Streamlining Act of 1994 transferred the responsibility for oversight of the Live Fire Test and Evaluation from the DTSE&E to the DOT&E along with a requirement to submit an unclassified annual report concurrent with the classified one to include live fire test results.

Activity. The DOT&E FY 1994 review activities for the 189 oversight programs included:

o approving 54 TEMPs;

o approving 49 operational test plans;

o preparing and submitting numerous reports to the Defense Acquisition Board;

o publishing three beyond LRIP reports;

o reviewing the planning, conducting, and evaluating operational test activities;

o meeting with Military Department OTAs, program officials, private-sector organizations, and academia; and

o providing information to the Defense Acquisition Board principals, the Secretary and Deputy Secretary of Defense, the Under Secretary of Defense for Acquisition and Technology, the Military Departments, and Congress.

Documents that the DOT&E action officers review, approve, and produce are illustrated in Appendix F.

Resource Requirements. The DOT&E currently employs 50 people, divided primarily into two groups: 26 action officers and 24 policy and support personnel. Each action officer is responsible for monitoring, reviewing, and reporting as few as 2 and as many as 21 individual programs, to include live fire test. Because of DOT&E workload and special needs, in FY 1994, the DOT&E contracted with the Institute for Defense Analysis (the Institute), a Federally Funded Research and Development Center, for approximately 62 staff years at a cost of $10 million to assist in monitoring, reviewing, and reporting the OT&E. The use of the Institute is consistent with the Office of Federal Procurement Policy Letter 84-1 and Federal Acquisition Regulations that allow the use of federally funded research and development centers for special needs that in-house resources cannot meet. In the future, DOT&E, because of an increased workload, will rely even more on the Institute for support. In 1990, DOT&E concluded that the then current staff of 48 could not do the work in-house and "do the job right."

Action Officers' Guidance and Training. Of the 26 action officers, 12 are active duty military officers who are assigned from operating units to DOT&E. These officers generally do not have acquisition or test and evaluation experience.

The DOT&E internal guidance and training for its action officers are limited. The action officers use an internal policy guide, the "New Assistant's Guide," that provides general, but limited, guidance. DOT&E management also developed a self-help video so the action officers can learn their new work responsibilities. Additionally, new action officers to DOT&E receive "on-the-job" training instead of formal training for monitoring, reviewing, and reporting operational testing for their assigned programs. The Defense Acquisition University offers courses on the basic acquisition process and test and evaluation, which would benefit the productivity of DOT&E new action officers and DOT&E.

The policy guide summarizes how to review test plans and the resources available to accomplish this task. However, the guide does not provide details for reporting the operational test results in the annual report.

New action officers work for a short time with outgoing action officers and DOT&E management to be trained on-the-job. The action officers develop an informal network with other action officers for assistance.

The report summarization process is verbally passed from the previous action officer to the new action officer. Also, prior annual reports are used as "guides" for the current annual report. Completeness and consistency of reporting were inconsistent and selectively accomplished and dependent more on the action officer assigned.

Completeness and Consistency of the Annual Report

The Secretary of Defense, the Under Secretary of Defense for Acquisition and Technology, and Congress are not getting complete and consistent operational test information on systems for decisionmaking, which lessens the credibility of DOT&E products. The "New Assistant's Guide" states that reports are the most important product of the Office and that the reporting is to be objective and complete. However, the objectiveness of the FY 1994 Annual Report summary for the Combat Service Support Control System is questionable.

The summary states that the DOT&E had not evaluated the test data from the system's September 1994 initial OT&E. The initial OT&E was to support the Army Systems Acquisition Review Council full-rate production (Milestone III) decision scheduled for April 1995. Although the report said that the DOT&E had not evaluated the test data, it states, "We are aware of no significant issues which would prevent the 1995 Milestone III decision." At the same time the Annual Report was published (February 1995), the Army OTA published its test report for the system's initial OT&E that concluded the system demonstrated neither operational effectiveness nor operational suitability.

The DOT&E statement did not clearly present the system's performance, which prevented DOT&E from presenting an objective, unbiased overview of the system. The "New Assistant's Guide" states that the action officers must "ensure that the operational effectiveness and suitability of weapon systems are tested adequately, evaluated objectively, and reported independently to acquisition decision makers."

Summary

DOT&E must maintain credible products on which Department acquisition decisions are based and provide an unbiased insight of system performance, to include the nonmajor systems, to the DoD senior management and Congress. Producing credible products may be accomplished with a well-constituted oversight program that has the appropriate professional staffing level to "do the job right" and definite standards and specific checks.

Recommendations, Management Comments, and Audit Responses

Unresolved Recommendations. We ask that DOT&E provide additional comments on unresolved Recommendation D.2. The DOT&E and the Air Force commented on the finding. See Appendix I for a summary of their comments and audit responses.

D.1. We recommend that the Under Secretary of Defense (Comptroller), provide the Director, Operational Test and Evaluation, the necessary funds for increased DoD civilian staff years.

Under Secretary of Defense (Comptroller) Comments. The Under Secretary of Defense (Comptroller) nonconcurred with the draft recommendation addressed to him, stating that the Director, Washington Headquarters Services, determines the funding and staffing levels of all OSD staff elements.

DOT&E Comments. Although not required to comment, the Director concurred, stating that he would work with the Comptroller to achieve increased civilian staff years.

Audit Response. The Under Secretary of Defense (Comptroller) comments were not responsive. However, the intent of the recommendation will be met if the Director seeks staff augmentation through the DoD budget process.

D.2. We recommend that the Director, Operational Test and Evaluation:

a. Conduct a new staffing-requirements study to determine the appropriate mix of in-house DoD staffing and contractor support requirements needed to perform the Director, Operational Test and Evaluation, mission.

DOT&E Comments. The Director concurred, stating that he would conduct the staffing and contractor support study.

Audit Response. The Director's proposed action meets the intent of our recommendation. We ask that he provide the effective date for the planned action in his response to the final report.

b. Provide the Director, Operational Test and Evaluation, staff formal guidance for writing the annual report and for ensuring that the reports are complete and consistent.

DOT&E Comments. The Director concurred, stating that he issued guidance on September 29, 1995, for writing the Annual Report and for ensuring that the reports are complete and consistent.

Audit Response. We examined the September 29, 1995, guidance issued by the Director; it did not address the intent of our recommendation. The guidance does reference 10 U.S.C. 2399 and 10 U.S.C. 2366 reporting requirements. However, to fully meet the intent of our recommendation, it should state what is to be included and should include a checklist for action officers to use to ensure a complete, consistent, and accurate report. We would be happy to assist the Director in developing such a checklist as an aid for action officers. We ask the Director to reconsider his response and provide additional comments to the final report.

c. Provide new action officers with formal training on the acquisition process, including test and evaluation.

DOT&E Comments. The Director concurred, stating that he initiated the development of a proactive training plan for action officers, which will include milestones for monitoring its execution.

Audit Response. The Director's action meets the intent of our recommendation. We ask the Director to provide us the estimated completion date for the plan and the general contents of the plan, to include acquisition training when warranted, in his response to the final report.

d. Include a summary of the operational testing performed on nonmajor weapon systems in the Director's annual report.

DOT&E Comments. The Director concurred, stating he would work with congressional staffs, OSD offices and the Military Departments to determine what operational test information on nonmajor weapon systems will be in the annual report.

Audit Response. The Director's proposed action meets the intent of our recommendation. However, he did not provide the date of when this action will be done. We ask that the Director provide estimated completion dates for these actions in his response to the final report.

APPENDIX B
DOT&E Man-hour Survey

1. The data used in this analysis was provided by the DOT&E action officers assigned to work the acquisition programs on the OSD T&E Oversight List. This data was not routinely maintained or collected, and relied on personal records and memories, and were validated by the respective Deputies.
2. All man-hours reported expended in Fiscal Year 1998 from IDA contractor direct support to programs on the OSD T&E Oversight List were documented.
3. Action officer expended man-hours on work not directly supporting specific acquisition programs are included and identified. Contractor hours not supporting specific programs on the OSD T&E Oversight List were not obtained.
4. Some action officers reported shortfalls as non-specific as to whether they should be contractor or government, while others broke them out. Shortfalls used in the analysis rolled up both contractor and government as a composite shortfall.
5. Some programs from the OSD T&E Oversight List having OT&E or LFT&E responsibilities show no operational test activity or were covered by effort on related sister programs.
6. TDY travel time and administrative work in support of specific programs on the OSD T&E Oversight List are included in the reported time expenditure for those programs. Otherwise, TDY travel time for other efforts are shown.

SURVEY DATA SUMMARY

PROGRAM	MAN-HOURS	MAN-HOURS	MAN-HOURS	AO
	In-house	Contract	Shortfall	Action Officer
AAAV	320	300	80	(b)(6) [redacted]
AAAV - Live Fire	200	300	250	
AAR-47-V2	100	300	400	
ABL	450	1400	693	
ABL - LFT&E	200	300	250	
ACDS BLK I	160	500	0	
ACTD (CPACTD)	25	0	0	
ACTD (JCM)	50	0	30	
ACTD (JMLS)	0	0	441	
ACTD (JTD)	37	0	441	
ACTDs (CID,ET AL)	40	0	560	
ACTD (TUAV-Outrider)	162	500	100	
ADC (X)	5	0	20	
ADC (X)	100	150	125	
ADDS/EPLRS	40	80	0	
ADVANCED MILSATCOM	80	40	140	
AEW	0	0		
AFATDS (ATCCS)	60	600	0	
AFMSS	150	0	275	
AGCCS	50	115	65	
AIEWS	210	840	160	
AIM-9X UPGRADE	320	320	224	
AIM-9X UPGRADE - Live Fire	200	300	250	
ALR-56M	50	75	175	
ALR-67/ASR V3	275	1540	0	
ALR-67-V2	100	200	300	
ALR-69 (ALL VERSIONS)	75	440	85	
AMRAAM (AIM-120)	176	265	40	
AMRAAM (AIM-120) - LFT&E	150	225	188	
AMSS	30	60		
AN/SPY-1 B/D (AEGIS)	50	160	40	
AN/SQQ-89 (SQS-53/SQR-19)	250	1187	180	
APR-39 (ALL VERSIONS)	100	150	250	
ASAS (ATCCS)	162	160	360	
ASPJ	50	220	630	
ATACMS BLOCK 1A (APAM)	147	1173	0	
ATACMS BLOCK 1A (APAM) - LFT&E	141	360	120	
ATACMS BLOCK II & IIA (BAT)	340	340	248	
ATACMS BLOCK II & IIA (BAT)-LFT&E	35	120	0	
AV-8B REMANUFACTURE	0	0		

				(b)(6)
AVENGER	37	0	74	[redacted]
B-1B CMUP/JDA M	50	257	0	
B-1B CMUP/ALL JPGRADI:S	50	256	0	
B-1B CMUP/ALL JPGRADI:S LFT&E	200	300	250	
B-1B CMUP/COM PUTER UPGRADE	50	257	125	
B-1B CMUP/DSU P	50	257	125	
B-2	150	733	70	
B-2 Live Fire	200	300	250	
BATTLEFIELD DI GIT (Incluc es FBCB2	700	3200	1400	
BLACKHAWK (UH-60L)	37	0	74	
BLACKHAWK (UH-60L) - LFT&E	17	24	0	
BMD Family of Systems	176	1623	264	
BMD Targets	88	160	1545	
BRADLEY FVS (M2/M3) UPGRADE	500	2058	50	
BRADLEY FVS (M2/M3) UPGRADE - LFT&E	200	384	196	
C-130J (ALL VARIANTS)	660	730	320	
C-130J (ALL VARIANTS) LFT&E	528	320	60	
C-17A	370	300	220	
C2 VEHICLE	80	40	280	
C2 VEHICLE - LFT&E	200	512	228	
C2 VEHICLE - LFT&E	240	240	0	
CCTT	74	5784	100	
CEC	240	700	400	
CEIS	50	135	20	
CH-47D [Improved Cargo Helc (ICH)]	294	294	294	
CH-47D [Improved Cargo Helc] - LFT&E	176	240	48	
CH60 CARGO HELICOPTER	175	502	80	
CH60 CARGO HELICOPTER - LFT&E	35	48	20	
CHCS II	200	520	110	
CHEM/BIO	20	979	200	
CHEMICAL DEMILITARIZATION	265	440	64	
CHEMICAL DEMILITARIZATION	220	440	160	
CMU (CHEYENNE MTN UPGRADE	220	600	120	
COMANCHE (RAH-66)	294	294	441	
COMANCHE (RAH-66)	80	0	0	
COMANCHE (RAH-66) - LFT&E	300	230	60	
CRUSADER	147	293	650	
CRUSADER - LFT&E	240	240	0	
CRUSADER - LFT&E	100	256	114	
CSEL	256	256	100	
CSSCS (ATCCS)	162	160	340	
CV(X)	240	0	0	
CV(X) - LFT&E	100	150	125	

CVN-68 Class	0	0	0	(b)(6) [redacted]
DARK STAR	132	220	0	
DCPDS	130	345	50	
DDG-51 (ALL VARIANTS)	350	802	140	
DDG-51 (ALL VARIANTS) - LFT&E	200	300	200	
DII/COE (DT&E oversight only)				
DJAS/CEFMS	70	170	215	
DJMS	70	170	235	
DMLSS	90	240	55	
DMS	200	520	215	
DMSP	20	10	40	
DOT&E Initiatives	160	0	0	
DPPS	170	430	260	
DSB Task Force Integrated T&E	900	0	0	
DSS	130	30	0	
E-2C REPRODUCTION	160	450	425	
E3	80	302	140	
E-3A (RSIP) AWACS	90	700	90	
E-6A/B	50	225	0	
EA-6B (ALL UPGRADES)	225	1175	0	
EDM	70	180	120	
EELV	200	680	100	
EFOG-M	147	368	147	
EFOG-M - LFT&E	10	10	0	
ESSM	110	800	0	
ESSM - LFT&E	180	180	0	
ESSM - LFT&E	150	225	188	
F/A-18 C/D (UPGRADES)	240	240	80	
F/A-18 E/F	1614	1614	324	
F/A-18 E/F - LFT&E	100	750	350	
F-15 FDL (JTIDS)	500	400	250	
F-15/TEWS	170	1030	80	
F-22	880	1250	250	
F-22 - LFT&E	528	430	40	
FAADS C2I (ATCCS)	60	120	0	
FAS	190	500	140	
FDS/ADS	100	294	20	
FMTV	70	491	450	
FOTT	147	662	0	
FOTT - LFT&E	10	10	0	
FUTURE COMBAT SYSTEM-LFT&E	34	50	41	
FUTURE INFANTRY VEHICLE-LFT&E	33	50	42	
FUTURE SCOUT/CAVALRY SYSTEM	36	147	50	
FUTURE SCOUT/CAVALRY SYSTEM - LFT&E	33	50	42	

				(b)(6)
GBS	200	590	100	[redacted]
GCCS	130	345	180	
GCSS-AF	170	435	85	
GLOBAL HAWK	132	220	85	
GTN	140	360	60	
H-1 UPGRADE	350	120	180	
HDBTDC	15	0	0	
HMMLTV	0	0	0	
HMMLTV - LFT&E	100	150	125	
HPCMP	170	430	180	
HSRS	70	175	125	
IDECM	250	1320	100	
IEW COMMON SENSOR	330	905	0	
IMDS	120	218	0	
Information Warfare	210	604	180	
ITAS	300	661	0	
JAMSS	30	75	25	
JASSM	340	340	248	
JASSM - LFT&E	150	225	188	
JAVELIN (AAWS-M)	74	294	221	
JAVELIN (AAWS-M) - LFT&E	70	120	60	
JCALS	200	520	180	
JDAM	635	1056	0	
JDAM - Live Fire	50	100	50	
Joint LFT&E	255	4000	2720	
JPALS	70	120	180	
JPATS	515	730	180	
JSF	150	500	100	
JSF - LFT&E	176	220	40	
JSIPS (Includes CIGGS &ABI)	100	160	320	
JSOW BASELINE	211	352	0	
JSOW BASELINE - LFT&E	150	64	16	
JSOW BLU-108	212	352	150	
JSOW BLU-108 - LFT&E	150	64	16	
JSOW UNITARY	212	352	150	
JSTARS (E-8C)	340	340	248	
JSTARS GSM	500	3520	2500	
JT&E (JSHIP)	10	10	10	
JT&E (JWF)	3	3	0	
JT&Es	10	10	40	
JT&Es	150	0	0	
JT&Es	40	40	40	
JTIDS	100	100	0	
JTRS	40	80	0	
KIOWA WARRIOR (OH-58D)	37	0	294	
KIOWA WARRIOR (OH-58D) - LFT&E	38	135	40	

KIOWA WARRIOR (OH-58D) - LFT&E	250	130	30	(b)(6) [redacted]
LAND WARRIOR	300	294	50	
LASER HELLFIRE	0	0	74	
LFT&E Bus. and Finance Management	1000	0	760	
LHD CLASS	20	0	50	
Live Fire Testing and Training Program	760	1760	1760	
LONGBOW APACHE (AH-64D)	294	588	147	
LONGBOW HELLFIRE	0	0	0	
LOSAT	31	74	221	
LOSAT - LFT&E	100	10	50	
LPD17(LX)	350	420	75	
LPD17(LX) - LFT&E	200	300	200	
M 993 7.62 MM AP - LFT&E	44	140	0	
M 995 5.56 MM AP - LFT&E	44	140	0	
M1 BREACHER - LFT&E	100	384	146	
M1 HAB - LFT&E	200	384	250	
M1A2 UPGRADE	500	588	850	
M1A2 UPGRADE - LFT&E	176	320	80	
M829E3 - LFT&E	88	60	20	
MCS (ATCCS)	700	1600	80	
MEADS	176	588	638	
MEADS - LFT&E	50	128	0	
MEADS - LFT&E	40	40	0	
MH-47E/MH-60K SOA - LFT&E	88	120	20	
MHC (COASTAL MINE HUNTER)	180	1158	140	
MIDS-FDL	--	--		
MIDS-LVT	500	400	200	
MILSTAR	380	630	180	
MINUTEMAN III GRP PHASE I	200	120	320	
MINUTEMAN III PRP	150	120	270	
MK-48 ADCAP (ALL MODS)	300	735	0	
MK-48 ADCAP (ALL MODS) Live Fire	100	150	125	
MLRS (ERR)	40	293	300	
MLRS (ERR) - Live Fire	100	150	125	
MLRS (GUIDED ROCKET)	50	440	0	
MLRS (GUIDED ROCKET) - Live Fire	100	150	125	
MLRS M270A1	100	880	300	
MLRS UPGRADE	0	0		
Modeling and Simulation	500	0	0	
Modeling and Simulation - LFT&E	400	900	0	
NAS	170	400	200	
NAS	250	400	280	

NAVSTAR GPS	412	293	138	(b)(6) [redacted]
NAVY AREA TBMD	352	882	722	
NAVY AREA TBMD - LFT&E	300	766	0	
NAVY AREA TBMD - LFT&E	40	40	0	
NBC RECON VEHICLE	147	2592	0	
NESP (EHF) (Part of MILSTAR)	80	80	90	
NEW ATTACK SUB (NSSN)	500	1029	2000	
NEW ATTACK SUB (NSSN) - Live Fire	200	300	250	
NMD	1144	2352	3532	
NMD - LFT&E	210	256	0	
NMD - LFT&E	40	40	0	
NON TOXIC AMMO - LFT&E	10	10	0	
NPOESS	60	70	110	
NSIPS	150	395	55	
NTCSS	100	255	175	
NTW	352	882	722	
NTW - LFT&E	50	128	0	
NTW - LFT&E	40	40	0	
OCSWS - LFT&E	50	123	57	
OFAs	200	480	680	
OFAs	380	3002	0	
OFAs	50	3263	0	
OFAs	250	0	0	
OICWS - LFT&E	50	123	57	
PATRIOT PAC-3	528	1981	1020	
PATRIOT PAC-3 - LFT&E	250	639	0	
PATRIOT PAC-3 - LFT&E	20	20	0	
PLS	0	0	0	
PREDATOR	440	1176	175	
QRCC/SSDS	600	700	320	
RAM	320	830	0	
RAM - LFT&E	150	225	188	
RCAS	170	430	120	
Resources & Administration	1510			
Resources and Administration	1760			
Resources and Administration	1760			
Resources and Administration	1760			
SADARM	500	1613	200	
SADARM - LFT&E	160	280	80	
SAP Programs	160	160	0	
SBIRS	500	700	1000	
SC-21 Redesignated DD 2[illegible]	175	320	80	
SC-21 Redesignated DD 2[illegible] - LFT&E	200	300	250	
SCAMP (MILSTAR, BLK II)	120	270	130	
SEA SPARROW AIM/RIM-[illegible]	0	0	0	

SEA SPARROW AIM/RIM-7 - LFT&E	120	120	0
SFW	50		0
SFW P31	50	176	0
SFW P31 - LFT&E	150	512	203
SH-60R	355	1308	65
SIDPERS3	130	330	230
SIIRCM/ATIRCM/CMWS	340	2350	0
SINCGARS	40	80	0
SIRFC	175	295	155
SLAM	440	440	83
SLAM - LFT&E	150	512	203
SM-2 (BLKS III/IIIA&B)	60	650	0
SM-2 BLK IV/IVA	60	700	0
SM-2 BLK IV/IVA - LFT&E	120	120	0
SMART CARD (DT&E oversight only)			
SMART-T	260	460	80
SPS	160	405	105
SSAI - LFT&E	250	0	0
SSN21/BSY-2	900	1323	2000
SSN21/BSY-2 - LFT&E	200	300	250
STAN/M&S	50	1395	1225
STARS	40	95	120
STINGER RMP	37	441	294
STRATEGIC SEALIFT	294	588	0
SUB COMMS (SCSS)	200	441	0
SWPS/TRICOMS	130	345	165
T-45TS	294	294	10
TACTICAL TOMAHAWK MPS	100	100	25
T-AGOS/SURTASS/LFA	50	135	20
TAMPS	240	240	48
TC-AIMS II	70	170	50
TCS	40	80	240
TDY Travel Time - LFT&E	240	240	0
TDY Travel Time - LFT&E	123	0	120
TDY Travel Time - LFT&E	336	300	100
TDY Travel Time - LFT&E	100	0	0
Test/Training LFT&E Initiatives -	240	240	0
THAAD/GBR	120	0	0
THAAD/GBR	704	1911	616
THAAD/GBR - LFT&E	150	383	0
THAAD/GBR - LFT&E	20	20	0
THEATRE MISSION PLAN CNTR	100	100	25
TITAN IV	10	0	60
TMD JOINT EXERCISES	25	0	0
TMIP	120	320	60
TOMAHAWK (SLCM)	180	50	50

(b)(6) [redacted]

TOMAHAWK (SLCM)	150	225	188	(b)(6) [redacted]
TOMAHAWK (SLCM) - LFT&E	130	180	0	
TRAC2ES	50	135	145	
TRIDENT II MISSLE	20	0	0	
UHF FOLLOW-ON SATELLITE	100	120	50	
USMC H-1 UPGRADE - LFT&E	40	140		
V-22	430	420	200	
V-22 - LFT&E	100	750	350	
VERTICAL LAUNCH ASROC	0	0	0	
WIDE AREA MUNITION - LFT&E	200	280	60	
XM4001 40mm CANISTER CARTIDGE - LFT&E	150	256	139	
Y2K Compliance	320			
Y2K Compliance	160	0	0	
Y2K Compliance	462	474	0	
Total Manhours	***65921***	***137431***	***58233***	
Total Man-years	***37.5***	***75.9***	***33.1***	
BOLD denotes work other than on the OSD T&E Oversight List				
1 ManYear=1760hrs (Government)				
1 ManYear=1810hrs (IDA)				

APPENDIX C
Contractor Tasks

CONTRACT TASKS

The following task areas are performed by the Institute for Defense Analyses (IDA) under contract DASW01-94-C-0054/DASW01 97-C-0056 for the Director for Operational Test and Evaluation (DOT&E) in the Department of Defense.

SUBJECT OR AREA	TASK NUMBER	OBJECTIVE
LAND WARFARE		
Unmanned Aerial Vehicles	T-P9-397	Evaluate T&E plans and assess test results
Anti-armor Systems	T-P9-419	Evaluate T&E plans and assess test results (Javelin, LOSAT, TOW-2, ITAS, EFOG-M/EFP)
Army Forward Area Air Defense	T-P9-432	Evaluate T&E plans and assess test results (STINGER, BSFV)
Army Aviation Systems	T-P9-574	Evaluate T&E plans and assess test results (RAH-66, AH-64D, OH-58D, Hellfire, ICH)
Tactical Wheeled Vehicles	T-P9-782	Evaluate T&E plans and assess test results (FMTV, NBCRS)
Armored Systems Modernization	T-P9-834	Evaluate T&E plans and assess test results (M1A2 HAB, M2/M3A3, BCEV)
Fire Support Systems	T-P9-1040	Evaluate T&E plans and assess test results (RSV, ATACMS, SADARM, BAT, MLRS, HIMARS)
Training & Training Support Systems	T-P9-1283	Evaluate T&E plans and assess test results (CCTT)
CBW Defense	T-P9-1579	Evaluate individual system and integrated capabilities of US military forces including fielded, developmental, ACTDs, & ATDs
NAVAL WARFARE		
Submarine Warfare Systems	T-P9-773	Evaluate T&E plans and assess test results (SSN 21, NSSN, Mk 48, SubECS)
Shipboard Air Defense Systems	T-P9-810	Evaluate T&E plans and assess test results (SM-2, AIEWS, ESSM, RAM, SLQ-32, SSDS, ACDS, and AAW test targets)
Anti-Submarine Warfare Systems	T-P9-811	Evaluate T&E plans and assess test results (SURTASS/ADS, AN/SQQ-89 I, LAMPS Mk III, Mk 50, CH-60 Variant)
Amphibious Warfare Systems	T-P9-871	Evaluate T&E plans and assess test results (AAAV, LPD 17)
AEGIS Ship System	T-P9-969	Evaluate T&E plans and assess test results

SUBJECT OR AREA	TASK NUMBER	OBJECTIVE
		(DDG 51, SC 21, SPY-1 B/D Upgrades)
Mine Countermeasures	T-P9-1146	Evaluate T&E plans and assess test results (AN/SQQ-32, AN/SYQ-13, AN/SLQ-48(V), AN/SSQ-94)
Strategic Sealift Systems	T-P9-1235	Evaluate T&E plans and assess test results plus reviewing program documents, drafting OT evaluation plan, and analyzing and reporting on testing
TACTICAL AIR WARFARE		
Joint Surveillance and Targeting Attack Radar System (JSTARS)	T-P9-393	Evaluate T&E plans and assess test results
Tactical Aircraft	T-P9-807	Evaluate T&E plans and assess test results (F-22, C-17, C-130J, F/A-18, V-22, JPATS, JSF, H-1 Upgrades, TAMPS)
Air Warfare Systems	T-P9-808	Evaluate T&E plans and assess test results (AIM-120, AIM-9X)
Air-to-Ground Weapons	T-P9-809	Evaluate T&E plans and assess test results (SFW, JDAM, JSOW, SLAM, JASSM)
Electronic Warfare Systems	T-P9-1047	Evaluate T&E plans and assess test results (ASPJ, ALQ-131, ALR-56M, F-15 TEWS, APR-39A(XE-2) ALR-67, EA-6B, ALR-69, ASR, SIIRCM/CMWS, SIRFC, IDECM)
STRATEGIC MISSILES		
Strategic Missile Systems	T-P9-1042	Evaluate T&E plans and assess test results (TOMAHAWK, Theater Mission Planning Center, TITAN IV, EELV, Minuteman III modernization)
Strategic Bomber Systems	T-P9-1043	Evaluate T&E plans and assess test results (B-2, B1-B, NAS(ATCALS, MAMS), AFMSS)
Ballistic Missile Defense	T-P9-1049	Evaluate T&E plans and assess test results (PATRIOT PAC-3, THAAD, TBMD, BMD, NMD, ABL)
Chemical Demilitarization Program	T-P9-1396	Identify operational T&E issues and test objectives, evaluate T&E plans and assess test results, advise and assist in execution and monitoring of T&E of demil facilities

C^3 AND COMPUTERS		
Major Automated Information Systems	T-P9-1044	Evaluate T&E plans and assess test results (CHCS, DMS, GTN, HPCMP, RCAS, SWIPS)
Space C^3 Surveillance Systems	T-P9-1045	Evaluate T&E plans and assess test results (CMU, DSP, SBIRS, DMSP, CMAH, NPOESS, RSA)
Airborne Sensors and C^3 Upgrades	T-P9-1048	Evaluate T&E plans and assess test results (E-3 AND E-2C Upgrades, E-6 TACAMO, JTIDS, MIDS)
Space C^3 & Navigation	T-P9-1399	Evaluate T&E plans and assess test results (MILSTAR, CSOC DSCS UFO, GPS)
Information Warfare/Electromagnetic Environmental Effects (E^3)	T-P9-158	Evaluate T&E plans and assess test results (policies and concepts, Common Imagery System Architecture, C^4ISR Test Architecture)
Army Battle Command and Intelligence Systems	T-P9-158	Evaluate T&E plans and assess test results (FBCB2, ATCCS (AFATDS, CHS, CSSCS, FAAD C^2I, MCS), MSE, SINCGARS, EPLRS JTR, ASAS, CID, JSIPS/CIGSS, IEWCS GBCS)
SPECIAL PROJECTS		
Advanced Concept Technology Demonstrations	T-P9-147	Identify technical and operational challenges to obtaining maximum military utility from each candidate ACTD
Test Capabilities for Precision Munitions and C^3I Weapons Systems	T-P9-142	Determine test resource deficiencies, and corrective actions, suggest improvements for management process for long range planning for investments
T&E Facilities	T-P9-158	Responds to FY97 Defense Appropriations Bill Report for independent study on T&E capabilities: find ways to manage and maintain existing T&E facilities more efficiently, and determine types of facilities to be modernized.
LIVE FIRE		
Live Fire T&E Program	T-P9-135	Provide analytic basis to determine vulnerability and lethality, and maintain an information support system to track events (Vulnerability: AAAV, LOSAT, AGS, M1A2, M2A3, C2V, DDG 51, SSN21, LPD 17, NAS, SC 21, OH-58D, RAH-66, F-22, ATF, B-2, F/A-18E/F, B-1B, etc Lethality: Javelin, ATACMS, SADARM,

		WAM, LOSAT, ER-MLRS, STAFF, etc)
Joint Live Fire	T-P9-1519	Evaluate JLF plans and activities, develop 5-year plan of issues and test options, attend test events, evaluate reports, assess test results, provide oversight on the archiving of test data, and recommend improvements to JLF program
STUDIES AND ANALYSIS		
OPA of Extended Range-Relocatable Over-the-Horizon Radar	T-P9-1570	Assist USSOUTHCOM in design and conduct of test and simulation for ER-ROTHR, and analyze and report results
OPA of Air Intercept Capability using AN/APS-144	T-P9-1569	Assist USSOUTHCOM to develop CONOPS, and strategy and conduct of test and simulation for air intercept capability, and analyze and report results
Operational Field Assessments	T-P9-1571	Develop operational issues, CONOPs, assess planning, conduct simulation studies, perform exercise design, analyze data, provide technical advice, attend exercises, and develop assessment report
Data Standardization	T-P9-1580	Develop an operational test data standardization program

APPENDIX D
OSD T&E Oversight List
As of March 3[illegible], 1998

PROGRAM	DT	OT	LF	COMPONENT
AAAV	X	X	X	NAVY
ABL	X	X	X	AIR FORCE
ACDS BLK I	X	X		NAVY
ADC (X)	X	X	X	NAVY
ADDS/ELPRS	X	X		ARMY
ADVANCED MILSATCOM	X	X		AIR FORCE
AEW	X	X		NAVY
AFATDS (ATCCS)	X	X		ARMY
AFMSS	X	X		AIR FORCE
AGCCS	X			ARMY
AIEWS	X	X		NAVY
AIM-9X UPGRADE	X	X	X	NAVY
ALR-56M	X	X		AIR FORCE
ALR-67/ASR	X	X		NAVY
ALR-69 (ALL VERSIONS)		X		AIR FORCE
AMRAAM (AIM-120)		X	X	AIR FORCE
AMSS	X			AIR FORCE
AN/SPY-1 B/D (AEGIS)	X	X		NAVY
AN/SQQ-89 (SQS-53/SQR-19)	X	X		NAVY
APR-39 (ALL VERSIONS)	X	X		ARMY
ASAS (ATCCS)	X	X		ARMY
ATACMS		X		ARMY
ATACMS BLOCK 1A (APAM)	X	X	X	ARMY
ATACMS BLOCK II & IIA (BAT)	X	X	X	ARMY
ATACMS UPGRADES	X	X		ARMY
AV-8B REMANUFACTURE	X	X		NAVY
AVENGER	X	X		ARMY
B-1B CMUP/JDAM	X	X		AIR FORCE
B-1B CMUP/ALL UPGRADES			X	AIR FORCE
B-1B CMUP/COMPUTER UPGRADE	X	X		AIR FORCE
B-1B CMUP/DSUP	X	X		AIR FORCE
B-2	X	X	X	AIR FORCE
BATTLEFIELD DIGIT (Includes FBCB2)	X	X		ARMY
BLACKHAWK (UH-60L)		X	X	ARMY
BRADLEY FVS (M2/M3) UPGRADE	X	X	X	ARMY
C-130J (ALL VARIANTS)	X	X	X	AIR FORCE
C-17A		X		AIR FORCE

C2 VEHICLE	X	X	X	ARMY
CCTT	X	X		ARMY
CEC	X	X		NAVY
CEIS	X	X		OSD (HA)
CH-47D (Improved Cargo Helo (ICH))	X	X	X	ARMY
CH60 CARGO HELICOPTER	X	X	X	NAVY
CHCS II	X	X		OSD (HA)
CHEMICAL DEMILITARIZATION	X	X		ARMY
CID	X	X		DOD
CMU (CHEYENNE MTN UPGRADE)	X	X		AIR FORCE
COMANCHE (RAH-66)	X	X	X	ARMY
CRUSADER	X	X	X	ARMY
CSEL		X		AIR FORCE
CSSCS (ATCCS)	X	X		ARMY
CV(X)	X	X	X	NAVY
CVN-68 Class	X	X		NAVY
DARK STAR	X	X		DOD
DCPDS	X	X		AIR FORCE
DDG-51 (ALL VARIANTS)	X	X	X	NAVY
DII/COE	X			DISA
DIMHRS	X	X		NAVY
DJAS/CEFMS	X	X		DFAS
DJMS	X	X		DFAS
DMLSS	X	X		OSD (HA)
DMS	X	X		DISA
DMSP	X	X		AIR FORCE
DPPS	X	X		DFAS
DSS	X	X		DLA
E-2C	X	X		NAVY
E-3A (RSIP) AWACS	X	X		AIR FORCE
E-6A/B		X		NAVY
EA-6B (ALL UPGRADES)	X	X		NAVY
EDM	X	X	X	DFAS
EELV	X	X		AIR FORCE
EFOG-M	X	X	X	ARMY
ESSM	X	X	X	NAVY
F/A-18 C/D (UPGRADES)	X	X		NAVY
F/A-18 E/F	X	X	X	NAVY
F-15 FDL (JTIDS)	X	X		AIR FORCE
F-15/TEWS	X	X		AIR FORCE
F-22	X	X	X	AIR FORCE
FAADS C2I (ATCCS)	X	X		ARMY
FAS	X	X		DLA
FDS/*ADS*		X		NAVY

FMTV	X	X		ARMY
FOTT	X	X	X	ARMY
FUTURE COMBAT SYSTEM	X	X	X	ARMY
FUTURE INFANTRY VEHICLE	X	X	X	ARMY
FUTURE SCOUT CAVALRY SYSTEM	X	X	X	ARMY
GBS	X	X		OSD
GCCS	X	X		DISA
GCCS (CAPSTONE)	X			AIR FORCE
GCSS-AF	X	X		AIR FORCE
GLOBAL HAWK	X	X		DOD
GTN	X	X		AIR FORCE
HDBTDC	X			DOD
HMMLTV	X	X	X	ARMY
HPCMP	X			OSD (DDR&E)
HSRS	X	X		DOD
IDECM	X	X		NAVY
IEW COMMON SENSOR		X		ARMY
IMDS	X	X		AIR FORCE
ITAS	X	X		ARMY
JASSM	X	X	X	AIR FORCE
JAVELIN (AAWS-M)	X	X	X	ARMY
JCALS	X	X		ARMY
JDAM	X	X	X	AIR FORCE
JMPS	X	X		NAVY/AF
JPALS	X	X		AIR FORCE
JPATS	X	X		AIR FORCE
JSF	X	X	X	DOD
JSIPS (Includes CIGGS & A3I)	X	X		AIR FORCE
JSOW BASELINE	X	X	X	NAVY
JSOW BLU-108	X	X	X	NAVY
JSOW UNITARY	X	X	X	NAVY
JSTARS (E-8C)	X	X		AIR FORCE
JSTARS GSM	X	X		ARMY
JTRS	X	X		DOD
KIOWA WARRIOR (OH-58D)	X	X	X	ARMY
LAND WARRIOR	X	X		ARMY
LHD CLASS		X		NAVY
LONGBOW APACHE (AH-64D)	X	X	X	ARMY
LONGBOW HELLFIRE	X	X	X	ARMY
LOSAT	X	X	X	ARMY
LPD17(LX)	X	X	X	NAVY
M 993 7.62 MM AP			X	ARMY
M 995 5.56 MM AP			X	ARMY
M1 BREACHER			X	ARMY
M1 HAB			X	ARMY

M1A2 UPGRADE	X	X	X	ARMY
M829E3			X	ARMY
MCS (ATCCS)	X	X		ARMY
MEADS	X	X	X	BMDO
MH-47E/MH-60K SOA			X	ARMY
MHC (COASTAL MINE HUNTER)	X	X		NAVY
MIDS-FDL	X	X		AIR FORCE
MIDS-LVT	X	X		NAVY
MILSTAR	X	X		AIR FORCE
MINUTEMAN III GRP PHASE 1	X	X		AIR FORCE
MINUTEMAN III PRP	X	X		AIR FORCE
MK-48 ADCAP (ALL MODS)	X	X	X	NAVY
MLRS (ERR)	X	X	X	ARMY
MLRS (GUIDED ROCKET)	X	X	X	ARMY
MLRS M270A1	X	X		ARMY
MLRS UPGRADE	X	X		ARMY
NAS	X	X		AIR FORCE
NAVSTAR GPS	X	X		AIR FORCE
NAVY AREA TBMD	X	X	X	BMDO
NBC RECON VEHICLE	X	X		ARMY
NESP (EHF) (Part of MILSTAR)	X	X		NAVY
NEW ATTACK SUB (NSSN)	X	X	X	NAVY
NMD	X	X	X	BMDO
NON TOXIC AMMO			X	ARMY
NPOESS	X	X		DOD
NSIPS	X	X		NAVY
NTCSS	X	X		NAVY
NTW	X	X	X	BMDO
OCSWS			X	ARMY
OICWS			X	ARMY
PATRIOT PAC-3	X	X	X	BMDO
PLS	X	X		ARMY
PREDATOR	X	X		AIR FORCE
QRCC/SSDS	X	X		NAVY
RAM	X	X	X	NAVY
RCAS	X	X		ARMY
SADARM	X	X	X	ARMY
SBIRS	X	X		AIR FORCE
SC-21	X	X	X	NAVY
SCAMP (MILSTAR, BLK II)	X	X		ARMY
SEA SPARROW AIM/RIM-7		X		NAVY
SFW		X		AIR FORCE
SFW P31	X	X	X	AIR FORCE
SH-60R	X	X	X	NAVY
SIDPERS3	X	X		ARMY

SIIRCM/ATIRCM/CMWS	X	X		ARMY
SINCGARS	X	X		ARMY
SIRFC	X	X		ARMY
SLAM	X	X	X	NAVY
SM-2 (BLKS III/III A&B)	X	X		NAVY
SM-2 BLK IV/IVA	X	X	X	NAVY
SMART CARD	X			OSD/CJCS
SMART-T	X	X		ARMY
SPS	X	X		DLA
SSN21/BSY-2	X	X	X	NAVY
STARS	X	X		DFAS
STINGER RMP	X	X	X	ARMY
STRATEGIC SEALIFT	X	X		NAVY
SUB COMMS (SCSS)	X	X		NAVY
SWPS/TRICOMS	X	X		AIR FORCE
T-45TS	X	X		NAVY
T-AGOS/SURTASS/LFA		X		NAVY
TAMPS	X	X		NAVY
TC-AIMS II	X	X		ARMY
TCS	X	X		DOD
THAAD/GBR	X	X	X	BMDO
THEATRE MISSION PLAN CNTR		X		NAVY
TITAN IV	X	X		AIR FORCE
TMIP	X	X		OSD (HA)
TOMAHAWK (SLCM)	X	X	X	NAVY
TRAC2ES	X	X		AIR FORCE
TRIDENT II MISSILE	X	X		NAVY
TUAV	X			ARMY
UHF FOLLOW-ON SATELLITE	X	X		NAVY
USMC H-1 UPGRADE	X	X	X	NAVY
V-22	X	X	X	NAVY
VERTICAL LAUNCH ASROC		X		NAVY
WIDE AREA MUNITION			X	ARMY
XM4001 40mm CANISTER CARTIDGE			X	ARMY

APPENDIX E

Referenced Documents

T&E references and sources

- *Audit Report of the DoD Inspector General -- Operational Testing Performed on Weapon Systems*, Report No. 96-107, May 1996.
- *Annual Report to the President and the Congress 1999, William S. Cohen, Secretary of Defense,* Appendix J: Government Performance and Results Act Performance Plan for FY00, Performance Goal 2.6
- *Secretary of Defense Report to Congress: Actions to Accelerate the Movement to the New Workforce Vision*, April 1, 1998
- *Statistics, Testing, and Defense Acquisition: New Approaches and Methodological Improvements*, National Research Council National Academy Press, Washington, D.C., 1998
- *Test and Evaluation Management Guide*, DSMC, August 1993, IG Report No. 96-107, "Operational Testing Performed on Weapons Systems", 6 May 1996
- DOT&E briefings and reports

APPENDIX F
Acronym Glossary
(Used in Text)

ACAT	Acquisition Category
ACTD	Advanced Concept Technology Demonstration
AOA	Analysis of Alternatives
B-LRIP	Beyond Low Rate Initial Production
CAE	Component Acquisition Executive
COEA	Cost and Operational Effectiveness Analysis
COI	Critical Operational Issue
COTS/NDI	commercial-off-the-shelf/non-developmental item
CTEIP	Central Test and Evaluation Investment Program
DAB	Defense Acquisition Board
DAWIA	Defense Acquisition Workforce Improvement Act
DIA	Defense Intelligence Agency
DoD	Department of Defense
DoD-IG	Department of Defense Inspector General
DoDD	Department of Defense Directive
DOT&E	Director, Operational Test and Evaluation
DT	developmental test
DT&E	developmental test and evaluation
DTEPI	Defense Test and Evaluation Professional Institute
FFRDC	Federally Funded Research and Development Center
IDA	Institute for Defense Analyses
IPT	Integrated Product Team
JOT&E	Joint Operational Test and Evaluation
LFT&E	Live Fire Test and Evaluation
LRIP	Low Rate Initial Production
MAISRC	Major Automated Information System Review Council
MDAP	Major Defense Acquisition Program
MRTFB	Major Range and Test Facility Base
M&S	modeling and simulation
OFA	operational field assessment
OSD	Office of the Secretary of Defense
OT	operational test
OTA	Operational Test Agency
OT&E	operational test and evaluation
RTA	Rotational Training Assignment

C

7

Section I. Organization and Management

Tab C. External Process

8. Executive – Key Interagency Relationships
9. Congressional
   a. Key Committees
      1. Testimony by The Honorable Philip E. Coyle, Before the Senate Armed Services Committee AirLand Forces Subcommittee, March 22, 2000, on Tactical Aviation
      2. Testimony by The Honorable Philip E. Coyle, Before the House Committee on Government Reform Subcommittee on National Security, Veterans Affairs, and International Relations, September 8, 2000 on National Missile Defense
   b. Major Reports to Congress
   c. Pending Legislative Issues
      1. F-22 Test and Evaluation
      2. Interim Armor Vehicle Comparison Plan
      3. Radio Frequency Integration and Testing Environment

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8

Executive - Key Interagency Relationships

National Aeronautics and Space Administration (NASA)

The Department of Defense has had working relationships with National Aeronautics and Space Administration for many years including the cooperative use of each agency's test facilities. In some areas (e.g., low speed wind tunnels), the Department of Defense is totally dependent on the National Aeronautics and Space Administration or other sources since it does not maintain test facilities in these areas.

In the 1990s, the National Aeronautics and Space Administration and the Department of Defense conducted a series of joint studies focused on improving the management, efficiency, and maintenance of various aeronautical and space facilities. A 1995-1996 study recommended the formation of six facilities alliances that would provide better coordination and joint planning activities. The six alliances were formed for major facilities in the categories of wind tunnels, aeropropulsion test facilities, rocket propulsion test facilities, space environmental simulation facilities, arc-heated test facilities, and hypervelocity ranges. The Department of Defense and the National Aeronautics and Space Administration signed memoranda of agreement for these six alliances in January 1998.

Since then, the two organizations have been working on forming a broader alliance in the area of aeronautical test facilities. In early 2000, the two organizations chartered a broader National Aeronautical Test Alliance (NATA) to provide integrated strategic management of and planning for aerodynamic, aerothermal, and aeropropulsion facilities. (attached). The National Aeronautical Test Alliance goes beyond the activities described in the earlier Memoranda of Agreement and includes a full-time joint management office with increased authority. The detailed concept of operations for the National Aeronautical Test Alliance is now being defined.

Department of Energy

Since 1996, the Director, Operational Test and Evaluation has been cooperating with the Assistant Secretary of Energy for Defense Programs on modeling and simulation activities applicable to system lethality and vulnerability and weapons stockpile stewardship.

The Department of Defense is required by Statute to conduct live fire testing to evaluate full-up, system-level lethality and vulnerability. Physical phenomena associated with threat-target interaction in system vulnerability and lethality live fire testing are difficult to simulate in three dimensions. The modeling and simulation technologies presently in use, hardware and software, are not sufficient and significant improvements are needed. As part of this initiative, the Department of Defense vulnerability community began exploiting the advanced modeling techniques used by the Department of Energy to aid in maintaining the safety, reliability, and performance of the United States nuclear weapons stockpile. This successful cooperative effort is now in its fifth year.

National Aeronautical Test Alliance
Interagency Agreement Between
The National Aeronautics and Space Administration
and
United States Department of Defense

I. Introduction

This Interagency Agreement (IAG) is entered into by the National Aeronautics and Space Administration (NASA) and the United States Department of Defense (DoD) (the "Parties") to establish a National Aeronautical Test Alliance (NATA).

II. Purpose

The purpose of the NATA is to facilitate the establishment of an integrated national strategy for management of their aeronautical test facilities. The objective of NATA is to provide a forum for DoD and NASA to consult on the integration of the management of aerodynamic, aerothermodynamic, and aeropropulsion facilities owned or operated by the United States, taking into account military, civilian, and commercial aerospace interests, to the extent permitted by law.

III. Background

In 1995, the U.S. President's National Science and Technology Council issued a report entitled, "Goals for a National Partnership in Aeronautics Research and Technology" which indicated that "newer European wind tunnels focused on aircraft development testing are generally superior to comparable U.S. facilities in overall capability." As a consequence, there has been increasing utilization of European facilities for U.S. commercial and military aircraft development testing. NASA and DoD share several concerns regarding this practice, including facilities access and data security risks. There have been a number of studies addressing these issues, *i.e., the National Facility Study (1993), the NASA/DoD Cooperation Study (1996), and the DoD Aeronautical Test Facilities Assessment Study (1997)*. In early 1998, NASA and DoD established a National Wind Tunnel Alliance (NWTA) and an Air Breathing Propulsion Test Facilities Alliance (ABPTFA), under the auspices of the Aeronautics and Astronautics Coordinating Board (AACB), to identify, study, and implement measures to strengthen the national infrastructure of aerodynamic and air breathing propulsion test facilities that support NASA and DoD missions, and the domestic aeronautics industry. NASA and DoD have now determined that the NWTA and ABPTFA approaches should be expanded upon to address the above concerns.

IV. Terms of Agreement

A. NASA and DoD agree to establish and support the NATA, as a team approach to be used as outlined in this IAG.

B. The NATA shall serve as a forum for coordinating NASA and DoD policy pertaining to such facilities and making recommendations, as appropriate, relevant to the use and management of such facilities to NASA and DoD management. Each agency agrees that it shall actively participate in the NATA on matters pertaining to such Government-owned test facilities. DoD issues will be coordinated through the Test and Evaluation Board of Directors Executive Agent prior to review by the Defense Test and Training Steering Group (DTTSG).

C. NASA and DoD further agree to provide the necessary resources to support the objectives of the NATA, consistent with applicable law. Such resources may include, but not be limited to, personnel, equipment, supplies, and facilities.

D. NASA and DoD shall individually retain their respective exclusive responsibilities and authority, direction and control over the following:

1. Real and tangible property, including equipment, located within their respective installations.

2. Oversight of NATA activities.

3. Funding for their participation on the NATA, consistent with applicable law.

4. Personnel. To the extent that personnel are assigned to work full-time on NATA-related topics, the assigning party agrees to accept input from the other Party for consideration in conducting annual performance appraisals.

V. Facilities

Designated test facilities within the purview of NATA are located at four installations within the continental United States: Ames Research Center (ARC), Arnold Engineering Development Center (AEDC), Langley Research Center (LaRC), and Glenn Research Center (GRC). The specific test facilities that fall under the managerial purview of NATA are identified by name and location in Appendix A of this IAG.

VI. Organization and Funding

The Parties agree that this IAG does not establish any new organizations and that it is not a funding document. NASA and DoD shall each provide support to the NATA from within their own agencies and shall fund their own participation on the NATA. The requirements of this IAG are subject to the availability of appropriated funds and no provision in this IAG shall be construed as a cor imitment t ɔ provide resourc(s ir violation of the Anti-Deficiency Act, 31 U.S.C. 1341 et se(|. or any ot ıer applic able statute ɔr regulation.

VII. Executive Agents

The Secretary of t ıe Air For(e or desi¡ nee sha l se ve as the DoD Executive Agent for implementation o: this agree nent with n DoD. Th: NASA Associate Administrator of Aero-Space Technolog) or designe e shall se ve as th: N ASA Executive Agent for implementation of this agreement wi hin NASA. The Ex cutive agen s shall implement the terms of this agreement, consis ent with applicable law.

VIII. Modificat ons

This IAG may be nodified b y written greeme ıt o the Parties signing below, or their designees.

IX. Terminati ɔn

This IAG may be erminated by either Party up ɔn : 0 day written notice to the other Party.

X. Effective Date and Term

This IAG become: effective on the dat : it is finally signed by both Parties and shall expire five (5) years thereafte , unless ot ıerwise te rminated in accordance with section IX. This IAG may also be renewed at the end of the appli able tenn b mutual written agreement of the Parties or their designees.

XI. Execution

National Aeronau ics and Space Admi ıistratio ı

By: ______________________ Date: Jun 5, 2000
Associate Deputy Adıninistrato

Department of De fense

By: ______________________ Date: MAY 12 2000
Deputy Se retary of Defense

Append x A

NATA Fa ilities

Facility	Location
12-Ft. Pressure W nd Tunnel	ARC
Unitary Plan Win Tunnels (11 Ft., 9x'' Ft., 8x'' Ft)	ARC
National Full Scal Aerodyn mic Com lex (40 x80 Ft., 80x 120 Ft.)	ARC
National Transoni Facility	LaRC
14x22 Ft. Wind Ti nnel	LaRC
Transonic Dynam cs Tunnel	LaRC
Unitary Pan Wind Tunnel (B th test se tions)	LaRC
16 Ft. Transonic T nnel	LaRC
20 Ft. Vertical Spi Tunnel	LaRC
20 In. Supersonic Vind Tunr el	LaRC
Low Turbulence P essure Tu nel	LaRC
0.3 Meter Cryoger ic Tunr el	LaRC
8 Ft. High Temper ture Tunn l	LaRC
20 In. M6 Hypersc nic Turne	LaRC
20 In. M6 CF4 Tu nel	LaRC
31 In. M10 Tunnel and 5 In. M6 HTT	LaRC
22 In. M20 Hypers onic Tunn l	LaRC
Icing Research Tu nel	GRC
8x6/9x15 Tunnels	GRC
Unitary Plan Tunn l (10x10 Supersonic)	GRC
Test Cells (PSL-3, PSL-4, and ECRL-2 3)	GRC
Hypersonic Test F cility	GRC
16T/16S	AEDC
4T	AEDC
Aerodynamic Prop ilsion Test Unit (AP TU)	AEDC
Test Cells C-1 and C-2	AEDC
Test Cells T-1, T-2 T-4 and T-5	AEDC
Test Cells J-1, J-2	AEDC
Test Cells T-11, T-12, SL-1, SL-2	AEDC
Von Karman Facili ies	AEDC
Tunnel 9 Nitrogen	AEDC

Opening Statement by

The Honorable Philip E. Coyle

Director, Operational Test and Evaluation

Before The

Senate Armed Services Committee

AirLand Forces Subcommittee

Tactical Aviation

March 22, 2000

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~~SASC - March 22, 2000~~

INTRODUCTION

Mr. Chairman, members of the Subcommittee. I appreciate the opportunity to appear before you to discuss the testing and evaluation programs for the F/A-18E/F, the F-22, and the Joint Strike Fighter. This is my third appearance before this subcommittee, and I very much appreciate your commitment to demonstrated performance through realistic test and evaluation. This commitment has been expressed in your statements and comments in these hearings, by the time you have devoted to these issues, and by the bipartisan approach you have taken with respect to achieving the best military capability for our warfighters. I look forward to bringing you up to date on our views of the current status of these programs.

F/A-18E/F SUPER HORNET

I will begin with the F/A-18E/F. Last year I told this Subcommittee that in the F/A-18E/F the Navy was getting the aircraft it wanted. Six months of intense operational testing this year has confirmed that judgment. The Navy is getting an aircraft that in most respects is substantially better than the F/A-18C/D. A side-by-side comparison of the two aircraft is shown on the charts here at the easel, and also at the back of this section of my full, prepared statement. The F/A-18E/F is superior in overall operational performance, flexibility, and survivability as a fighter/attack aircraft. In addition, F/A-18E/F can perform missions that are not available in the F/A-18C/D. I am referring to the ability to perform as a refueling tanker and the ability to replace the EA-6B electronic warfare aircraft -- a need that has been well documented by this Subcommittee.

Testing often reveals new problems, but we did not experience anything that was unexpected during OPEVAL. Results were consistent with the previous Operational Test periods we reported last year. This consistency is indicative of the extensive testing prior to IOT&E. The F/A-18E/F has accumulated nearly 8,000 hours of developmental and operational flight test to date, over 3,500 more than last year. This testing identified strengths that will be utilized by the fleet and deficiencies that will be corrected or mitigated by the program manager. The Navy and the F/A-18 E/F Program Manager continue to take an open and balanced approach in this regard.

AREAS OF SIGNIFICANT ENHANCEMENT

The F/A-18E/F has notable attributes. These include tactical flexibility, the ability to carry more weapons than the F/A-18C/D, improved survivability over the C/D, improved carrier landing and takeoff performance, remarkable weapon delivery accuracy, air combat maneuvering capability, and increased bring-back.

Bring back is the ability to land upon the carrier with unexpended ordnance. Typically, the bring-back of an aircraft is limited by the maximum loads that the aircraft can sustain on a repeated basis. During operational missions, it is common that self-protect weapons are not expended. Similarly, weapons loaded for contingency operations are often not expended and with the preponderance of operations other than war, the likelihood of this happening has increased. With the increased use of expensive self-protect and "smart" weapons, routine jettisoning of unexpended ordnance in order to reduce the landing weight below bring-back constraints is not affordable. Over the lifetime of the aircraft, this could amount to millions of dollars.

The F/A-18E has an increased bring-back payload of about 3,400 lbs. as compared to the Lot XIX F/A-18C. The increased payload allowed by this bring-back can be used as increased fuel, increased self-protection loads, increased offensive weapon load, or any combination thereof. For example, the self-protect capability of the F/A-18E could be increased by carrying two to three additional AMRAAM and/or one to two more HARM over what the F/A-18C/D could carry. The F/A-18F has an increased bring-back of approximately 2,400 lbs. as compared to a Lot XIX F/A-18C.

When serving as a tanker, the F/A-18E/F can match the altitude and speed performance of the carrier's other strike and attack aircraft, refueling other aircraft that return to the carrier in a low fuel state, thereby extending their flight time to allow an orderly recovery of aircraft within the established carrier cycle time for flight operations. This capability also helps to take some of the burden off the aging S-3 tankers, another need well documented by this Subcommittee.

AREAS OF CONCERN AND RECOMMENDATIONS

In my full, prepared testimony I also describe areas of concern for the F/A-18E/F. These include the wear and tear on carried weapons due to under-wing vibration, and low top speed in relation to current, state-of-the-art fighters, especially at higher altitudes. Some areas of concern are common to the C/D including deficiencies with the targeting forward looking infrared sensor and performance of the AN/APG-73 radar.

I also recommend improvements to the F/A-18E/F. These include a new, active electronically scanned radar, continued effort to lessen under-wing vibration, addition of the Joint Helmet Mounted Cueing system and the AIM-9X, an advanced FLIR, positive ID capability and decoupled front and rear cockpits. We also recommend that the program complete its battle damage repair program.

One of the principal justifications for the F/A-18E/F is its capacity for growth to correct problems inherent in some existing key subsystems that are common to the F/A-18C/D. The F/A-18E/F was designed with these improvements in mind. It is essential that these Navy roadmap improvements be rapidly developed, tested, and incorporated.

Until these improvements are made, the F/A-18E/F will not fully realize its potential and the operational capabilities for which it was envisioned.

F-22 RAPTOR

The F-22 Raptor is now in Engineering and Manufacturing Development (EMD) to replace the F-15 as this country's air dominance fighter. The F-22 has been in the EMD phase since 1991 and has completed almost 15 percent (about 600 hours) of the planned flight testing, approximately 400 hours more than when I testified before this committee last year. The F-22 design emphasizes stealth, supercruise, and integrated avionics to provide major improvements in effectiveness and survivability.

Initially, the F-22 program had planned a Low Rate Initial Production (LRIP) commitment in December 1999. However, Congress delayed the LRIP decision until December 2000 when more test data will be available. The Congress also wisely required some flight testing of Block 3.0 software, which includes a fused architecture for radar; Communication, Navigation and Interrogation (CNI); and Electronic Warfare (EW).

F-22 test results thus far are quite positive. The flight test envelope now extends above 50,000 feet, in excess of Mach 1.5, and with excursions from minus 40 degrees to greater than 60 degrees angle of attack, and without any major impediments, except for fin buffeting in the vertical tails. Two Key Performance Parameters—supercruise and internal missiles payload—have been demonstrated this year. Performance of the F119 engine has been outstanding throughout the allowable flight envelope. Several problems have been identified in testing to date, but they are being addressed and corrected.

Operational Assessment

In support of the December 1999 Defense Acquisition Executive (DAE) review, the Air Force Operational Test and Evaluation Center (AFOTEC) conducted an early Operational Assessment (OA). Although only limited flight test data were available, aircraft component design problems, potential maintainability concerns, and programmatic issues were identified and are described in my complete statement. The

Air Combat Command (ACC) and the F-22 System Program Office (SPO) are taking action to resolve them.

Flight Test Program Progress

The principal issue that I have with the test program is that it is proceeding much more slowly than in previous aircraft development programs, and even these lagging testing schedules continue to slip over time. Continuing slips in flight test aircraft deliveries reduce the aircraft-months available for testing. The issue is shrinking flight test operating months in the development program prior to the start of dedicated Initial Operational Test and Evaluation (IOT&E). Over the past three years we have lost 49 flight test months that should have been available for flight testing.

To accommodate lost test time and reduce test costs, the total flight test hours have been reduced from 4,337 hours to 3,757 hours. This is a 13 percent reduction due mostly to deferral of the requirement for external combat configuration testing and hoped-for avionics test efficiencies. To squeeze these 3,757 test hours into the available flight test time will require test flying at an increased rate.

Increasingly optimistic proposed development test schedules, schedules that have not been met to date, threaten the start of dedicated IOT&E in August 2002. Nevertheless, flight test program progress should improve significantly this year with additional test aircraft. Four new flight test aircraft are to be delivered this year.

My full, prepared statement details issues with static and fatigue testing, with avionics testing, with weapons testing, and with low observability (LO) testing and maintenance. Of special concern is the potential for LO maintainability problems to adversely impact the suitability evaluation as they did in the B-2 program.

The current test program does not include any operational testing under adverse environmental conditions, especially in rain, lightning, and cold weather. Adverse environments will be simulated in the climatic test chamber at Eglin AFB, FL, but this is basically a static test (although engines, flight controls and landing gear will be operated). All planned EMD flight testing, including IOT&E, is to be based at Edwards AFB, CA, and Nellis AFB, NV, where rain and high humidity are infrequent.

My full statement also describes the status of the live fire testing work. We are concerned that a decision by the Air Force to remove some fire suppression systems, and other factors, have increased the aircraft's probability of being killed given a hit. Estimates are now that the vulnerable area is some 30 percent higher than the F-22 specification calls for.

Cost Cap Concerns

While a cost cap may have been useful earlier in the F-22 program, it now appears to be harming the test program. At this point, the test budget is essentially the only uncommitted part of the EMD budget. Changes to reduce costs and stay within the cost cap almost always result in less testing and increased development risks. Any further reduction of testing tasks increases the risk of not being ready to start or successfully complete IOT&E. A specific current example is the inability to add engineers to maintain the static and fatigue testing schedules.

Another testing deferral, proposed as a cost-saving measure, is the external combat carriage of AIM-120 missiles and external fuel tanks. Current plans are to defer this testing outside of the F-22 EMD program budget to the SEEK EAGLE program at a later undefined period. This is also a deferral of an ORD-required capability outside of the F-22 development program.

Recommendations

A most helpful congressional action would be to remove the EMD cost cap and institute an alternative method for controlling the F-22 program cost. One suggested alternative is to retain the total program cost cap, adjusted for inflation, while removing the EMD cost cap. This would achieve the overall program cost control objective, but allow the ORD-defined combat capabilities to be effectively and efficiently demonstrated during EMD prior to dedicated IOT&E. This would certainly require an extension of EMD, probably a delay of up to one year of IOT&E (from 2002 to 2003) and Milestone III. I would support the continued LRIP proposed ramp-up rates (long lead of 16 aircraft in FY01 and long lead of 24 aircraft in FY02) to preserve the industrial base and negotiated target price commitment curves.

Statement by
The Honorable Philip E. Coyle
Director, Operational Test and Evaluation

Before The
Senate Armed Services Committee
AirLand Forces Subcommittee

Tactical Aviation

March 22, 2000

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INTRODUCTION

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F/A-18E/F SUPER HORNET

With your permission I will begin with the F/A-18E/F. Last year, in my testimony before this subcommittee, I said that in the F/A-18E/F the Navy was getting the aircraft it wanted. Six months of intense operational testing this year has confirmed that judgement. In addition, the Navy is getting an aircraft that in most respects is substantially better than the F/A-18C/D. A side-by-side comparison of the two aircraft is shown on the charts at the back of this section. In particular, the F/A-18E/F is superior in overall operational performance, flexibility, and survivability as a fighter/attack aircraft. In addition, I would like to call your attention to the missions that the F/A-18E/F can perform that are not available in the F/A-18C/D. Here I am referring to the ability to perform as a refueling tanker and the ability to replace the EA-6B electronic warfare aircraft. The need for an aircraft to take the place of the EA-6B has been well documented by this Committee.

The F/A-18 E/F program has just completed a six month formal Operational Evaluation (OPEVAL) by the Navy. The Navy report was released last month and judged the aircraft operationally effective and operationally suitable. Our independent assessment and Live Fire Testing report will be forwarded to Congress before the end of the month. Testing often reveals new problems, but we did not experience anything that was unexpected during OPEVAL. Results were consistent with the previous Operational Test periods, which we reported last year. This consistency is indicative of the extensive testing prior to IOT&E. The comprehensive test effort to date has resulted in the F/A-18E/F being a mature program. The F/A-18E/F has accumulated nearly 8,000 hours of developmental and operational flight test to date, over 3,500 more than last year. This testing identified strengths that will be utilized by the fleet and deficiencies that will be corrected or mitigated by the program manager. The Navy continues to take an open and balanced approach in this regard.

BACKGROUND

The F/A-18E/F Super Hornet, like the F/A-18C/D before it, is a multi-mission strike fighter combining the capabilities of a fighter with those of an attack aircraft. Recognized deficiencies with the F/A-18C/D gave rise in 1991 to Navy Operational Requirements (OR) for an F/A-18E/F Upgrade. This document served as the basis for multiple acquisition reviews, which resulted in approval to enter EMD for the F/A-18E/F. The OR stated that the number one priority was increased internal fuel. In addition, it identified three principal improvements over the existing F/A-18C/D needed in the F/A-18E/F Upgrade:

- Increased mission radius/payload flexibility.
- Increased carrier recovery payload.
- Improved survivability/reduced vulnerability.

The OR also identified required improvements in several other areas. These included combat performance (turn rate, climb rate, and acceleration as compared to the Lot XII F/A-18C/D); and growth capability (for general avionics, electrical, environmental control system, flight control, and hydromechanical systems) to support future roadmap improvements.

While the 1991 OR required both a single-seat (F/A-18E) and a two-seat version (F/A-18F), originally the two-seat version was envisioned to serve as a trainer. Subsequently, the Navy directed that the F/A-18F would become the inventory replacement for the F-14. A revised Operational Requirements Document (ORD) was promulgated in 1997. This ORD specifically directed that the F/A-18E/F enter service in two increments. Specifically, the F/A-18F would be initially fielded as a baseline two-seat aircraft (comparable to a Lot XII F/A-18D), and then further upgraded to incorporate decoupled or independent cockpits. This would allow the aircrew to conduct near simultaneous air-to-air and air-to-ground missions.

TEST AND EVALUATION ACTIVITY

OPEVAL of the F/A-18E/F was conducted from May through November 1999. Air Test and Evaluation Squadron Nine (VX-9), a component of the Navy's Operational Test and Evaluation Force (COPTEVFOR), conducted the testing.

OPEVAL was conducted in accordance with the Chief of Naval Operations (CNO) Project Test and Evaluation Master Plan (TEMP) 20[illegible]-04 for the F/A-18E/F. The TEMP was reviewed and approved by DOT&E. The test plan provided for approximately 700 F/A-18E/F sorties and 445 support sorties from other aircraft (F/A-18C/D and simulated adversary aircraft such as F-16, etc). The test team included 14 primary pilots and nine Weapon System Operators. The test team had a variety of experience levels, both in type aircraft and total flight hours. This expertise spanned almost all of the tactical combat aircraft the Navy has operated over the last 20 years. These included S3, A6, A7, F14, and all variants of the F/A-18.

OPEVAL was conducted using a total of seven aircraft delivered under the low rate initial production (LRIP) Lot 1 contract. These OPEVAL aircraft consisted of three F/A-18E (single-seat) aircraft and four F/A-18F (two-seat) aircraft. Not all weapons planned for eventual employment from the F/A-18E/F were cleared for use during OPEVAL. A large number of payload configurations comprising 29 distinct load-outs were employed for the test. Configuration changes and improvements in future F/A-18E/F production lots are expected. The Lot 1 aircraft and the payloads tested in OPEVAL were representative of the operational configurations to be fielded.

The principal testing location during OPEVAL was the Naval Air Weapons Center-Weapons Division at China Lake, CA. In addition to the testing at China Lake, three extended periods of detached operations were conducted.

1. **IOT&E Air-to-Ground Phase** - The evaluation began on May 27, 1999, at China Lake, CA. Flights in support of Air-to-Ground Weapons, Air-to-Air Sensors, Air Combat Maneuvering, Defense Suppression, and Survivability were conducted. During this phase, several items of significance were accomplished. There were multiple ordnance flights dropping a variety of weapons such as Mk 82 (500 lb.), Mk 83 (1000 lb.), and CBUs (cluster bombs). Also, for the first time since the A-6 aircraft, a new organic "by design" tanking capability was demonstrated by the F/A-18E/F during day and night operations. Maintenance personnel became acquainted with a new computerized portable maintenance system associated with this aircraft. In support of the subsequent simulated air combat phase, each aircrew received instruction and flights focusing on high angle of attack maneuvering and general confidence building events. These included air-to-air weapons performance verification and several range profiles to verify the flight performance data base.

2. **Air Combat Phase** - This phase took place at NAS Key West, FL, from June 14-25, 1999. During this detachment, portions of Fighter Escort, Combat Air Patrol, Air Combat Maneuvering, Tactics, and Survivability were assessed. Scenarios generally included up to four Super Hornets versus an equal or larger number of opponents. Mixed formations of F/A-18C's and Super Hornets were also flown to compare the two aircraft in similar scenarios. The 185th Fighter Squadron Air National Guard from Sioux City, IA, provided adversary support flying F-16Cs. These F-16Cs emulated the latest generation MiG-29 threat aircraft and flew realistic threat tactics.

3. **Carrier Operations** - The Super Hornet operated from the deck of the USS JOHN C. STENNIS, CVN 74, near the southern California coast, from July 12-28, 1999. The aircraft was integrated into Carrier Air Wing NINE and conducted simulated alert launches, long-range strikes and tanking among many other tasks. Initially, aircraft were deployed from NAS China Lake to USS JOHN C. STENNIS. This allowed the OPEVAL pilots numerous opportunities to conduct carrier landings and catapult launches in the F/A-18E/F in both daylight and night conditions. The aircraft then remained aboard for integration into the normal ship air plan.

4. **Combined/Joint Operations** - The Super Hornet operated from Nellis AFB, NV, participating in a Combined/Joint Exercise Red Flag from August 16-27, 1999. Red Flag is an intense training exercise involving Air Force, Navy, Marine Corps and multinational assets. A realistic air campaign is conducted to attack representative threat targets with inert

and live munitions. Adversary aircraft and multiple surface-to-air threat systems oppose these assets. The exercise was conducted on an instrumented range. All parameters were recorded and played back for after action review.

5. **Survivability, Air-to-Air Missile and Smart Weapon Usage** - During September through November 1999, operational testing at China Lake focused upon survivability flights. These also included the delivery of air-to-air missiles and smart weapons. Survivability flights involved the conduct of operationally representative strike missions. The targets and/or en route flight paths were defended by a variety of actual and surrogate threat Surface-to-Air Missile systems. Air-to-air gunnery and air-to-ground sensor flights rounded out the China Lake operational testing activity.

EFFECTIVENESS TESTING

Effectiveness testing during OPEVAL exercised the F/A-18E/F in representative operating environments. The conduct of realistic mission scenarios encompassed all of the primary missions of the F/A-18E/F, namely: Interdiction; War-At-Sea; Fighter Escort; Combat Air Patrol; Deck Launched Interceptor; Air Combat Maneuvering; Defense Suppression; Close Air Support; Forward Air Controller (Airborne); and Tanker. The reconnaissance mission was not tested during OPEVAL. In accordance with the approved TEMP, this mission is planned to be tested during Follow-On Operational Test and Evaluation.

The following addresses specific areas of F/A-18E/F tested performance which, in the opinion of DOT&E have a significant impact, positive or negative, upon its operational mission effectiveness.

AREAS OF SIGNIFICANT ENHANCEMENT

Tactical Flexibility - The attributes of the F/A-18E/F, as confirmed by testing, contribute significant tactical flexibility for the planning and execution of a wide variety of missions. Tactical flexibility extends not only to the planning and execution of combat missions but also to the integration of these combat missions into the support capability of the carrier. Most notable in this regard are the fuel and fuel transfer capabilities of the F/A-18E/F force. In some circumstances, the increased fuel load of the F/A-18E/F will allow the air wing commander flexibility in recovering aircraft within the carrier operating cycle.

Payload flexibility - Payload flexibility is a major element of tactical flexibility. Increasing the options available to the F/A-18E/F to plan and execute missions increases mission effectiveness and aircraft survivability. Along with the increased payload of the F/A-18E/F, this aircraft also has two more weapon stations than the F/A-18C/D. This combination of increased weapon stations and payload-carrying capability may be used in a variety of ways to increase mission effectiveness. Payload advantages allow the F/A-18E/F to achieve the desired probability of destruction with fewer sorties in the threat area, or carry additional self-protect weapons. As an example, a Super Hornet could carry several precision guided munitions, a targeting pod to self-designate targets, and air-to-air and air-to-ground self-protect missiles.

Carrier Performance - Aircraft performance operating on and off the aircraft carrier was remarkable. The approach speeds are slower than the F/A-18C/D in similar configurations. Quick throttle response, combined with aircraft stability and low approach speeds, resulted in excellent glide slope control, an important safety characteristic for carrier operations. The aircraft also demonstrated a high tolerance for hard CV landings. The immediate power response and power available also gives the aircraft exceptional wave-off characteristics.

The aircraft has increased bring-back over its predecessor. This is the ability to land on the carrier with unexpended ordnance. Typically, the bring-back of an aircraft is limited by the maximum loads; i.e., kinetic energy that the aircraft can sustain on a repeated basis. During operational missions, it is common that self-protect weapons are not expended. Similarly, weapons loaded for contingency operations are often not expended, and with the preponderance of operations other than war, the likelihood of this happening has increased. With the increased use of expensive self-protect and "smart" weapons, routine jettisoning of unexpended ordnance in order to reduce the landing weight below bring-back constraints is not affordable. Over the lifetime of the aircraft this could amount to millions of dollars. In the past, to avoid this problem, the fleet has flown contingency operations with fewer weapons than the aircraft could carry. This exposes pilots to added risk. F/A-18E/F aircrew will not face this problem.

Due to the slower landing speed and more robust structure of the F/A-18E/F, the F/A-18E increases the allowable bring-back payload by about ,400 lbs., as compared to the Lot XIX F/A-18C. The increased payload allowed by this bring-back can be used as increased fuel, increased self-protection loads, increased offensive weapon load, or any combination thereof. For example, the self-protect capability of the F/A-18E could be increased by carrying two to three additional AMRAAM and/or one to two more HARM over what the F/A-18C/D could carry. The F/A-18F has an increased bring-back of approximately 2,400 lbs., as compared to a Lot XIX F/A-18C.

Tanker Capability - The capability of the F/A-18E/F to conduct a tanker mission offers great flexibility for carrier operations, both by providing a tanker to refuel aircraft en route or returning from their assigned missions and by adding flexibility to recovery operations. Since the F/A-18E/F tanker can match the altitude and speed performance of the carrier's other strike and attack aircraft, it can keep up with the mission package. This provides great flexibility in planning and executing long-range missions, including the support of inevitable changes to the planning. By serving as a recovery tanker, the F/A-18E/F tanker, positioned near the carrier, can refuel aircraft that return to the carrier in a low fuel state, thereby extending their flight time to allow an orderly recovery of aircraft within the established carrier cycle time for flight operations.

Earlier versions of the F/A-18 are not capable of performing this tanker mission. Accordingly, carrier operations at long-range are currently limited by the scarce availability of existing S-3 tankers. The introduction of the F/A-18E/F, with its inherent ability to function as a tanker, will add major flexibility to the carrier air wing, enhancing both its effectiveness and its safety. Following carrier operations aboard the USS JOHN C. STENNIS, all flight operations personnel interviewed by DOT&E personnel reported very favorable opinions as to the affect that F/A-18E/F will have on overall carrier operations.

Survivability Enhancements - Survivability improvements for F/A-18E/F include reduced vulnerability design through structural improvements and incorporation of an active fire suppression system, and reduced susceptibility due to the incorporation of the ALE-50 towed decoy, the ALR-67 V(3), a reduced radar cross-section, and increased numbers of expendable countermeasures. Changes in cockpit display options also contribute to survivability improvements by creating a cockpit environment conducive to increased situational awareness. In addition, the F/A-18E/F gains considerable benefit from the additional fuel it carries. This can be translated into routing alternatives or use of lower altitudes to avoid threat areas, or into use of afterburner to maintain energy while maneuvering during a threat engagement.

Air Combat Maneuvering Handling Qualities - The F/A-18E/F resists departure even under aggressive maneuvering, at high angles of attack. Testing of intentionally induced departures has shown quick and predictable recovery once the controls were released, with the nose below the horizon, and airspeed increased. Pilot confidence engendered by these flight characteristics is likely to provide significant benefits to the effectiveness of this aircraft in missions demanding aggressive maneuvering; e.g., close-in air-to-air combat or maneuvering versus missile shots.

OPEVAL also confirmed another associated enhancing characteristic—positive nose pointing. The F/A-18E/F has unusual agility and control of the pitch axis, allowing the pilot to point the nose and take the first shot on most engagements. This nose pointing capability impressed the pilots of adversary aircraft during operational tests of Air Combat Maneuvering.

Weapon Delivery Accuracy - During OT-IIB and OPEVAL, many sorties were conducted to evaluate the bombing accuracy of the F/A-18E/F. These sorties executed weapons deliveries using operationally realistic delivery profiles in the conduct of Interdiction, Close Air Support, and Forward Air Controller (Airborne) Missions. The deliveries included large numbers of general-purpose bombs from a large number of delivery profiles involving varying altitudes and dive angles. In addition, a number of deliveries of laser guided bombs were conducted.

The delivery accuracy of these weapons was excellent, exceeding the ORD accuracy requirements. The tested results are equal to or better than those experienced from the F/A-18C using the current operational flight programs (OFP 11C and OFP 13C).

AREAS OF CONCERN

External Stores - Although an unusually large number of store configurations were cleared for carriage, OPEVAL was constrained to 29 specific configurations. This compares to two store configurations for the FA-18A at the time of its development. In addition, the Stores Limitation Manual governing OPEVAL imposed several carriage, release, and aircraft restrictions associated with the 29 cleared configurations. Air-to-air missiles could not be employed if they were carried on a store station adjacent to air-to-ground ordnance. Numerous munitions could be carried and/or employed only from selected store stations, although the plan is to clear these munitions from other stations as well. Consequently, many of the load advantages planned for the F/A-18E/F were not demonstrated during OPEVAL. Nonetheless, the 29 configurations cleared for OPEVAL did include some loads beyond the capability of the F/A-18C.

Aero-acoustic Under-Wing Environment - Operational testing included the carriage of and the actual release or firing of several key weapons (AIM-120, AIM-7, AIM-9, Maverick, HARM, SLAM, Laser Guided Bombs, Mines, Mk 80 series general-purpose bombs, etc). However, testing has revealed that the noise and vibration environment under the wing of the F/A-18E/F is more severe than that of the F/A-18C/D. Accordingly, several stores have experienced some form of damage such as fins or support structure cracking. Some of the stores cleared for carriage during OPEVAL required additional inspections or maintenance. The F/A-18E/F program office and the developing contractor have conducted extensive activities to identify the root causes of the increased noise and vibration environment and to develop "fixes" to ameliorate the effect of this environment.

Aerodynamic Performance and Energy Maneuverability - The only Key Performance Parameter (KPP) related to energy maneuverability of the F/A-18E/F is a single value of specific excess power, Ps, specified at .9 Mach number and 10,000 ft MSL altitude. The specified value is Ps=600ft/sec. This value is low by current fighter state of the art and reflects the modest energy performance demanded by the Navy for the Super Hornet. The OPEVAL measured value is 619 ft/sec. The consequences of low specific excess power in comparison to the threat are poor climb rates, poor sustained turn capability, and a low maximum speed. Of greatest tactical significance is the lower maximum speed of the F/A-18E/F since this precludes the ability to avoid or disengage from aerial combat. In this regard, the F/A-18E/F is only marginally inferior to the F/A-18C/D, whose specific excess power is also considerably inferior to that of the primary threat, the MiG-29.

At subsonic speeds the climb and turn rates and the acceleration performance of the F/A-18E/F are comparable to those of both the F/A-18C/D and the primary threat. At transonic and supersonic speeds, the F/A-18E/F will experience large decelerations (airspeed bleed-off) during a maneuvering fight. Maneuvering air combat in the transonic/supersonic portion of the flight envelope are not of high tactical relevancy since any maneuvering engagement rapidly migrates to the so-called "corner" of the flight envelopes (typically 0.6 Mach at 15,000 feet MSL). In this regard, the F/A-18E/F has little or no disadvantage. In fact, given that the unloaded subsonic acceleration performance of the F/A-18E/F is excellent, the higher bleed rates experienced by the F/A-18E/F may be considered an advantage since this facilitates reaching the corner speed faster and translates to positive nose pointing in a dogfight. The principal consequence of this limitation as it bears on survivability is the inability of F/A-18E/F to avoid or disengage ("bugout") from a close-in fight. In this regard, the F/A-18E/F is marginally inferior to the Lot XIX C/D and significantly inferior to the MiG-29. Many fighter aircrews and air warfare analysts believe that, with modern aircraft and missiles, the probability of a close-in fight requiring a disengagement is small. Within this context, the reduced energy maneuverability of the F/A-18E/F is not viewed as a major detriment to its overall operational effectiveness. As the F/A-18E/F incorporates planned improvements, specifically, the Joint Helmet Mounted Cueing System and the AIM-9X missile, these differences in energy-maneuverability will pose even less concern to operational effectiveness in the air-to-air role.

Counterbalancing the poor energy-maneuverability performance of the F/A-18E/F in the air-to-air arena is its extraordinary departure resistance. The F/A-18E/F's flight control software and complex flight control surfaces have resulted in an aircraft that is almost immune to unintentional departures from controlled flight. The impact of this to the tactical arena is likely to be significant. During a close-in air-to-air engagement, maintaining aircraft control typically consumes a large fraction of a pilot's concentration. By removing this burden from the average pilot, the pilot of an F/A-18E/F can concentrate fully on winning the fight rather than "flying" the airplane. Since most tactical pilots are by definition "average," this property alone may improve the overall effectiveness of the F/A-18E/F fleet significantly over that of its predecessor, or for that matter, over most tactical aircraft in use today. Future tactics development for the F/A-18E/F are likely to capitalize on this property to arrive at a highly capable close-in fighter.

Buffet - During OT-IIB and the OPEVAL, pilots reported two forms of buffet. The first is only experienced in 1G transonic flight and is described by pilots as "driving on a gravel road." The other occurs at a variety of altitudes and configurations and is associated with high angles of attack. While such buffet does not interfere with the mission, some pilots may find that the frequent occurrence of light to moderate buffet causes pilot fatigue. OPEVAL pilots found that they were able to avoid the buffet by holding at lower altitudes or at a slightly higher airspeed.

Wing Drop / Lateral Activity - Early during the developmental testing of the EMD design, pilots reported experiencing abrupt, uncommanded rolls. The phenomenon was nicknamed "wing drop," and gained considerable attention in the press. Wing drop occurred as flow separated unevenly from one wing to the other creating large rolling moments. The program office and the developing contractor designed and tested numerous configuration changes intended to prevent the uneven flow separation. The final design added a porous fairing over the wing fold area of the wing. Operational testing (OT-IIB) conducted with a prototype version of the porous fairing verified that this design change was successful in eliminating the wing drop.

The LRIP aircraft used in OPEVAL incorporated the production version of the porous fairing over the wing fold area. During the OPEVAL, some minor "residual lateral activity" has been observed, but its magnitude has been assessed as insignificant by the aircrews. This residual lateral activity is characterized by changes in bank angle that are small (<10 degrees) and very low roll rates (<10 degrees/sec). It is unclear if this "residual lateral activity" results from the same causes that produced "wing drop." These effects are of such different scope and severity that all of the OPEVAL pilots have commented that it is virtually unnoticeable during tactical operations

Lack of Decoupled Cockpits in the Two-Seat F/A-18F. The revised ORD for the F/A-18E/F specifically states that the initial version of the two-seat F/A-18E/F is to have "coupled" cockpits. Decoupled cockpits; e.g., allowing the pilot to concentrate on the air-to-air picture while the back-seater addresses an air-to-ground mission, is purposefully delayed until a future improvement to the F/A-18F. While the production configuration of the F/A-18F, tested during OPEVAL, meets the expectation of the CRD, it is apparent that the full potential of the F/A-18F will not be realized until the two cockpits are decoupled.

AREAS OF COMMON CONCERN TO F/A-18C/D

Many key subsystems incorporated into the F/A-18E/F, as tested in OPEVAL, were retained from the earlier F/A-18C/D. Some of these subsystems introduce constraints that limit the effectiveness of both the F/A-18C/D and F/A-18E/F. These subsystems with known deficiencies include: the Targeting Forward-Looking Infrared (TGTFLIR) sensor; the AN/APG-73 radar; and the Cockpit Video Recording System (CVRS).

Targeting Forward Looking Infrared Sensor - Known deficiencies of the TGTFLIR include limited resolution, inadequate magnification, insufficient stability, and poor reliability. Due to the limited resolution, F/A-18 aircrew are frequently unable to classify or identify targets at ranges that support the full capabilities of inventory weapons. The limited target magnification capabilities of the TGTFLIR prevent the employment of maximum range capabilities of inventory laser guided bombs against a full range of viable targets. Frequent target "break locks" occur as the F/A-18 pulls g's while pulling off of the target, resulting in loss of guidance to laser guided bombs and the inability to assess bomb hits/damage. All of these problems were seen during OPEVAL.

AN/APG-73 Radar - Previous testing of this radar conducted under the AN/APG-73 Radar Upgrade Program determined that this radar is largely ineffective in the presence of electronic attack.

Positive Identification (PID) Capability - During OPEVAL, the F/A-18E/F lacked a PID capability.

AREAS OF PRIOR CONCERN RESOLVED IN OPEVAL

ALE-50 Burnoff - The severing of the ALE-50 tow cable due to the use of afterburner and/or maneuvering observed during OT-IIA has been somewhat ameliorated with the use of a new towline material. Nonetheless, the ALE-50 maneuvering envelope remains restricted. Exceeding established limits at specific power settings resulted in degradation and possible separation of the ALE-50. During OPEVAL, about ten percent of the deployed ALE-50 towed decoys degraded and/or separated from the F/A-18E/F after pilots inadvertently exceeded the envelope during tactical maneuvering. However, the pilots did find it a valuable survivability tool.

Inability to Add Energy by Rapidly Converting from Nose High to Nose Low - The significant problem of very poor linear acceleration from minimal airspeeds, seen in OT-IIB, has been corrected by modification of the flight control software. All pilots during OPEVAL have reported excellent acceleration from minimal airspeeds.

VALIDITY OF KEY PERFORMANCE PARAMETERS (KPPs)

Range Requirements - The F/A-18E/F has met or exceeded all required thresholds. Throughout its history, the F/A-18A/B/C/D has received praise for its versatility and general performance. However, it has been criticized for its limited range and payload, restricting the ability of the carrier force to project power at extended ranges. Shorter cycle times and near exclusive use of scarce tanker assets is an undesirable workaround frequently used.

The ORD establishes three KPPs that address the required range capability of the F/A-18E/F.

Mission	Objective Range F/A-18E/F	Threshold Range F/A-18E/F	Criteria Met
Fighter Escort Mission Radius	425 nm	410 nm	Yes
Interdiction Mission Radius • w/2 – 480 gallon external tanks: • w/3 – 480 gallon external tanks:	 400 nm 450 nm	 390 nm 430 nm	 Yes

Associated with these KPP range requirements, as established by the ORD, are specific flight profiles. There are the Fighter Escort Mission and Interdiction Mission flight profiles established by the F/A-18E/F Specification. These profiles are well defined in the system specification and are documented in the F/A-18E/F TEMP.

While the *System Specification* defines specific profiles to be used as contractual range requirements and KPPs, these Specification mission profiles are not representative of the actual aircraft configurations or flight profiles that would be used in combat operations. Accordingly, the CNO defined a set of operationally representative flight profiles to be assessed in the OPEVAL. Those flight profiles and the associated range requirements were provided by the CNO and incorporated into the approved TEMP and are well-defined.

OT&E of Range Performance - In order to increase the efficiency of flight testing, the Navy and Boeing developed a methodology to assess range performance using a Flight Performance Data Base. This data base was constructed based on theoretical considerations, wind tunnel and engine-run data, and developmental flight test data. The data base represents a table that provides a value for specific range under any combination of aircraft weight and drag indexes in the flight regime. Successful use of the Flight Performance Data Base is dependent on the accuracy of the calibration data points and the number of the calibration points within the flight envelope. During the operational evaluation, the operational testers of VX-9 independently checked the data base through operational flight test results. The process was closely observed and carefully reviewed by DOT&E.

Calibration of the *Performance Data Base* was conducted by VX-9 pilots using a flight "segment" approach by which fuel consumption data was collected in small, dedicated portions of many flights under various aircraft configurations, gross weights, and flight loads experienced during the conduct of the operational evaluation. Deviations between actual and predicted fuel use were insignificant, being normally distributed with an average deviation of a few percent. Also, for the dominant segments (i.e., cruise/climb) the deviations were less than one percent.

Based upon the results of the Flight Performance Data Base calibration by the operational evaluation aircrews the accuracy of the data base is considered valid by DOT&E within the limits of precision available. The Flight Performance Data Base has been used to analytically compute the range performance of the F/A-18E/F in the mission profiles defined by the ORD and those defined by CNO.

Of the twelve mission profiles, nine were CNO-defined operational missions and were computed using a 4000 lb. fuel reserve. The remaining three are the ORD-defined specification missions using a 2000-lb. reserve fuel. This point has created concern and some confusion among oversight organizations and requires an explanation. The reason for the difference in the definition of required reserve fuels appears to be largely historical, although no official reason could be found. The specification/ORD missions were defined as "combat missions" and as such the fuel reserve for these missions was determined according to the mandate of the aircraft specification document, MIL-SPEC SD565-3. This specification requires a fuel reserve in terms of loiter time after a 100 nautical mile divert while retaining the external tanks. For the F/A-18E/F, the loiter time requirement equates to about 2000 lb. All computations of ORD profile ranges were conducted to include the 100 nautical mile divert leg to arrive overhead at the divert location with 2000 lbs. of fuel. In contrast, the CNO operational missions did not have a reserve fuel specified, and as such the threshold values were interpreted relative to current F/A-18C/D practices. For these missions, the peacetime training reserve fuel of 4000 lbs. was used. If a lower reserve were to be used for these missions, both thresholds and calculated values would increase proportionally.

LIVE FIRE TEST & EVALUATION (LFT&E)

One of the objectives of the F/A-18E/F LFT&E Program was to reduce some of the aircraft vulnerabilities identified through past Joint Live Fire (JLF) Testing of earlier models of the F/A-18. The F/A-18E/F design changes include the addition of an active onboard fire suppression system in selected dry bays—areas which contain various wires, cables, fuel and hydraulic lines and located in close proximity to fuel tanks. The aircraft also has incorporated improved ballistic protection for the fuel cells to prevent fuel from being ingested by the engines causing fires or engine failure and a more survivable stabilator bearing attachment. LFT&E also yielded survivability improvements in the flight control system, including increased separation of the redundant hydraulic lines to reduce vulnerability to ballistic threats. While the F/A-18E and

F versions of the aircraft are about 20 percent larger than the C & D models, their vulnerable areas have not grown proportionately due to these survivability improvements.

The Live Fire Test Program was adequate to assess the survivability of the F/A-18E/F aircraft. Hundreds of controlled damage tests and ballistic tests were performed on F/A-18E/F components and surrogates to jointly fill the need to identify and correct potential design flaws and assure their success. The Live Fire Testing culminated with approximately 30 tests into a nearly full-up F/A-18E/F test aircraft, complete with running engine. This test article had been previously used for drop and barrier tests to assure that its design was sufficiently robust to hold up under demanding aircraft carrier operations. It was then reconditioned and reconfigured for the Live Fire Tests.

DoD Instructions recommend that the Services investigate battle damage repair during the LFT&E Program whenever practical to demonstrate that damage can be repaired, and ensure that required procedures, equipment, and materials are available. Due to time constraints, the Navy's F/A-18E/F LFT&E Program did not include an aircraft battle damage repair program, and thereby missed an early opportunity to investigate this important issue. Many of the test articles damaged during Live Fire Testing, including the nearly full-up aircraft, are still available to support a battle damage repair program, and we recommend that the Navy conduct an F/A-18E/F battle damage repair program while the opportunity still exists.

DEFICIENCIES

As is to be expected with any aircraft at this stage, operational testing has identified a number of deficiencies, perhaps about 100 items—of which I believe about 25-30 are appropriately considered major deficiencies. By a major deficiency, I mean a deficiency that will, or could, degrade the operational effectiveness or suitability of the aircraft. The other deficiencies are more of the nature of annoyances, which should be fixed if practical, but can be successfully "lived with" if needed.

There are several aircraft performance areas in which the aviator prefers more. While the F/A-18E/F brings other enhancing characteristics to the aerial combat arena, in selected areas—such as maximum speed, transonic acceleration, and sustained turn rate its performance is constrained by the basic aerodynamics of the aircraft and the thrust of its engines. Barring major aerodynamic redesign or reengineering, these are performance limitations that must be lived with. Approximately five of the identified deficiencies fall in this category. These deficiencies are very close to the early predictions of aircraft performance, and are not a surprise to the manufacturers or the Navy.

RECOMMENDATIONS

Stores Carriage and Release - The underwing noise and vibration environment is now clearly recognized as being more severe than that of the F/A-18C/D. This does raise special concerns about the ability to obtain full weapon life. This is not a new issue and other aircraft such as the F-15 have had similar issues with external stores. Clearing all planned weapons and stores configurations, while maintaining the effectiveness and reliability of the weapons without increasing their associated logistics burdens, is a concern. The carriage and release limitations and required maintenance procedures during OPEVAL, if not substantially removed, would significantly jeopardize the overall effectiveness and suitability of this aircraft for fleet operations. Accordingly, DOT&E recommends close attention to the progress of efforts to ameliorate these noise and vibration issues.

With the continuing clearance and release to the fleet of additional stores configurations, the F/A-18E/F should be able to carry numerous payload configurations that are beyond the ability of the current F/A-18C. In general, given comparable air-to-ground loadouts on both the F/A-18E/F and the F/A-18C/D, the F/A-18E/F will be able to carry additional air-to-air missiles and/or self-protect missiles. This extensive combination of planned loads is expected to provide significant payload flexibility to the fleet. Currently, there are prohibitions on release of mixed loads (i.e., air-to-air missiles next to air-to-ground weapons) because of time constraints for required flight testing to clear adjacent weapon release/launch positions. Removal of these constraints deserves high priority.

Joint Helmet Mounted Cueing System and AIM-9X - Two of the key roadmap systems, the JHMCS and the AIM-9X, are essential to the operational effectiveness of the F/A-18E/F in the within-visual-range aerial combat arena. The JHMCS and the AIM-9X will provide to the F/A-18E/F the ability to rapidly designate and attack threat aircraft at large off-boresight angles. When equipped with these systems, the relative aircraft performance capabilities in close-in combat will decrease in importance. Currently, key threat systems currently possess the AA-11 Archer missile with its off-boresight capability. Until the JHMCS and the AIM-9X are incorporated, the F/A-18E/F will have significant disadvantage versus such threats.

The JHMCS also has the potential also to provide significant benefits by enabling the rapid designation of off-boresight ground targets.

Active Electronically Scanned Array (AESA) - The Navy is developing the AESA to replace the AN/APG-73 radar. The AESA is made up of large numbers of independent transmitter/receiver (T/R) modules. These active elements, under high-speed computer control, enable the radar to rapidly change its waveform and the pointing direction of its radar beam. This promises a multitude of improved and new capabilities, including much needed electronic protection and reduced probability of intercept modes. This capability is essential to provide not only effective combat capability in the Electronic Attack arena, but also enhances survivability through signature reduction.

Advanced Targeting FLIR (ATFLIR) - The Navy is developing an ATFLIR to correct the performance and reliability deficiencies of the current TGTFLIR. In order to make full use of standoff weapon capabilities, the ATFLIR is a needed capability.

Positive Identification (PID) Capability - The Navy roadmap calls for equipping the F/A-18E/F with a Combined Interrogator Transmitter (CIT). While the CIT will not provide positive ID of "hostiles," it will enable interrogation and positive ID of "friendlies" using the NATO standard Mark XII encrypted Identification Friend/Foe system.

Decoupled Cockpits - The dual cockpit configuration tested in OPEVAL meets the ORD requirements for initial fielding. However, it is apparent that the full capability inherent in a two-person aircrew can not be reached until the cockpits are decoupled—along with numerous related cockpit configuration fixes.

Multi-Function Information Distribution System (MIDS) - When incorporated into the F/A-18E/F, MIDS should provide the aircrew with enhanced situational awareness by providing tactical information from other friendly platforms via Link 16. In view of the F/A-18E/F's lack of effective self-contained positive ID of "hostiles," the MIDS capability offers significant potential to provide identification from other cooperating platforms, thereby enabling application of the F/A-18E/F's BVR capabilities within likely rules-of-engagement. In addition, in some situations MIDS may enable the F/A-18E/F to penetrate enemy airspace without use of its air-to-air radar, thereby denying to an enemy early indication of the Super Hornet's presence.

Integrated Defensive Electronic Countermeasures (IDECM) - The Navy is developing the IDECM to reduce the susceptibility of the F/A-18E/F. OPEVAL has demonstrated that the F/A-18E/F, equipped with the ALE-50 meets the ORD survivability requirements. However, more capable threats continue to proliferate. Consequently, IDECM is needed to provide the necessary survivability in potential future threat environments.

There are remaining deficiencies that largely fall into the "should fix" category. These include several troublesome subsystems: for example, the Cockpit Video Recording System, which has limited capability while it is working and breaks too often. None of these deficiencies is, by itself, a "show stopper." But, cumulatively, they are more than just annoyances and their aggregate resolution is more than a "nice-to-have." I believe this is an area in which the Navy should make appropriate tradeoffs. I have discussed many of these items with the F/A-18E/F program manager, and I am assured that a large number of these remaining deficiencies will be addressed and corrected.

One of the principal reasons underlying the upgrade to the F/A-18E/F is the need for growth capacity to accept further improvements and correct problems inherent in some existing key subsystems common to the F/A-18C/D. The F/A-18E/F has been designed with this growth capacity in mind, and it is essential that these Navy roadmap improvements be rapidly developed, tested, and incorporated.

Until these improved capabilities are provided, the F/A-18E/F cannot fully realize its potential and the operational capabilities for which it was envisioned.

F-22 RAPTOR

The F-22 Raptor is now in Engineering and Manufacturing Development (EMD) to replace the F-15 as this country's air dominance fighter. The F-22 has been in the EMD phase since 1991 and has completed almost 15 percent (about 600 hours) of the planned flight testing, approximately 400 hours more than when I testified before this committee last year. The F-22 design emphasizes stealth, supercruise, and integrated avionics to provide major improvements in effectiveness and survivability.

Initially, the F-22 program had planned a Low Rate Initial Production (LRIP) commitment in December 1999. However, Congress delayed the LRIP decision until December 2000 when more test data will be available. The Congress also wisely required some flight testing of Block 3.0 software, which includes integration of the radar; Communication, Navigation, and Interrogation (CNI); and Electronic Warfare (EW) modes in a fused architecture, as a December 2000 Defense Acquisition Board (DAB) exit criterion.

F-22 test results thus far are quite positive. Several problems have been identified in testing to date, but they are being addressed and corrected. The principal issue that I have with the test program is that it is proceeding much more slowly than in previous aircraft development programs, and even these lagging testing schedules continue to slip over time. Continuing slips in flight test aircraft deliveries reduce the aircraft months available for testing as shown in Table 1 below. The issue is shrinking flight test operating months in the development program prior to the start of dedicated Initial Operational Test and Evaluation (IOT&E). This shrinkage is shown from the Joint Cost Estimating Team (JET) reschedule to the current operating schedule, identified as proposed. The intermediate schedules are the Master Schedule 24 and the ASIT 1.1 schedule. Over the past three years we have lost 49 flight test months which could have been available for testing.

Scheduled / Planned Flight Test Months			
JET (5/97)	MS-24 (12/98)	ASIT-1.1 (11/99)	Proposed (3/00)
243 months	2[illegible]4 months	203 months	194 months

Table 1

This is a reduction of 20 percent in the available flight test months in the past three years from the JET baseline. To accommodate the loss of test time and reduce test costs, flight test changes have reduced the total flight test hours from 4,337 hours to 3,757 hours. This is a 13 percent reduction due mostly to deferral of the requirement for external combat configuration testing and hoped-for avionics test efficiencies. To squeeze these 3,757 test hours into the available flight test time will require an increased test flying rate.

Basically, not enough of the test program has been completed to know whether or not significant development problems remain to be corrected.

OPERATIONAL ASSESSMENT

In support of the December 1999 Defense Acquisition Executive (DAE) review, the Air Force Operational Test and Evaluation Center (AFOTEC) conducted an early Operational Assessment (OA). This OA focused on aircraft performance, programmatic voids, testability, and readiness to test. Although only limited flight test data were available for this assessment, aircraft component design problems, potential maintainability concerns, and programmatic issues were identified. Cockpit design problems highlighted included internal canopy reflections, glare shield blockage, and switch design. Aircraft design issues highlighted included erratic braking, hot brakes, and unpredictable landing gear strut settling. Another significant aircraft operating issue is environmental control system (ECS) problems with moisture, cockpit heating/cooling, canopy fogging and icing, and fuel temperature overheating. Avionics design concerns included potential sensor track fusion throughput limitations, radar warning latencies, Missile Launch Detector (MLD) false alarms, and faulty load sharing of some antennas. Also replacement of the Common Integrated Processor (CIP) computer immediately after IOT&E poses additional risk. Low Observable (LO) maintainability concerns concentrated on hazardous materials used for brush-roll LO repairs and lack of an independent method for verifying LO repairs during operations. Programmatic security issues included complex crypto keys encryption, security clearance delays, and LO signature protection during testing. These problems, along with recommend corrective actions were discussed with Air Combat Command (ACC) and the F-22 System Program Office (SPO) and actions are ongoing to resolve these problems. This OA process is continuing and AFOTEC will provide another assessment to support the December 2000 DAB LRIP decision.

FLIGHT TEST PROGRAM PROGRESS

The flight test program employs both of the existing test aircraft flying at Edwards AFB. These aircraft have accumulated about 600 hours expanding the allowable flight envelope with emphasis on flying qualities and airplane/engine performance data. Flight test program progress should improve significantly this year with additional test aircraft. The third flight test aircraft arrived at Edwards AFB on March 15, 2000, and is scheduled to start structural flight testing activities in mid May. The fourth flight test aircraft, and the first with mission avionics installed, is scheduled to start the avionics flight test program in June. Initially, the fifth flight test aircraft also will emphasize avionics tests starting in September. The sixth flight test aircraft is scheduled to reach Edwards AFB to start integrated avionics and LO testing in late October. The seventh flight test aircraft is scheduled to fly shortly after the beginning of next year. Flight testing this year has not revealed any major problem within the allowable flight envelope. Within limitations, this envelope extends above 30,000 feet, in excess of Mach 1.5, and from minus 40 degrees to greater than plus 60 degrees angle of attack. The allowable test envelope has been expanded as planned without any major impediments, except for fin buffeting in the vertical tails. Two Key Performance Parameters—supercruise and internal missiles payload—have been demonstrated this year. Performance of the F119 engine has been outstanding throughout the allowable flight envelope. There have not been any inflight shutdowns because of engine problems in the first 600 hours of the test program. In addition, engine performance in the test cells has met requirements, and minor hardware problems with low-pressure turbine blades and combustor oxidation/erosion are being corrected.

Airframe/engine performance has also been very good throughout the large angle of attack excursions. Despite test pilot attempts to induce spins at high angles of attack, the aircraft has been very stable and shows no tendency to depart controlled flight.

STATIC AND FATIGUE TESTING

Static testing on the static test article was initiated in April 1999, and the 100 percent limit load testing of critical structure was completed in October 1999 as a December 1999 DAE exit criterion. Ultimate load testing to 150 percent of design load was resumed in February with the first aileron loads test. Although the aileron itself did not fail during this test, a problem with the adjacent flaperon was identified and the flight test aircraft were grounded until an interim fix could be installed. An exit criterion for the December 2000 DAB is completion of the 150 percent ultimate loading of the aircraft structure. Previous aircraft program experience with structural failures at these high load conditions indicates some risk in meeting this criterion. Ultimate load static test completion was scheduled for October 1999 under the 1997 JET proposed plan, and then rescheduled to be completed in February 2000. This testing, now scheduled to be completed prior to the December 2000 DAB, is more than a year behind the JET schedule. Any redesigns to correct static test failures will need to be incorporated into the production vehicles, therefore, it is important to successfully complete the static test program prior to an LRIP commitment.

Fatigue testing has slipped even more than static testing. The fatigue test article was delivered to the test laboratory in November 1999; however, fatigue testing is not scheduled to start until at least August of this year. The JET schedule planned for first-life fatigue test completion in December 1999 but slipped to February 2001 in the November 1999 plan. Even this later completion date is now in jeopardy because of additional delays in starting the testing, related primarily to limited test and engineering personnel shared with the static test program. Any major failures during fatigue testing will also require production aircraft redesigns. Incorporating redesigns into production will depend on where in the first life spectrum any failures occur. An exit criterion for the December 2000 DAB is initiation of fatigue testing with the goal of completing 40 percent of the first life testing. This goal doesn't appear to be achievable based on the planned fatigue testing start date of August or later this year.

AVIONICS FLIGHT TEST PROGRAM

The primary challenge remaining in the F-22 EMD phase is flight testing of the integrated avionics suite. As previously mentioned, a December 2000 DAB exit criterion established by Congress is flight testing of Block 3.0 software in a flight test aircraft. A 3S software block will be a precursor developmental operational flight program (OFP) to be tested in all of the development laboratories, including the Flying Test Bed (FTB), and then in the fourth flight test aircraft starting in August. Testing of the Block 3.0 OFP is planned to be initiated in November on the fifth test aircraft. Much of the avionics test emphasis this year will be in support of this challenging requirement.

AVIONICS LABORATORY TESTING

A Boeing 757 aircraft is the FTB for the F-22 integrated avionics suite. This flying test laboratory started test support of the F-22 program in November 1997 and flew 80 sorties (404 hours) with the F-22 APG-77 radar installed in an integrated forebody (IFB) resembling the F-22 production IFB (replacing a conventional radome). This test set-up included one Common Integrated Processor (CIP) plus simulated cockpit controls to evaluate radar modes and functions, in addition to an early APG-77 radar. This initial radar testing was finished in the summer of 1999, and the FTB has been modified in the interim to install a replica of the F-22 wings, containing simulated sensor antennas, on top of the 757 fuselage. This allows an expansion of the avionics testing that will include the Communication, Navigation, and Interrogation (CNI), and Electronic Warfare (EW) functions, as well as integration with the radar functions. A second CIP was also installed during this FTB modification to allow continued development of the software to support this integrated avionics suite. The FTB will continue testing leading to delivery of Block 3.0 software to flight test aircraft in October. Although this software development task is critical to successful development of the F-22 integrated avionics suite, it does not substitute for testing in a flight test aircraft.

The Avionics Integration Laboratory (AIL) at Boeing, Seattle is another important avionics development facility for integrated avionics hardware and software integration. This AIL is now completing testing of the Block 2.0 software OFP that will be delivered to the FTB in April. Next, the AIL will test the Block 3S software on the way to checking out the Block 3.0 OFP for delivery to the FTB and then to the fifth flight test aircraft to satisfy the December 2000 DAB exit criterion requiring flight test of the Block 3.0 OFP.

Another major avionics development asset is the System Integration Laboratory/Integrated Hardware-in-the-Loop Avionics Test (SIL/IHAT) test facility at Edwards AFB. This facility will become operational this year to support the avionics flight test program. This should be very valuable for development and troubleshooting of problems as the avionics flight test program starts at Edwards AFB this summer.

The Air Combat Simulator (ACS) is under development in Marietta, GA, and is the first occupant of the newly constructed Air Vehicle Integration Facility (AVIF). This simulator will allow the evaluation of large numbers of simulated sorties in complex engagement scenarios not practicable in open-air testing. This simulator also is critical to provide data for an adequate operational test and evaluation, to augment the 240 sorties dedicated to the Initial Operational Test and Evaluation (IOT&E). Development progress is generally on schedule, except for lagging deliveries of threat models. However, there is very little schedule margin to deliver an operational capability to support the start of IOT&E pilot training in February 2002.

WEAPONS TESTING

Flight testing of the AIM-120 (AMRAAM) and AIM-9M (Sidewinder) air-to-air missiles has consisted of carriage in the internal weapons bays on most test missions, and extension of an AIM-9 missile from its weapons bay at several subsonic flight conditions. Separation of each of these two missile types will be demonstrated this year, to satisfy one of the exit criteria established for the December 2000 DAE. This requirement will be satisfied by executing a separation and launch of each missile on a preprogrammed trajectory. Ground tests of missile ejections into pits or other containment barriers will precede this flight testing.

LOW OBSERVABLE (LO) MAINTAINABILITY

LO maintainability is recognized as a high-risk area. The contractor has learned valuable maintainability and support lessons from the B-2 and F-117. The preferred LO repair process is currently the brush and roll technique, but this process may require more support equipment and hazardous waste handling facilities than planned. Hazardous materials operations restrict the ability to perform concurrent maintenance, potentially affecting overall sortie generation. Maintaining low observable characteristics during sustained operations is a major program challenge. In addition, practical operational LO measurement equipment has not been planned for F-22 operational use; maintenance plans are to rely solely on maintainer adherence to technical data under a "process control" strategy. The viability of this process has not been demonstrated and will not be until early operational experience is accumulated. Of special IOT&E concern is the potential for LO maintainability problems to adversely impact the suitability evaluation, as it did in the B-2 program.

The current test program does not include any operational testing under adverse environmental conditions, especially in rain and cold weather. Of particular concern in this area is that the flight test aircraft cannot be flown near thunderstorms to identify potential rain-induced problems or to gather data on static discharge impact on the aircraft, a continuing B-2 problem. Adverse environments will be simulated in the climatic test chamber at Eglin AFB, but this is basically a static test (although engines, flight controls and landing gear will be operated). Test aircraft will not be operationally flown or maintained in these adverse environments. All planned EMD flight testing, including IOT&E, is to be based at Edwards AFB, CA, and Nellis AFB, NV, where rain and high humidity are infrequent.

TEST SCHEDULE DELAYS

Delayed flight test aircraft, scheduled for delivery this year, are significantly increasing the risk to completion of adequate flight testing prior to the start of dedicated IOT&E scheduled for August 2002. Increasingly optimistic proposed development test schedules, schedules that have not been met to date, accentuate this risk. Forty-nine flight test months to complete the EMD flight test program have been lost due to major slips in the flight test aircraft delivery schedules from the 1997 JET schedule. The F-22 SPO proposed a new flight test schedule in November 1999 for the remainder of EMD to allow completion of all the remaining critical developmental tasks. This schedule established a goal of 26.4 flight hours per month for all of the flight test aircraft, and a minimum requirement of 25 hours per month in order to fulfill all of the remaining test objectives. Because of various problems, the two flight test aircraft have not reached this goal. Actual flight hour performance was 22.8 hours in November, 23.7 hours in December, 19.0 hours in January, and 19.4 hours in February. In addition, the flight test aircraft sortie generation performance in March will be significantly worse than these data primarily because of the flaperon repair requirement described previously in this testimony. These data do not engender confidence that the proposed flight test schedule can be achieved, even if no additional major test-related problems occur. Even with the recent decrease of planned flight test hours during EMD to 3,757 hours, it is increasingly unlikely that the necessary development flight testing will be completed in time to begin Dedicated IOT&E in August of 2002. The strike of Boeing engineers and technicians has aggravated this problem at a critical phase of the avionics development and laboratory and test process.

LIVE FIRE TEST AND EVALUATION (LFT&E)

The F-22 Live Fire Test and Evaluation Program is progressing in accordance with the strategy and alternative plan that I approved in 1997. Fifteen of the twenty-one scheduled ballistic tests have been completed. Test results show that some of the unprotected dry bays are more vulnerable to ballistically initiated fires than desirable. Live Fire Testing also has led to a F-22 wing redesign that replaced selected composite spars with titanium spars. The avionics coolant system has been redesigned to provide automatic shutoff of pressurized lines containing flammable fluids in the event of damage.

Two of the six Live Fire test series that have not been completed are intended to assess the potential for sustained fires. One test series will investigate fire in the wing leading edge using both a simulator and a full-up wing. The other fire tests will evaluate the effectiveness of the engine nacelle fire suppression system given combat damage. In addition, a full-scale engine simulator has been used to conduct hundreds of peacetime fire events. However, the engine nacelle Live Fire tests will specifically address threat-induced fires. Two other test series will investigate hydrodynamic ram damage to fuel tanks located in the wings and fuselage. The first flight test aircraft is scheduled to be flown to the test range at Wright Patterson Air Force Base, OH, in June of this year to prepare for Live Fire testing. This aircraft will be used to conduct the wing hydrodynamic ram and wing leading edge fire test series. The test article for the fuselage hydrodynamic ram tests is the second forward fuselage produced during EMD. The remaining two tests were intended to assess the capability of the onboard fire protection system in the main landing gear bays and the aft wing attach bays. The Air Force has decided to remove the fire protection system from these dry bays. The assessed probability of kill given a hit is very high in these unprotected bays based on our evaluation of existing test data for other dry bays.

It is important that the upcoming Live Fire Test with high explosive incendiary threats against the F-22 wing be done with flight representative airflows and loads with the wing properly fixed to the aircraft. Prior tests with the wing mounted in a test fixture have shown the potential to introduce unrealistic results. These tests must be conducted realistically because they will evaluate the new wing design that was changed as a result of poor performance during previous Live Fire Tests. The Air Force has recently stated that they intend to conduct these tests with the wing attached to the fuselage.

Fire and explosion are the leading causes of aircraft loss, and the fuel tanks onboard the F-22 represent the largest presented area of any F-22 aircraft subsystem. Hence, effective fire suppression is mandatory to achieve a survivable aircraft design. The decision by the Air Force to remove some of these fire suppression systems and other factors have further increased the aircraft's probability of being killed given a hit and estimates are now that the vulnerable area is some 30% higher than the F-22 specification had called for. The F-22's vulnerable area estimates could increase further as a result of the remaining test series.

The original onboard inert gas-generating system (OBIGGS) design could not withstand the F-22's vibration environment. A new OBIGGS design and vender has been selected. Functional testing of the new OBIGGS design using the Fuel System Simulator needs to be redone. These tests are expected to demonstrate the new design achieves the inherent concentration needed to protect the fuel tanks against explosion. The F-22 should demonstrate its fire and explosion survivability prior to the decision to enter full-rate production.

COST CAP CONCERNS

While a cost cap may have been useful earlier in the F-22 program, it now appears that the EMD cost cap is harming the test program. The cost cap is causing many programmatic changes to reduce costs, which almost always result in less testing and increased development risks. Further, these development risks become greater with elapsed time as the cost reduction options become harder to implement. At this point in the EMD phase, cost reductions are largely test related since the test budget is essentially the only remaining uncommitted EMD budget. Not only are testing tasks often eliminated, but there is concomitant inefficient rescheduling of the remaining tasks. Any further reduction of testing tasks increases the risk of not being ready to start or successfully complete IOT&E. A specific current example is the inability to add engineers to maintain the static and fatigue testing schedules.

The AIM-9X and Joint Helmet Mounted Cueing System (JHMCS) will not be tested in IOT&E. This important capability will be tested in Follow-On Test and Evaluation (FOT&E) prior to Initial Operational Capability (IOC). Another testing deferral, proposed as a cost-saving measure, is the external combat capability demonstration. This combat capability is the carriage of AIM-120 missiles and external fuel tanks. Current plans are to defer this testing outside of the F-22 EMD program budget to the SEEK EAGLE program at a later undefined period. This is also a deferral of an ORD-required capability outside of the F-22 development program.

RECOMMENDATIONS

A most helpful congressional action would be to remove the EMD cost cap and institute an alternative method for controlling the F-22 program cost. One suggested alternative is to retain the total program cost cap, adjusted for inflation, while removing the EMD cost cap. This would achieve the overall program cost control objective, but allow the ORD-defined combat capabilities to be effectively and efficiently demonstrated during EMD and allow more testing prior to dedicated IOT&E. This would certainly require an extension of EMD, probably a delay of up to one year of IOT&E (from 2002 to 2003) and Milestone III. I would support the continued LRIP proposed ramp-up rates (long lead of 16 aircraft in FY01 and long lead of 24 aircraft in FY02) to preserve the industrial base and negotiated target price commitment curves.

JOINT STRIKE FIGHTER (JSF)

The Joint Strike Fighter Program is intended to develop and deploy an affordable family of strike aircraft meeting the requirements of the Air Force, Navy, Marine Corps, UK Royal Navy and Air Force and possibly other allies. This family of strike aircraft will consist of three variants: Conventional Takeoff and Landing (CTOL), Aircraft Carrier Suitable (CV), and Short Takeoff and Vertical Landing (STOVL). The focus of the program is affordability: reducing the development, production, and ownership costs of the JSF family of aircraft. The JSF will be a single-seat, single-engine aircraft capable of performing and surviving lethal strike warfare missions using an affordable blend of key technologies developed by other aircraft programs and integrated into the JSF in a block upgrade approach. The STOVL variant will retain the option for a two-seat version. A multi-year $2.2 billion JSF Concept Demonstration And Risk Reduction effort commenced in November 1996, with competitive contract awards to Boeing and Lockheed Martin for the Concept Demonstration and Risk Reduction Program. These competing contractors are building and will fly two concept demonstrator aircraft, conduct concept unique ground demonstrations, and continue refinement of their ultimate delivered weapon system concepts.

The Joint Strike Fighter program was placed under oversight for OT&E and LFT&E in June 1995 as the Joint Advanced Strike Technology (JAST) program. Representatives from DOT&E and the Navy and Air Force Operational Test Agencies (OTAs) participate in several of the Integrated Program Teams (IPT) established by the JSF program.

In support of an affordable, highly-common family of next-generation multi-role strike fighter aircraft, the JSF program employed an iterative approach to achieve fully validated, affordable operational requirements which were recently codified in an approved Operational Requirements Document. This approach emphasized the early and extensive use of cost-performance trades. To assess military utility in support of these trades, the JSF program is continuing development of its Virtual Strike Warfare Environment (VSWE), a Modeling and Simulation (M&S) environment, to ensure consistent models and data bases. The Service Operational Test Agencies (OTAs), AFOTEC and COMPOTEVFOR, as part of the first Early Operational Assessment, are actively participating in several simulations that the program has established to provide insights to determining the final operational requirements. This active participation by the OTAs at the early requirements-formulation stage is both unusual and commendable. As a result, we expect the operational testers to have a full understanding of the trades and reasoning underlying the final requirements. Such understanding provides a sound foundation for successful operational testing in future years. This open process for requirements development and the availability of the VSWE provides needed avenues to improve the linkage between the test and requirements processes. In addition, the models used in conjunction with the VSWE may prove useful also in the test and evaluation process, although experience has shown that the best available models are not sufficiently credible for all T&E needs.

During the JSF Concept Demonstration and Risk Reduction phase begun in 1996, competing contractor teams led by Boeing and Lockheed Martin are each building, qualifying, and will fly two concept demonstrator aircraft, designated the X-32 and X-35, respectively.

Rather than being prototypes with full-up systems, these demonstrators incorporate the engine and key features of the outer mold lines of the contractor's preferred JSF design, but they will largely use off-the-shelf systems and avionics. These demonstrators are intended to demonstrate the viability of each contractor's design concept for a common, modular family of strike aircraft, including the ability to accomplish short takeoff, hover and transition to flight, up-and-away performance, and low speed handling consistent with landing aboard a carrier. During this phase, each contractor is responsible for planning and executing the ground and flight tests and demonstrations. Flight-testing of these demonstrator aircraft is planned later this year. Government personnel are actively participating in test planning and execution with the competing contractors. The principal purpose of this demonstration program is to assist the contractors in determining designs and reduce associated risks for the Preferred Weapon System Concepts that they will propose for Engineering and Manufacturing Development (EMD).

The ongoing Concept Demonstration and Risk Reduction phase will allow early test insights into the viability of the basic aircraft designs. More challenging to assess in this phase will be the contractors' progress in developing the integrated avionics suite that will be essential to the final JSF design, as well as validating the needed improvements in operational supportability and the cost of ownership. Improved insights into the risks of integrated avionics had been hoped for prior to the planned JSF Milestone II decision next year from the ongoing F-22 program, which is leading the way in facing such challenges. Since both of the competing JSF contractors are key members of the F-22 team, the lessons learned from that program have the potential to reduce the risks in similar areas of the JSF.

It is essential that the Live Fire Test Program be done realistically and thoroughly. To accomplish its combat mission, the JSF will be expected to go into harm's way. The JSF will replace several existing aircraft, some of which have proven to be very survivable in combat due to prior Live Fire and Joint Live Fire Testing and resultant design modifications. Vulnerability modeling and simulation tools alone are inadequate to effectively predict damage at the component level. Reliable vulnerability predictions at the subsystem and full system levels are even more uncertain.

Given the JSF's anticipated challenging threat environment, its new and as yet undemonstrated technologies, materials, fly-by-wire controls, avionics integration, and single engine design (coupled with the demonstrated inadequacy of our current vulnerability modeling and simulation capability even at the component level), full-up, system-level live fire testing of at least one variant is the practical, affordable and correct approach. Unique design features of other JSF variants can be tested at the component and subsystem levels, drawing applicable insights for common areas shared from the full-up, system-level testing of the aircraft variant selected. While the JSF Program Office may propose a waiver request from full-up, system-level Live Fire Testing for all JSF aircraft variants, I disagree with this approach. At least one of the variants must undergo full-up, system-level LFT&E. The other variants could draw from this testing coupled with component and subsystem level live fire testing of variant-unique areas. We are working with the Program Office to assure availability of full-up, full-scale test articles for an acceptable LFT&E strategy.

As we discussed with this committee last year, none of the major components of the F-119 engine were Live Fire tested under the F-22 program. I am happy to report that some limited tests of engine components are being planned and funded by JSF using unserviceable F-119 components from the F-22 program and these tests are scheduled to begin this year.

The Service OTAs are currently conducting an Early Operational Assessment (EOA), but the Program Office does not plan to include the EOA findings in the source selection criteria. Structuring the participation of the OTAs poses unique challenges since the OTAs must carry out thorough assessments while preserving the legitimate proprietary information of each contractor in this competitive environment. The EOAs will, however, be useful in assessing the maturity of key JSF technologies at the end of Concept Demonstration and Risk Reduction, and assessing the likelihood that the proposed capability will meet user requirements.

My staff has been heavily involved in cooperation with JSF staff and the OTAs in shaping the plans for OT&E activities during EMD. These plans will be definitive in the TEMP update just before Milestone II, which will be further updated with even greater detail following down-select and contract award for EMD.

As I look down the road, the planning for EMD provides ample opportunities for the conduct of Operational Assessments leading up to Dedicated IOT&E/OPEVAL. As the program matures, it will be essential to define specific accomplishments or characteristics that each of these Operational Test periods must confirm, consistent with the event-driven acquisition strategy required by DoD Regulations and adopted by JSF. Current planning for Dedicated IOT&E includes six production-representative test articles for block I, 12 for Block II, and 18 for block III. While this quantity of aircraft appears adequate for the conduct of a thorough operational test, it is none too many since three different aircraft configurations must be tested in the accomplishment of a variety of missions. With deliveries of three variants in multiple blocks, staggered over multiple years, it will be difficult to structure a test program that capitalizes on the similarities of the three variants and supports a full-rate production decision for all three variants in 2009 on the basis of Block I OT&E. I believe that we will have a better idea after Block II testing, and a complete evaluation of all mission capabilities after Block III OT&E.

At this relatively early stage of the JSF program, the integration of program planning and test and evaluation planning appears to be on a sound foundation. A program as complex as the JSF (multiple aircraft configurations for multiple users) especially needs to employ fully the Integrated Program and Process Development concept to develop operational requirements and formulate integrated T&E strategies. Operational Test Agencies must participate fully and continuously in relevant program activities. Despite the near-term concerns of the competitive environment, I am confident that we will establish a thorough program of operational assessments during Concept Demonstration and Risk Reduction to support progress of the JSF program, and, later during EMD, thorough operational testing of the JSF.

Opening Statement by

The Honorable Philip E. Coyle

Director, Operational Test and Evaluation

Before the

House Committee on Government Reform

Subcommittee on National Security, Veterans Affairs, and International Relations

National Missile Defense

September 8, 2000

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Introduction

Mr. Chairman, members of the Committee, thank you for the opportunity to discuss the testing of the National Missile Defense (NMD) system. I have not had the opportunity to address this Committee before and am pleased to do so.

You requested that today's testimony focus on the impact of the test results to date on technology maturity and deployment schedules. You also indicated we address the relationship between the Anti-Ballistic Missile (ABM) Treaty and the current proposals to design, test, and deploy an effective missile defense system. First, I would like to briefly discuss the progress so far.

Progress So Far

The NMD program has demonstrated considerable progress towards its defined goals in the last two years. The Battle Management Command, Control, and Communications (BMC3) system has progressed well. Potential X-Band Radar performance looks promising, as reflected in the performance of the Ground Based Radar-Prototype (GBR-P). A beginning systems integration capability has been demonstrated, although achieving full system-of-systems interoperability will be challenging.

The ability to hit a target reentry vehicle (RV) in a direct hit-to-kill collision was demonstrated in the first flight intercept test last October. However, in this test, operationally representative sensors did not provide initial interceptor targeting instructions, as would be the case in an operational system. Instead, for test purposes, a Global Positioning System (GPS) signal from the target RV served to first aim the interceptor. We were not able to repeat such a successful intercept in the two subsequent flight intercept tests. Also, the root cause of the failure in the most recent flight intercept test has not been determined.

Testing Limitations

Because of the nature of strategic ballistic missile defense, it is impractical to conduct fully operationally realistic intercept flight testing across the wide spectrum of possible scenarios. The program must therefore complement its flight testing with various types of simulations. Overall NMD testing is comprised of interrelated ground hardware and software-in-the-loop testing, intercept and non-intercept flight-testing, computer and laboratory simulations, and man-in-the-loop command and control exercises. Unfortunately, these simulations have failed to develop as expected. This, coupled with flight test delays, has placed a significant limitation on our ability to assess the technical feasibility of the NMD system.

The testing program has been designed to learn as much as possible from each test. Accordingly, the tests so far have all been planned with backup systems so that if one portion of a test fails, the rest of the test objectives might still be met. Developmental tests in a complex program, especially those conducted very early, contain many limitations and artificialities, some driven by the need for specific early design data and some driven by test range safety considerations. Additionally, the tests are designed so that they will not produce debris in orbit that will harm satellites. Also, the program was never structured to produce operationally realistic test results this early. Accordingly, it was not realistic to expect these test results could support a full deployment decision now, even if all of the tests had been unambiguously successful, which they have not been. Notwithstanding the limitations in the testing program and failures of important components in all three of the flight intercept tests, the program has demonstrated considerable progress.

Compliance with the ABM Treaty has not had an adverse impact to date on the developmental testing of the NMD system. In the future, we desire additional Ground Based Interceptor test launches from more operationally representative locations than the existing Kwajalein Missile Range. Additional target launch sites which are not restricted by the Treaty would expand the test envelope beyond that currently available, as recommended by the Welch panel, to validate system simulations over the rest of the operating regimes. Furthermore, we need a radar to skin track the incoming RV (rather than tracking a beacon transponder as has been done with the FPQ-14 radar on Oahu) during early mid-course flight in order to support creation of the Weapon Task Plan which first aims the interceptor. Some of the options for these improvements could raise ABM Treaty issues. Any NMD test activity must be sufficiently well defined in order to properly assess the ABM Treaty implications and determine whether the activity can be conducted under the existing Treaty.

Future Test Planning

Under the program-of-record, test results are not likely to be available in 2003 to support a recommendation then to deploy a C1 system in 2005. This is because the currently planned testing program is behind, because the test content does not yet address important operational questions, and because ground test facilities for assessment are considerably behind schedule.

NMD developmental testing needs to be augmented to prepare for realistic operational situations in the IOT&E phase, and is not yet aggressive enough to keep pace with the currently proposed schedules for silo and radar construction and missile production. The testing schedule, including supporting modeling and simulation, continues to slip while the construction and production schedules have not. Important parts of the test program have slipped a year in the 19 months since the NMD program was restructured in January 1999. Thus, the program is behind in both the demonstrated level of technical accomplishment and in schedule. Additionally, the content of individual tests has been diminished and is providing less information than originally planned.

I am especially concerned that the NMD program has not planned nor funded any intercept tests until IOT&E with realistic operational features such as multiple simultaneous engagements, long-range intercepts, realistic engagement geometries, and countermeasures other than simple balloons. While it may not be practical or affordable to do all these things in developmental testing, selected stressing operational requirements should be included in developmental tests that precede IOT&E to help ensure sufficient capability for deployment. For example, the current C-band transponder tracking and identification system, justified by gaps in radar coverage and range safety considerations, is being used to provide target track information to the system in current tests. This practice should be phased out prior to IOT&E. This will ensure that the end-to-end system will support early target tracking and interceptor launch.

There is nothing wrong with the limited testing program the Department has been pursuing so long as the achieved results match the desired pace of acquisition decisions to support deployment. However, a more aggressive testing program, with parallel paths and activities, will be necessary to achieve an effective IOC by the latter half of this decade. This means a test program that is structured to anticipate and absorb setbacks that inevitably occur. The NMD program is developing test plans that move in this direction.

The time and resource demands that would be required for a program of this type would be substantial. As documented in the Congressional Budget Office (CBO) report on the budgetary and technical implications of the NMD program[1], the Safeguard missile program conducted 165 flight tests. The Safeguard program was an early version of NMD. Similarly, the full Polaris program conducted 125 flight tests, and the full Minuteman program conducted 101 flight tests. Rocket science has progressed in the past 35 years, and I am not suggesting that a hundred or more NMD flight tests will be necessary. However, the technology in the current NMD program is more sophisticated than in those early missile programs, and we should be prepared for inevitable setbacks. It is apparent that in these early programs an extensive amount of work was done in parallel from one flight test to another. Failures that occurred were accepted, and the programs moved forward with parallel activities as flight testing continued.

As in any weapons development program, the NMD acquisition and construction schedules need to be linked to capability achievements demonstrated in a robust test program, not to schedule per se. This approach supports an aggressive acquisition schedule if the test program has the capacity to deal with setbacks. On three separate occasions, independent panels chaired by Larry Welch (General, USAF Retired) have recommended an event driven, not schedule driven, program. In the long run, an event driven program might take less time and cost less money than a program that must regularly be re-baselined due to the realities of very challenging technical and operational goals.

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[1] CBO Papers, *Budgetary and Technical Implications of the Administration's Plan for National Missile Defense,* April 2000

Conclusion

Aggressive flight testing, coupled with comprehensive hardware-in-the-loop and simulation programs will be essential for NMD. Additionally, the program will have to adopt a parallel, "fly through failure," approach that can absorb tests that do not achieve their objectives in order to have any chance of achieving an FY 2005 deployment of an operationally effective system. As noted by CBO, the Navy's Polaris program successfully took such an approach 30 years ago.

Deployment means the fielding of an operational system with some military utility which is effective under realistic combat conditions, against realistic threats and countermeasures, possibly without adequate prior knowledge of the target cluster composition, timing, trajectory or direction, and when operated by military personnel at all times of the day or night and in all weather. Such a capability is yet to be shown to be practicable for NMD. These operational considerations will become an increasingly important part of test and simulation plans over the coming years.

Recommendations

In the full statement of my testimony, which has been provided to the Committee, I make a series of recommendation to enhance the testing program. This includes more realistic flight engagements, tests with simple countermeasures beyond those planned, flight intercept tests with simple tumbling RVs, and tests with multiple simultaneous engagements.

Mr. Chairman, I would be pleased to answer any questions you may have.

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PROGRESS SO FAR

The NMD program has demonstrated considerable progress towards its defined goals in the last two years. The Battle Management Command, Control, and Communications (BMC3) system has progressed well. Potential X-Band Radar (XBR) performance looks promising, as reflected in the performance of the Ground Based Radar-Prototype (GBR-P). A beginning systems integration capability has been demonstrated, although achieving full system-of-systems interoperability will be challenging.

The ability to hit a target reentry vehicle (RV) in a direct hit-to-kill collision was demonstrated in the first flight intercept test last October. However, in this test, operationally representative sensors did not provide initial interceptor targeting instructions, as would be the case in an operational system. Instead, for test purposes, a Global Positioning System (GPS) signal from the target RV served to first aim the interceptor. We were not able to repeat such a successful intercept in the two subsequent flight intercept tests. Preliminary analysis has been completed on the root cause of the failure in the most recent flight intercept test, but has not been fully determined.

TESTING LIMITATIONS

Because of the nature of strategic ballistic missile defense, it is impractical to conduct fully operationally realistic intercept flight testing across the wide spectrum of possible scenarios. The program must therefore complement its flight testing with various types of simulations. Overall NMD testing is comprised of interrelated ground hardware and software-in-the-loop testing, intercept and non-intercept flight-testing, computer and laboratory simulations, and man-in-the-loop command and control exercises. Unfortunately, these simulations have failed to develop as expected. This, coupled with flight test delays, has placed a significant limitation on our ability to assess the technological feasibility of NMD.

The testing program has been designed to learn as much as possible from each test. Accordingly, the tests so far have all been planned with backup systems so that if one portion of a test fails, the rest of the test objectives might still be met. Developmental tests in a complex program, especially those conducted very early, contain many limitations and artificialities, some driven by the need for specific early design data and some driven by test range safety considerations. Additionally, the tests are designed so that they will not produce debris in orbit that will harm satellites. Also, the program was never structured to produce operationally realistic test results this early. Accordingly, it was not realistic to expect these test results could support a full deployment decision now, even if all of the tests had been unambiguously successful, which they have not been. Notwithstanding the limitations in the testing program and failures of important components in all three of the flight intercept tests, the program has demonstrated considerable progress.

Compliance with the ABM Treaty has not had an adverse impact to date on the developmental testing of the NMD system. In the future, we desire additional Ground Based Interceptor test launches from more operationally representative locations than the existing Kwajalein Missile Range. Additional target launch sites which are not restricted by the Treaty would expand the test envelope beyond that currently available, as recommended by the Welch panel, to validate system simulations over the rest of the operating regimes. Furthermore, we need a radar to skin track the incoming RV (rather than tracking a beacon transponder as has been done with the FPQ-14 radar on Oahu) during early mid-course flight in order to support creation of the Weapon Task Plan which first aims the interceptor. Some of the options for these improvements could raise ABM Treaty issues. Any NMD test activity must be sufficiently well defined in order to properly assess the ABM Treaty implication and determine whether the activity can be conducted under the existing Treaty.

SCHEDULE ISSUES

Since the program was restructured in January 1999, the NMD program has experienced numerous program development delays, while the construction and production schedules have not slipped. To the program's credit, the flight test program has been event driven, with tests conducted only when the Program Office felt ready. As a result, Integrated Flight Test (IFT) IFT-3 was conducted 18 months behind the original 1996 schedule and four months behind the 1999 schedule. More recently, as illustrated in Figure 1, additional significant test slips have occurred since the January 1999 program restructure. In particular, IFT-5 was to be conducted about six months before a June 2000 Deployment Readiness Review (DRR) but was actually executed on July 8. This forced the DRR to be moved to August 2000. IFT-6, which had also been planned to precede the DRR, is expected to occur in January or February 2001.

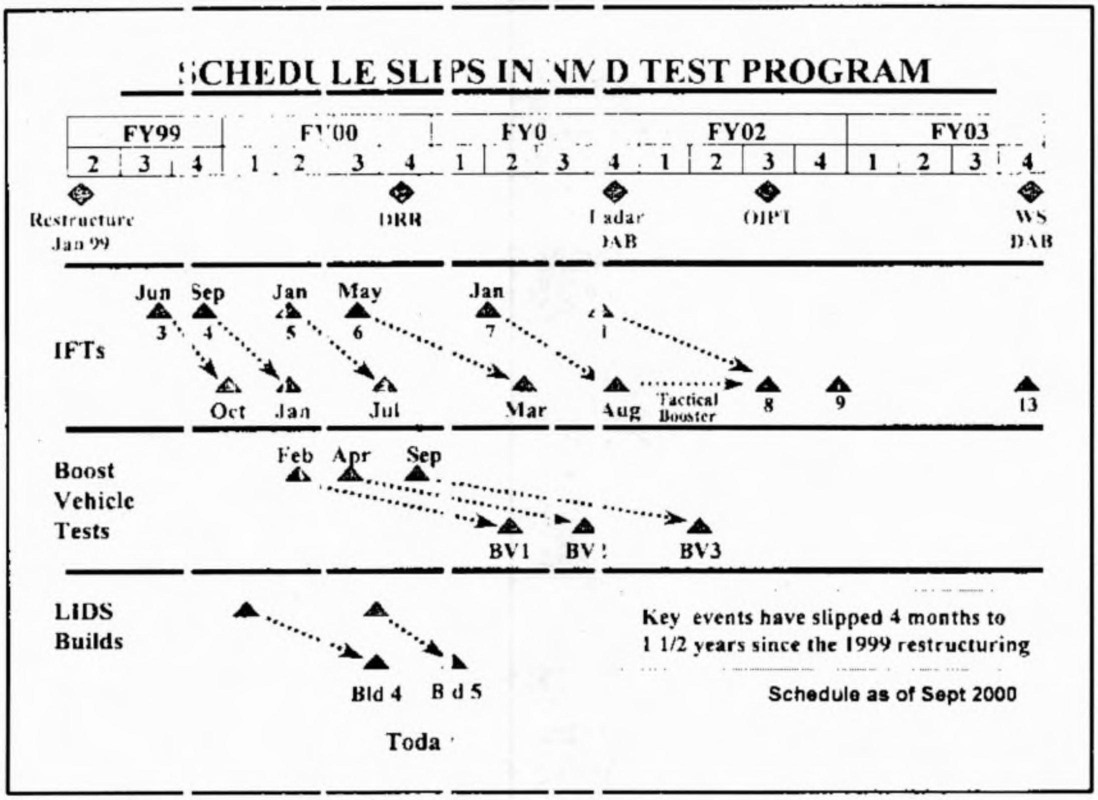

Figure 1. Schedule Slips in the NMD Test Program

Development delays have already caused schedule slips of flight tests of the tactical booster to beyond the DRR. Boost Vehicle (BV) test #1 was originally scheduled for February 2000, then July 2000, and now second quarter of FY01. BV2 has slipped about a year. BV3, the first test to integrate the Exoatmospheric Kill Vehicle (EKV) with the booster, is behind about a year and a half. Additionally, the first use of the operational booster stack in an intercept test will now occur in IFT-8, vice IFT-7 as originally planned. As a result, the authorization of long lead acquisition for the Capability 1 (C1) interceptor system will have to be delayed commensurate with that testing.

Delays in the flight test program are the most visible, but developmental problems in simulation and ground test facilities may have an even greater impact. Since the flight test scenarios are severely constrained, ground testing and simulation are critical to evaluating system performance and the fulfillment of Operational Requirements Document (ORD) requirements.

Integrated Ground Tests (IGTs), using the computer processor-in-the-loop Integrated System Test Capability (ISTC) simulation, were to provide operationally realistic data on 13 "design-to" scenarios. A high fidelity digital simulation, the Lead Systems Integrator (LSI) Integration Distributed Simulation (LIDS), was to have been used by the contractor and Operational Test Agency (OTA) team to perform analysis of an even broader set of scenarios to demonstrate that the entire United States would be adequately defended. The ISTC proved to be too immature to provide reliable estimates of performance, and the development of the digital simulation, LIDS, is behind schedule and was not available to support analyses of overall system performance as originally intended.

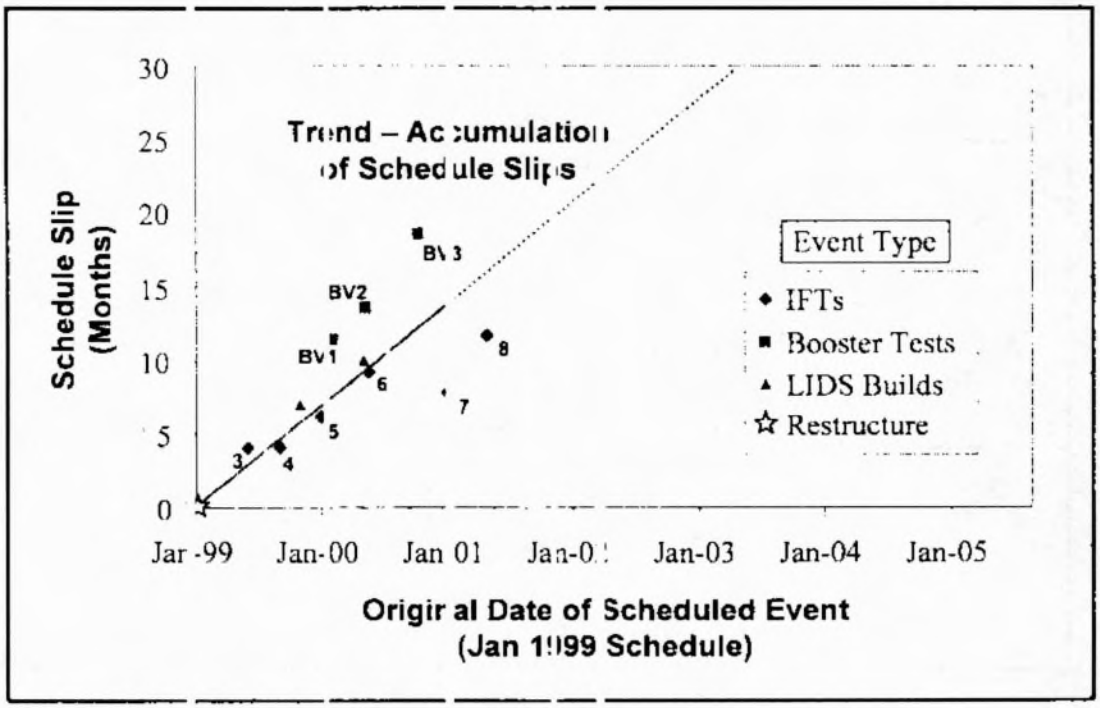

Figure 2. Accumulation of Slips in Test and Development Schedule

Unless these trends are reversed, an Initial Operational Capability (IOC) in FY05 appears unlikely. Figure 2 illustrates the trend of development schedule slips and estimates schedules slipping at a rate of 10 months every three years. If these trends persist and efforts by the NMD Joint Program Office (JPO) to "buy back" schedule are unsuccessful, the first flight test with a production representative interceptor (IFT-13), scheduled for the first quarter of FY03, would slip about two years.

TEST RESULTS

TEST PROGRAM

The NMD Test and Evaluation Program is being planned and executed by the NMD Lead System Integrator, Boeing, under the direction of the NMD Joint Program Office. The test program is derived from the current NMD Test and Evaluation Master Plan (TEMP) and aims to demonstrate, incrementally, progress toward C1 capability by fulfilling the following objectives:

- Demonstrate end-to-end integrated system performance, including the ability to prepare, launch, and fly-out a designated weapon; and kill a threat-representative target through body-on-body impact

- Demonstrate end-to-end target detection, acquisition, tracking, correlation, and handover performance.
- Demonstrate real-time discrimination performance.
- Demonstrate NMD system kill assessment capability.
- Demonstrate the ability of the NMD battle management software to develop and coordinate battle engagement plans; prepare, launch, and fly out a designated weapon, and kill a threat representative target.
- Demonstrate integration, interface compatibility, and performance of system and sub-system hardware and software.
- Demonstrate human-in-control operations of the NMD system.
- Demonstrate system lethality.

In the first three years of the NMD program – the Initial Development Phase – test events consisted of Integrated Ground Tests (IGTs) 3, 4, and 5; IFTs 1A, 2, 3, 4, and 5; Modeling and Simulation activities; Risk Reduction Flights (RRFs); and User Exercises. This phase culminates with the DRR. Near-term test and evaluation focuses on the ability to provide accurate test information and data in support of the DRR. Test and evaluation activities are also essential for the development and maturation of system elements.

The NMD program activities following the DRR will focus on completing the development of the NMD C1 expanded system. The test and evaluation activities during this period consist of Integrated Ground Tests, Integrated Flight Tests, Modeling and Simulation, Risk Reduction Flights, and User Exercises – as for the initial development phase – and are intended to support developmental activities and future DAB decisions if the next President decides to authorize deployment. The next DAB will decide whether to proceed with the Upgraded Early Warning Radar (UEWR) Upgrade, XBR build, and BMC3 integration into the Cheyenne Mountain Operations Center, and two years later, the DAB will decide if the weapon system is ready for production.

LIMITATIONS ON INTEGRATED FLIGHT TESTS

The flight test program has demonstrated basic functionality of the NMD system elements. The most notable achievements have been the hit-to-kill intercept of IFT-3 and significant "in-line" participation in IFT-4 and IFT-5 by system elements. However, the configuration of the NMD system during both IFT-4 and IFT-5 remains a limited functional representation of the objective system, as discussed below.

Early integrated flight tests, like IFT-4 and IFT-5, make use of surrogate and prototype elements, because the NMD program is still in its developmental phase. As such, element maturity in near-term flight testing is limited:

- An interim build of the BMC3 – Capability Increment 3A – will be utilized in all integrated flight tests through IFT-6. It is a build with about 60 percent of the planned functionality but has the basic engagement functions necessary to execute a mission. The next build, Build Increment 1, may not add any new functionality but will begin the re-hosting of the software onto a Defense Information Infrastructure / Common Operating Environment and Joint Technical Architecture compliant architecture. IFT-7, scheduled in FY01, will be the first time Build Increment 1 is used in an integrated flight test.

- Defense Support Program (DSP) satellites which provide launch warning to the BMC3 in the form of Quick Alert messages, act as the Space Based Infrared System (SBIRS) element. DSP satellites are not able (and were not designed) to perform surveillance and boost track functions at the levels necessary to meet NMD ORD system effectiveness requirements and, therefore, will be replaced by SBIRS satellites. DSP messages are not currently in NMD tactical format and, during integrated flight testing, require message translation by range assets at the Joint National Test Facility[1] before being forwarded to the BMC3.
- The Payload Launch Vehicle, a two-stage booster system consisting of modified Minuteman II motors and supporting subsystems, has been the surrogate for the interceptor booster in all integrated flight tests to date. The tactical booster[2] was scheduled to be flown in IFT-[illegible], see Figure 2, but schedule slips in Boost Vehicle testing have delayed the first flight of the tactical booster to IFT-8.
- The Ground Based Radar Prototype, located at Kwajalein Missile Range (KMR), supports integrated flight tests as the prototype element for the X-Band Radar. GBR-P participation in integrated flight tests is limited, because as discussed below, its siting at KMR precludes it from adequately supporting weapon task planning by the BMC3. As a result, Global Positioning System (GPS) instrumentation and/or a C-band transponder on the target reentry vehicle are the sources of information for weapon task planning by the BMC3.

In part, the operational realism of integrated flight testing has been limited by having located the GBR-P at KMR. As illustrated in Figure [illegible], the GBR-P is not sufficiently forward in the test geometry, as it would be in many operational scenarios,[3] requiring that other sensors provide data to the BMC3 for weapon task planning. In the integrated flight tests conducted to date and for the foreseeable future, these "other sensors" are either GPS data sent from the RV and/or the FPQ-14 radar receiving data from a C-band transponder on the target RV. The FPQ-14 radar located on Oahu, Hawaii, picks up the C-Band signal radiating from the target RV and provides the BMC3 with target track information as though it were from a UEWR. Similarly, as in IFT-3 and IFT-4, the GPS can provide the BMC3 with target track information as though it were from an X-Band Radar. In tests to date, the BMC3 was required by the concept of operations to generate a Weapon Task Plan only after the threat object – the RV – had been resolved by

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[1] The Joint National Test Facility is located at Schriever Air Force Base near Colorado Springs, Colorado.

[2] The tactical booster is a Commercial-off-the-Shelf (COTS), three-stage, ICBM-class missile that has a burnout velocity nearly 2.5 times that of the Payload Launch Vehicle. Launched from central Alaska, the tactical booster must be powerful enough to engage threats, in a timely manner, targeted at the East Coast.

[3] Missiles launched from eastern Asia would generally come into the X-Band Radar's field of view much earlier than in test scenarios. Missiles coming over the North Pole or from the Middle East would generally have to rely on other sensors for generating the Weapon Task Plan.

ground based radars. Although the GBR-P acting as the XBR surrogate can acquire the target *cluster* soon after radar horizon break, the GBR-P alone is not capable of supporting the Weapon Task Plan generation because, in the test geometry, the target RV cannot be discriminated early enough.

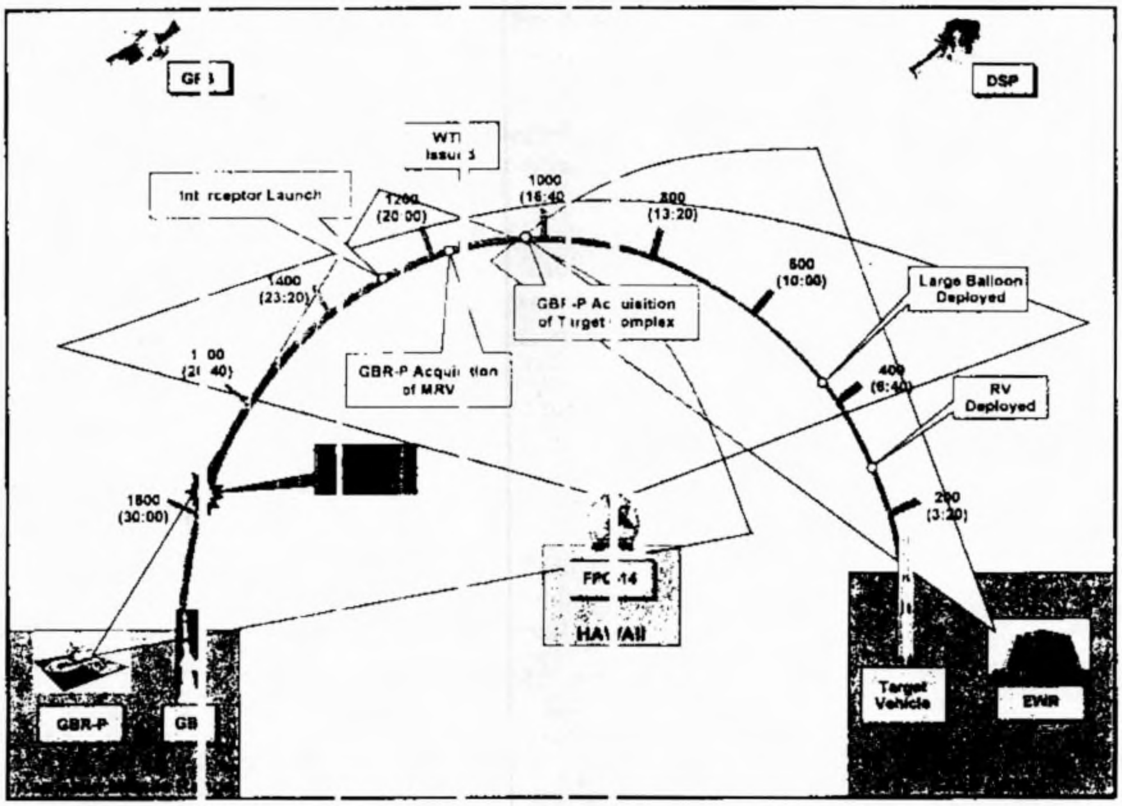

Figure 3. Integrated Flight Test Geometry

Another critical function performed by the BMC3 is the generation and uplink of In-Flight Target Updates (IFTUs) – target data sent to the EKV while in flight – to correct for any targeting errors. In the "on-line" portion of IFT-3, the GBR-P acting as the XBR surrogate was not required nor planned to be the sole provider of track data to the BMC3 for IFTU generation. Rather, GBR-P track data was augmented by FPQ-14 data for IFTU generation. GBR-P participation in IFTU generation -- especially of IFTUs sent late in the engagement timeline – has increased in recent flight tests. In particular, the BMC3 generated all three IFTUs exclusively from GBR-P data in IFT-5.

Characteristic of ballistic missile defense flight tests, limitations associated with developmental testing impact the operational realism of integrated flight tests. Safety concerns about intercept debris and range constraints impose limitations on engagement scenarios. While a

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[4] The NMD system is required to engage the threat under one of three "categories" of operation: (A) resolved and discriminated RV; (B) cluster track of threat complex; or, (C) space-based sensor data of boosting missile.

successful intercept during any future flight test will be a significant achievement in the development of the NMD system, it should be seen in context of the caveats enumerated above as well as the following limitations:

- **Engagement Conditions**. Test target launches from Vandenberg Air Force Base (VAFB) and interceptor launches from KMR place significant limitations on achieving realistic engagement conditions. A target missile cannot be launched from a "threat country" toward the United States. Test targets are outbound from the United States rather than inbound relative to early warning radars. Consequently, during flight tests, early warning radars track the target complex during phases of its flight different from what is expected during a true engagement. The target missile launched near the early warning radar presents an easy target for detection and is tracked during its boost phase. Other limitations on engagement conditions include the fact that interceptor flyout range and time of flight are short,[5] intercept altitudes are low (for debris containment), and closing velocities during the endgame are not stressing. These limitations would be mitigated somewhat with the addition of a new test geometry to the flight test program - for example, target launches from Kauai or Wake Island and interceptor launches from Kodiak Launch Complex in Alaska, or target launches from Kodiak and interceptor launches from KMR.
- **Target Suite Reduction**. The target suites flown in IFTs 3, 4, and 5 each contained only two objects – a Medium Reentry Vehicle (MRV) and a Large Balloon – a significant reduction in complexity from the original plan. Target requirements listed in the JPO-signed 1997 TEMP called for nine to ten objects in flight tests IFT-1 through IFT-5, suites that contained both unsophisticated and sophisticated decoys. In 1998, target requirements were pared down to three balloons (one large and two small balloons) and the MRV. Then, in July 1999, less than three months before IFT-3, the target suite was further reduced to two objects, as indicated above. In all cases, the deployment bus is in the field of view of the EKV seeker and also has to be discriminated.
- **Target Suite Complexity.** The NMD test program is designed to test within the C1 threat space, which means that target suites in flight tests will have at most unsophisticated countermeasures, even though the threat from accidental or unauthorized launches could employ sophisticated countermeasures. Currently, the most stressing intercept flight tests will fly target suites consisting of a mock warhead and a collection of simple balloon decoys. The target suites flown in IFT-3, IFT-4, and IFT-5 were each limited to an MRV and a Large Balloon. Signature simulations show that since the large balloon and deployment bus have infrared (IR) signatures very dissimilar to the MRV, the EKV can easily discriminate the MRV from these objects.
- **Multiple Simultaneous Engagements (MSE)**. NMD system performance against multiple targets is not currently planned for demonstration in the flight test program, although multiple engagements are expected to be the norm in NMD system operation. The Joint Program Office has plans for constructing a second interceptor silo at

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[5] An issue related to the short interceptor flyout is that the COTS booster is nearly too powerful for flight testing with short GBI flyout ranges. The LSI and JPO are considering options e.g., not firing the third stage or initiating extreme general energy management – to resolve this issue.

Kwajalein Missile Range as well as a second missile silo at VAFB, therefore, some of the additional infrastructure cost for performing such testing is already in the NMD budget. From a technical viewpoint, Multiple Simultaneous Engagement testing is considered essential for the following reasons:

- There may be unanticipated synergistic effects between simultaneously deployed EKVs; many questions or issues simply cannot be resolved from the testing of 1-on-1 engagements. Debris, BMC3 workload, discrimination, etc., all make extrapolating from 1-on-1 to more likely scenarios uncertain.

- Effectiveness requirements pertaining to M-on-N engagements will be carried out through modeling and simulation. In order to have traceability to the real world, these simulations need "anchoring" and validation from M-on-N flight-testing.

Operational engagements for the NMD C1 System are expected to cover a much larger engagement space than what can be achieved during integrated flight tests. Figures 4, 5, and 6 illustrate the differences. Figure 4 shows that targets launched from VAFB in California toward KMR in the Western Pacific occupy one point of the target-apogee vs. target-range parameter space. Figure 5 underscores the fact that interceptor flyout in the VAFB-KMR engagement is on the very low end of the engagement space – a flyout range of roughly 700 kilometers – and at a fixed intercept altitude of 230 kilometers. And, Figure 6 compares the flight envelope – closing velocity vs. interceptor ground range – of the test program to that of the C1 engagement space. The engagement space of the test program occupies nearly a single point.

Integrated ground testing using simulated environments and full threat scenarios will be used to evaluate the performance and effectiveness of the NMD C1 system throughout the engagement envelope. These ground activities, along with modeling and simulation, are planned to mitigate flight test limitations described above. Unless additional points in the flight envelope of Figure 4 are flown in integrated flight tests, the scope and validity of system performance estimated in ground testing would remain limited.

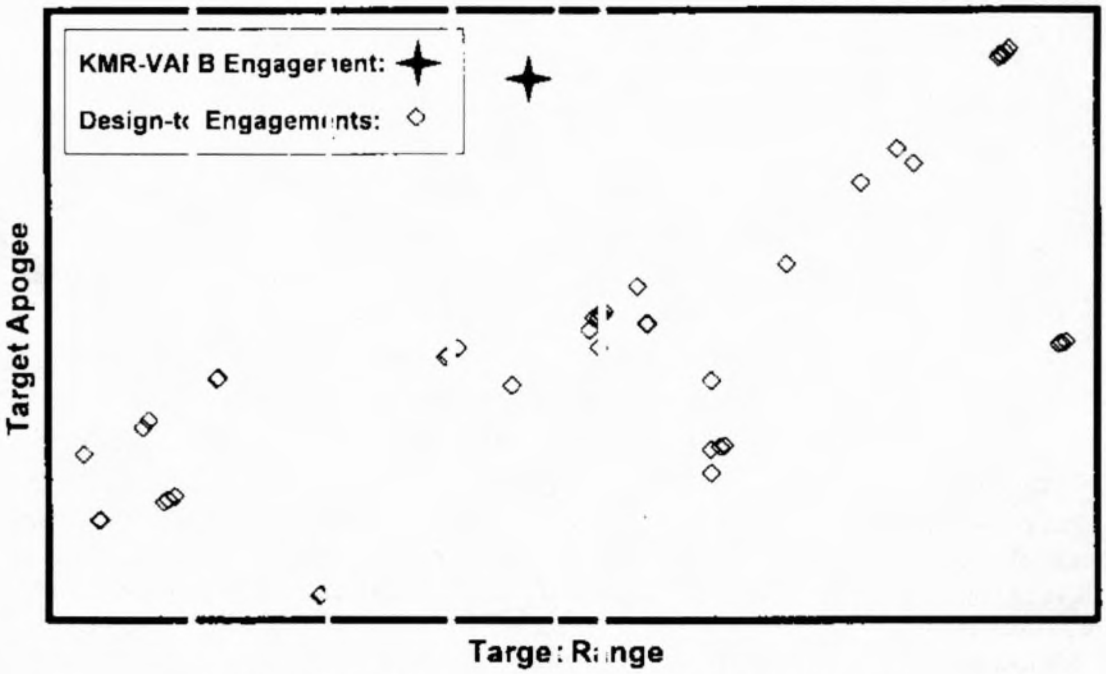

Figure 4. Target Apogee vs. Target Range Parameter Space

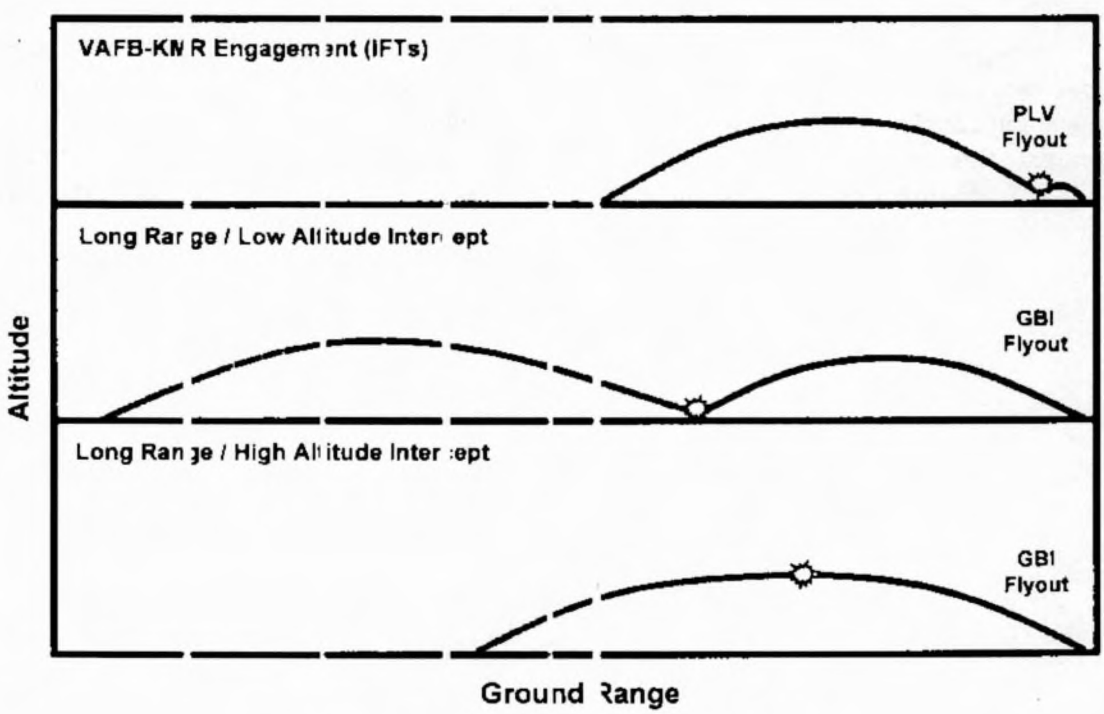

Figure 5. Interceptor Flyout Comparisons

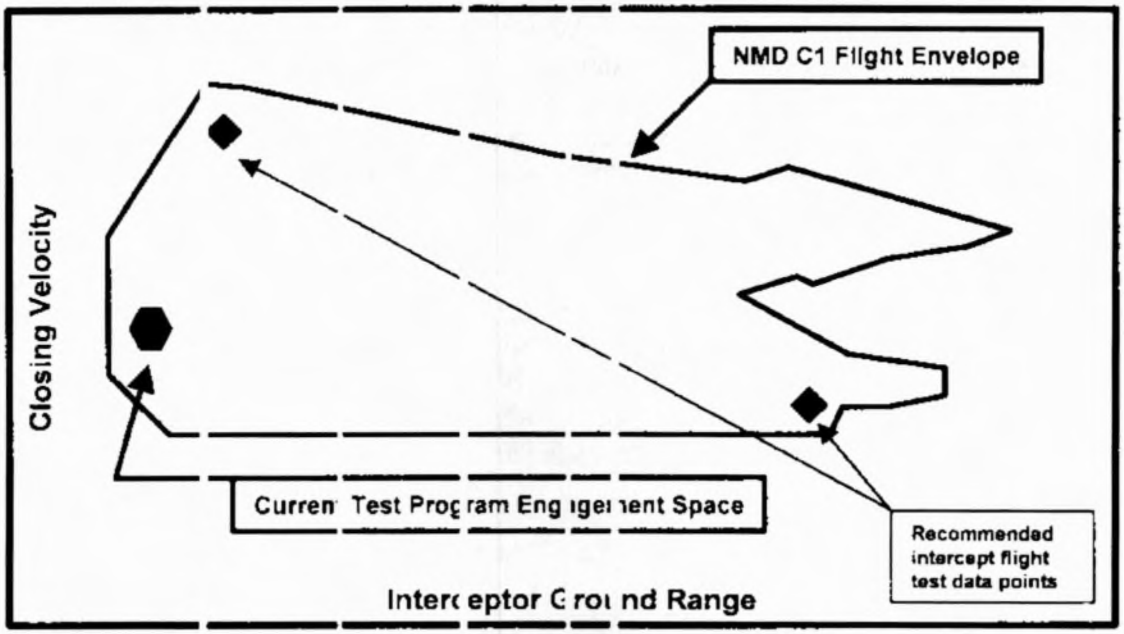

Figure 1. Closing Velocity vs. Interceptor Ground Range Parameter Space

FLIGHT TEST RESULTS

Integrated Flight Test 1A – Boeing EKV Flyby

Integrated Flight Test 1A (IFT-1A), conducted on June 24, 1997, was the first flight test of the NMD Test Program. A test was attempted in January 1997 (IFT-1) but was aborted because the surrogate for the ground based interceptor booster failed to launch. The primary objective of IFT-1A and the subsequent test IFT-2, was to provide a basis for down-selecting candidate EKVs built by competing contractors, Boeing and Raytheon

IFT-1A assessed the performance of the Boeing EKV sensor, collected phenomenological data used for post-test analysis of the onboard discrimination algorithms, and collected functional data on the dynamic flight-test environment and its effects on the EKV. Range assets and surrogate hardware – GPS and the FPQ-14 radar tracking a C-band transponder – were used to guide and deliver the EKV to a point in space where it began executing sensor functions; the BMC3 element played no role in the execution of IFT-1A. Since the EKV did not have propulsion capabilities, it was incapable of intercept but came to within 5,200 feet of the target reentry vehicle.

The principal component of the Boeing EKV design is a multiple-waveband IR sensor that allows the EKV to acquire, track, and collect data on objects of the representative threat target suite. The sensor payload consists of a focal plane array of highly sensitive silicon-based sensors and a cryogenic cooling assembly at the end of an optical telescope.

The EKV sensor payload was launched from Meck Island in the Kwajalein Atoll and set on a trajectory that permitted it to view a pre-planned target scene. The target suite was launched from VAFB using a specially configured Minuteman I booster and consisted of nine objects: one medium reentry vehicle, two medium rigid light replicas, one small canisterized light replica, two canisterized small balloons, two medium balloons, and a large balloon. Viewing objects of the target suite, the EKV seeker successfully gathered signature and phenomenology data which, in turn, were used to verify predictions made by corresponding models and simulations. One of the medium balloons did not fully inflate.

- Nine of ten objects of the target suite (including the deployment bus) were detected. For some unknown reason, one of the canisterized small balloons was not observed. As stated in the GBI 60-Day Report for IFT-1A, "No object detected on the focal plane could be correlated with the white canisterized small balloon; therefore, no seeker measurements for this object are available."
- Space (exoatmospheric) operation of the silicon seeker was verified.
- The EKV seeker collected IR signature data that were downlinked to ground receiving stations. Predictions from target signature models match seeker measurements acquired in flight for both IR bands.
- Using IR signature data collected by the EKV, post-test execution of discrimination algorithms were able to discriminate successfully the medium reentry vehicle as the threat object of the target suite. The successful discrimination of the medium reentry vehicle should not be viewed as a verification of the discrimination algorithms in an operational engagement, but rather, as a successful experiment.

Integrated Flight Test 2 – Raytheon EKV Flyby

Integrated Flight Test 2 (IFT-2) conducted on January 16, 1998, was the second flight test of the NMD Test Program. The objectives of IFT-2 were the same as that for IFT-1A, namely, to assess the performance of the EKV sensor built by the second EKV contractor, Raytheon Missile System Company. The same target suite of nine objects was flown.

EKV seeker data was downlinked and used for evaluating sensor performance and for performing post-test discrimination and signature analyses of the target suite. Range assets and surrogate hardware – GPS and the FPQ-14 radar tracking a C-band transponder – guided the EKV to a point in space where it began executing sensor functions; the BMC3 element played no role in the execution of IFT-2. As in IFT-1A, the Raytheon EKV did not attempt to intercept the medium reentry vehicle since it had no propulsion capabilities.

The principal component of the Raytheon EKV design is a multiple-waveband, Visible/IR sensor payload that allows the EKV to acquire, track, and collect data on objects of the representative threat target suite. The sensor payload consists of an HgCdTe focal plane array and a cryogenic cooling assembly at the end of an optical telescope. As in the launch of the Boeing EKV, the Raytheon EKV sensor payload was launched from Meck Island at KMR and set on a trajectory that permitted it to view a similar target scene of ten objects (nine objects of the target suite plus the deployment bus). And, as in IFT-1A, one of the medium balloons did not fully inflate.

IFT-2 was successful in collecting target object data, and post-test analyses demonstrated that the MRV could be discriminated from the other objects of the target suite. Because the discrimination algorithms were not executed in real time and relied on simulations that were anchored by IFT-2 test data, the successful discrimination of the medium reentry vehicle should not be viewed as a verification of the discrimination algorithms in an operational engagement, but rather, as a successful experiment.

At the recommendation of the Lead System Integrator (Boeing North American), the NMD Joint Program Office opted to down-select to a single EKV design prior to IFT-3, which afforded more intercept test opportunities before the DRR. The Joint Program Office selected Raytheon as the EKV contractor over Boeing.[6]

Integrated Flight Test 3 – Intercept Achieved

The first NMD *intercept* attempt of a target reentry vehicle by the Raytheon-built EKV was successful, albeit with significant limitations to operational realism, on October 2, 1999. IFT-3 began with the launch of a Minuteman-based booster from VAFB and the subsequent deployment of its target payload – MRV and Large Balloon – for reentry near KMR. An interceptor was launched from Meck Island to engage the MRV, and EKV intercept of the MRV occurred at an altitude of 230 km, 1,782 seconds after target liftoff. IFT-3 was planned and jointly executed by the NMD Joint Program Office and Boeing, the LSI. Future flight tests are being planned and executed by Boeing.

IFT-3 was an element test of the Raytheon-built EKV, not an Integrated System Test. IFT-3 was comprised of two concurrent test activities: an "in-line" test that focused on the performance of the EKV, and a simultaneous "on-line" or shadow test that focused on assessing NMD functionality as an integrated system using prototype elements that approximate the objective system. The principal objective of the on-line test was to demonstrate integration and operation of system elements as a risk reduction effort for future flight tests, IFT-4 and IFT-5.

IFT-3 In-Line Test (EKV Flight Test)

The in-line or flight test part of IFT-3 was a test of the Raytheon-built EKV. GPS track information of the target RV was used to guide and deliver the EKV to a point in space where it began executing mission-critical functions: midcourse guidance, target-complex acquisition, real-time discrimination, target selection, active homing, and intercept. Although the EKV successfully intercepted the MRV, acquisition of the target complex by the EKV was accomplished in an off-nominal manner because of a malfunctioning Inertial Measurement Unit (IMU) onboard the EKV. The IMU problem was caused by a vendor calibration procedure error, which was corrected for IFT-4.

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[6] Originally, the EKV down-selection was to occur after IFT-3 and IFT-4, intercept attempts of a target RB by the Boeing and Raytheon EKVs, respectively.

Because of the problem with IMU operation, the EKV was forced to utilize its "step-stare" capability that is activated only during off-nominal situations.

- The IMU was unable to measure angular position (pointing) of the EKV with sufficient accuracy to allow for nominal target acquisition. Large angular slew rates of the EKV, performed during star shots to refine angular navigation, were directly responsible for the malfunction of the IMU. The anomalous behavior of this IMU should not be seen in future flight tests, because a new tactical IMU built by Fibersense – will be used in the C1 EKV design and flown in integrated flight tests beginning with IFT-6 in January 2001.
- When the EKV "opened its eyes," no object of the target complex was in its field of view. The EKV executed the "step stare" procedure to extend its field of view and, subsequently, acquired the Large Balloon, deployment bus, and MRV. Had the Large Balloon not been deployed with the target suite, the EKV probably would have acquired the deployment bus and, subsequently, acquired and intercepted the MRV.
- Discrimination and target selection of the MRV from the Large Balloon and deployment bus were successfully accomplished. The guidance, navigation, and control functions were performed without incident and resulted in the intercept of the MRV.

IFT-3 On-Line Test (Shadow Test)

The on-line portion of IFT-3 ran in parallel with the in-line test to assess the performance of NMD functionality as an integrated system using prototype and surrogate elements. Elements operating on-line did not affect the operation of the in-line test but did demonstrate NMD functionality in a configuration more representative of the integrated system that might be deployed. The most notable results of the IFT-3 on-line test pertained to BMC3 and GBR-P performance.

The BMC3 successfully demonstrated integrated system performance through the coordination of system elements operating in shadow mode. It performed engagement planning that ultimately led to a successful (simulated) mission. GBR-P performance was generally poor and unsuitable for anchoring associated radar simulations. GBR-P track quality was adversely affected by a software error in the antenna mount motion equation. A software fix was implemented and later verified in the target of opportunity flight, RRF-7, which was conducted in November 1999, and in IFT-4 and IFT-5.

Integrated Flight Test 4 – Intercept Not Achieved

Integrated Flight Test 4, which was conducted on January 18, 2000, was the first *end-to-end* NMD flight test attempting a hit-to-kill intercept of a target reentry vehicle. Whereas IFT-3 was an element test of the Raytheon-built EKV, IFT-4, using surrogate and prototype elements, strived to demonstrate NMD system integration in a configuration more representative of the system that might be deployed. In particular, both the BMC3 and the GBR-P participated in the flight test "in-line." The FPQ-14 radar located in Oahu, Hawaii, was to have used the C-Band transponder data from the MRV to provide the BMC3 with target track information as though it were from a UEWR. The FPQ-14 data, however, was (erroneously) judged in real time to be of poor quality. Instead, GPS track data of the MRV was used in IFT-4 after being translated into XBR format. The geometry of the test scenario of IFT-4 was identical to that of IFT-3.

The EKV failed to intercept the MRV, a failure directly traceable to the cryogenic cooling system of the EKV. The primary cooling line that delivers krypton to the IR focal plane arrays was restricted with either frozen moisture or other contamination, and the IR sensors were prevented from cooling down to their operating temperatures. Consequently, the IR sensors did not acquire or track target objects for terminal homing and intercept.

IFT-4 demonstrated the successful operation and integration of NMD elements. Data analysis of IFT-4 has been completed, and the following assessment of test results can be made:

- **Battle Management, Command, Control, and Communications**. The non-tactical flight test version of the BMC3 operated in a fully functional, dual node configuration (Commander-in-Chief and Site). In particular, the BMC3 demonstrated end-to-end tracking of the target complex and successfully generated Weapon Task Plans, Sensor Task Plans, one of three In-Flight Target Updates, and a Target Object Map.
- **Defense Support Program**. DSP satellites successfully acquired the boosting Minuteman II target vehicle and sent Launch Alert and Boost Event Reports to the BMC3.
- **Early Warning Radar Test Article.** Post-mission analysis indicates that the EWR provided the BMC3 with sufficiently good track data of the target cluster for successful GBR-P cueing. It must be noted, however, that the EWR test article is located up-range and has the advantage of tracking targets at close range as opposed to longer ranges expected in typical NMD engagements. At close range, the radar return signal is large, which enables the radar to generate higher quality tracks of deployed objects.
- **Ground Based Radar-Prototype**. The GBR-P participated in IFT-4 as a surrogate X-Band Radar element. Its participation in IFT-4 as an *integrated* element of the system was limited, since its track data and discrimination information was not utilized by the BMC3 for the generation of the Weapon Task Plan. The GBR-P was successful in many respects: it acquired the target complex, tracked and resolved all objects of the target complex, and correctly discriminated all tracked objects as either tank-like, debris, or RV. In addition, the GBR-P supplied track information used by the BMC3 for the generation of one IFTU.

Integrated Flight Test 5 – Intercept Not Achieved

Integrated Flight Test 5 was conducted on July 8, 2000. It was to be an end-to-end NMD intercept flight test nearly identical to IFT-4 and aimed to demonstrate NMD system integration with surrogate and prototype elements in a configuration representative of the system that might be deployed. The most prominent new feature of the test was the participation of the In Flight Interceptor Communications System as the communication link between the BMC3 and EKV. As in all previous intercept tests, a Minuteman-based target system was launched from VAFB, and its target payload consisting of an MRV was deployed for reentry near KMR. The target payload also included a Large Balloon, but it was never deployed because of some unknown failure of the deployment mechanism. Then, at 1,294 seconds after target liftoff, an interceptor was launched from Meck Island to engage the MRV. The planned intercept, which did not occur, was to have been at an altitude of 230 km, 1,782 seconds after target liftoff, identical to the planned intercepts on IFT-3 and IFT-4.

The failure to intercept the MRV is the direct result of the EKV not separating from the upper stage assembly of the Payload Launch Vehicle, the surrogate for the interceptor booster. Preliminary failure analysis of the telemetry data indicates that the EKV did not receive a second-stage burnout message, a prerequisite for initiating the separation sequence. The cause of this failure has not yet been determined but appears to be isolated to the Payload Launch Vehicle. A notable consequence of the failure is that all EKV events subsequent to separation, e.g., sensor operation and divert and attitude activities, did not occur. Therefore, none of the EKV primary objectives were met.

The FPQ-14 radar located at the Kaena Point Satellite Tracking Station in Oahu, Hawaii, which tracked the C-Band transponder on the MRV, played an important role in IFT-5. Unlike IFT-4 in which GPS track data was the source for Weapon Task Plan generation, the BMC3 generated the Weapon Task Plan using FPQ-14 transponder data. GPS was still used, however. The FPQ-14 data, prior to being used to generate the Weapon Task Plan, was checked against the GPS track for accuracy; GPS data could have been used in the event that FPQ-14 data was of poor quality.[7] The Weapon Task Plan directed the launch of the interceptor at 1,294 seconds time after liftoff (TALO).

The GBR-P, the prototype X-Band Radar, successfully participated in IFT-5 as an integrated element of the system. It received target cluster cues from the BMC3, tracked all objects of interest, and correctly performed real-time discrimination on all target objects. The GBR-P tracking and discrimination timeline of IFT-5 closely matched the timeline predicted by pre-mission simulations, except that MRV acquisition occurred earlier than predicted. GBR-P participation in integrated flight tests is increasing. In IFT-5, all In Flight Target Updates (IFTUs) including the backup IFTU were generated solely from GBR-P track data. However, GBR-P track data was prevented from entering the BMC3 element until after the Weapon Task Plan had been sent to the Weapon System and, therefore, did not contribute to Weapon Task Plan generation.[8]

IFT-5 demonstrated integrated system performance through the operation of the non-tactical, flight-test version of the BMC3. The BMC3 provided end-to-end tracking of the target complex utilizing multiple sensor sources and demonstrated all operations of engagement planning and real-time communications. It successfully generated the Weapon Task Plan, Sensor Task Plans, Communication Task Plans, and IFTUs. Failure of EKV operation precluded the successful in-line operation of the In-Flight Interceptor Communications System (IFICS) – closure of the BMC3-EKV communication link – and, thus, associated objectives were not fully achieved, e.g., the receipt of In Flight Status Reports from the EKV were not evaluated. System integration of early warning elements with the BMC3 was achieved. DSP satellites successfully acquired the

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[7] In IFT-4, the FPQ-14 transponder track data was judged to be of unsatisfactory quality and, therefore, only GPS data was used to generate the Weapon Task Plan.

[8] The GBR-P is unlikely to resolve and discriminate the RV from other objects in the target cluster early enough to generate a weapon task plan. The test plan for all intercept tests to date calls for launching the interceptor only after the RV has been resolved and identified.

boosting Minuteman II target vehicle and sent Quick Alert and Boost Event Reports to the BMC3. The EWR also acquired and tracked the target complex, including spent fuel tanks, early in the mission timeline.

INTEGRATED GROUND TESTS

Boeing is performing ground testing to mitigate the risks associated with the limited flight test program. Ground testing can exercise the system through variation of threat characteristics such as launch point, aimpoint, trajectory, apogee, number of RVs, target type, and environmental effects. This ground testing is done in month-long phases called Integrated Ground Tests. IGT-4 and IGT-5 occurred in 1999; IGT-6 will not occur until after the DRR.

These ground tests use the ISTC at the U.S. Army Space and Missile Defense Command's Advanced Research Center in Huntsville, Alabama. ISTC provides test execution and control, threat and environment data, and test drivers for some NMD elements. Each NMD element is represented at a standalone computer station called a node. Each node incorporates system element mission and communications processors, which run prototype element software. ISTC supplies the nodes with simulated inputs -- threats and associated environments, natural and man-made – which are nominally consistent for each NMD element in the scenario.[9]

IGTs use a combination of models, software-in-the-loop, and hardware-in-the-loop to test the NMD engagement space and threat in an operational environment. They are supposed to validate the functionality and functional interfaces between the elements, subject the system to stressing environments and tactical scenarios, and evaluate target-intercept boundary conditions. IGTs can help to identify "unknowns" in an interactive system context and verify interoperability of NMD system elements.

There was very little operational hardware or software used in IGT-4 or IGT-5. The BMC3 was a prototype, flight-test version of the operational BMC3; it included some real communications hardware (T1 links). It is *possible* that some of the software in the UEWR representation could eventually be used in the operational UEWR. Also, some of the EKV digital signal processing software and data processing software might be used in the operational EKV.

The element hardware components are represented digitally in the Processor Test Environment. It duplicates the real-time tactical interfaces in order to inject the perceived data into the test article. For example, the Processor Test Environment for the GBR-P element contains simulation software that represents the transmitter, receiver, antenna, signal processor, measurement generation, beam volume, detection response, and radar status.

IGT-4 and IGT-5 had a number of limitations. For example, the threat apogees were unrealistically high in IGT-4, which provided optimistic assessments of timelines and radar detections. Because the simulation had limited processing capability, Boeing (LSI) eliminated most of the threat objects in many of the scenarios, which was unrealistic for testing discrimination, radar resource management, and BMC3 processing capabilities. In addition, all of the element representations suffered from limitations that produced significantly different

[9] One exception is the gravity model, which is different for the EKV and the other elements.

performance than is expected from the NMD C1 system. These limitations included, but were not limited to:

- Only five high-fidelity representations of the EKV were available. There were 15 low fidelity models, but the two representations could not be used together. Thus, a full-up scenario involving multiple RV attacks could not be represented.
- UEWR representations did not include pulse integration, leading to lower than expected signal-to-noise ratios and objects not being tracked.
- UEWR tracking accuracies often failed to meet specifications.
- The XBR was represented by a modified GBR-P model that differed in power-aperture product, field-of-view, sensitivity, slew rate, etc. Work-arounds such as increases to target cross sections were implemented to mitigate some, but not all, of these limitations.

The primary goal of IGT-4 and IGT-5 was to demonstrate the integration of BMC3 with the UEWR and XBR. Boeing successfully demonstrated integration between these three NMD elements in the two IGTs. The secondary goal of the IGTs was to assess the C1 architecture and performance against a limited set of C1 scenarios. This goal was less successful, in part because of the immaturity of the element representations in IGT-4 and IGT-5. The exact amount attributable to element model immaturity is currently undefined and will remain so until truly element-representative models are installed in ISTC.

Boeing demonstrated integration between the BMC3 and radars by generating and recording messages between the elements. They confirmed that the planned messages had been exchanged between the BMC3 and the GBR-P and UEWR, and measured the time delays between the messages.

The radar performance in IGT-4 and IGT-5 was generally poor. In IGT-4 the XBR had reasonable position track performance but the velocity track performance was much worse than specifications. The XBR improved in IGT-5 and usually met the track accuracy performance. The UEWR failed to detect a significant number of RVs in IGT-4 and IGT-5. Once an RV was acquired, the performance of the UEWR representation at a given time was generally much better than specifications in both position and velocity tracking. However, the UEWR rarely succeeded in maintaining the specified track accuracies against RVs throughout an engagement. The probability of track maintenance was well below the NMD system specification requirements for both the XBR and UEWR. The XBR discrimination results were also well below the NMD system specification requirements.

The ISTC hardware and software used to date in the IGTs are immature and do not provide an adequate representation of the NMD C1 architecture. None of the major NMD elements - BMC3, XBR, UEWR, Weapon System, and DSP/SBIRS – are mature enough to provide a good assessment of the C1 system. The 1997 TEMP discussed the consequences if the representations were not mature before the DRR: "The validity and credibility of the surrogates and the representations must be fully characterized with respect to the NMD system and element requirements prior to making any decisions based on data drawn from tests using these systems. Without this information, the results of the tests will be inconclusive at best and misleading at

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worst." IGT-4 and IGT-5 did demonstrate the integration of the BMC3 with the UEWR and XBR (not with the weapon system, however), but these tests provided only limited data to support an evaluation of the effectiveness of the initial, proposed NMD C1 system at the DRR.

BATTLE PLANNING EXERCISE 99-5 AND BMC3 ASSESSMENT

Battle Planning Exercise 99-5 (BPEx 99-5) was conducted in the BMC3 Element Laboratory at the Joint National Test Facility on September 28-30, 1999. Conceived in 1998 by U.S. Space Command (USSPACECOM/J35), BPEx events enable the User to examine and assess as-built BMC3 operational functionality for the purpose of influencing future development of the BMC3 element. The OTA Team was invited by USSPACECOM to co-lead BPEx 99-5 to benchmark BMC3 behavior in support of the Deployment Readiness Review.

The primary objective of BPEx events is to identify operational defects of the BMC3 element to be corrected in future builds. BPEx 99-5 was performed, in particular, to evaluate BMC3 element behavior in support of the OTA Team's early operational assessment of Key Performance Parameters #2 and #3 – human in control (HIC) and automated battle management – for the DRR. The evaluation of Key Performance Parameter #1, effectiveness of the NMD system to defend the United States against ballistic missile attacks, was not an objective of BPEx 99-5. The test environment representing the NMD system consisted of the following components:

- Two representative nodes of the BMC3 element – CINC and Site – running Capability Increment 3A software.
- Trained military personnel – from USSPACECOM, NORAD, Army Space Command, and Air Force Space Command – were assigned specific roles as BMC3 operators during the exercises. These operators are known as "Smart Rounds" and underwent intensive training before the exercises were conducted.
- A "simulation cell" provided simulated external input from the national command authority (NCA) and Integrated Tactical Warning/Attack Assessment (ITW/AA) to the CINC BMC3 node.
- The BMC3 Test Exerciser simulated the remaining elements of the NMD system: DSP/SBIRS, Upgraded Early Warning Radar, X-Band Radar, and the Weapon System.

Notable BMC3 Behavior

The following BMC3 behavior was observed during BPEx 99-5 execution:

- **Phantom Tracks (Track Splitting).** For scenarios in which the tracking of a threat object transitions from the XBR to a UEWR, the correlation algorithms of the BMC3 treat the UEWR returns as originating from a new, lethal object. In other words, the track of the "old" threat object splits into two tracks thereby creating a phantom track. Whenever there is sufficient battlespace for an engagement, the BMC3 battle manager would automatically allocate interceptors against this phantom object.
- **Battlespace (Time-to-Go) Bars.** The BMC3 software provides visual displays – blue horizontal bars – illustrating the time that remains for engaging a given threat object. These "time-to-go" graphics bars did not provide accurate situational awareness to the

operator, because kinematic capability of the interceptor is the only constraint defining the time-to-go. The graphics bars do not reflect limitations from solar exclusion, IFICS loading, interceptor launch rates, intercept spacing, and nuclear weapons effects avoidance, for example.

- **Kill Assessment.** Whenever the BMC3 cannot make a kill assessment for a given engagement -- because of a lack of radar coverage – an alarm is sounded and the target is treated as a "leaker." With the current radar architecture, kill assessments are frequently not available. Hence, the operator is led to believe that there are actual leakers and is dependent upon nuclear detonation reports from external sensors for situation awareness.

BMC3 Assessment

The BMC3 element is currently at an early stage of development and noted shortcomings are likely to be addressed before the initial operational capability. NMD operators had difficulty with resource management, engagement control, and situation awareness.

- **Resource management.** In the majority of scenarios, more interceptors than nominally required by the ORD were expended to defeat threat objects. For example, in a scenario with two RVs, 1[illegible] interceptors were launched. The reason for such behavior is two-fold:
  - Interceptors were launched against phantom tracks.
  - The BMC3 was very conservative during the exercises. Anything with a lethality-value greater than 0.02 (out of a maximum of 1.00) was engaged.
- **Engagement control.** When NMD operators believed that interceptors were allocated against phantom tracks, they tried a variety of techniques to override the automated battle manager to prevent the launch of interceptors.
  - Management-by-exception (MBE)[10] holds were placed on phantom tracks to prevent interceptors from being launched. Although such actions should have worked, they were unsuccessful in all cases. The system simply was not behaving according to operator actions. In any event, MBE was not intended by BMC3 developers to be used as a resource management tool.
  - The only successful technique used to prevent interceptors from being launched against phantom tracks was to allocate all remaining interceptors to reserve status.
- **Situation Awareness.** BPEx 99-5 indicated a lack of situation awareness on the part of NMD operators.
  - As mentioned above, battlespace graphics bars did not give NMD operators an accurate estimation of all times a threat object could be engaged. Engagements with short timelines were most problematic. There were scenarios for which the battle manager did not allocate interceptors – because the system did not have the

[10] MBE is defined as the capability of the Human-in-Control to make inputs influencing the system engagement behavior on a track-by-track basis.

battlespace to engage the threat – even though the associated graphics bars indicated positive battlespace. This was particularly frustrating to the operators who could not control the engagement to launch interceptors.

- The possibility of phantom targets stemming from radar-to-radar handover tended to make NMD operators anxious. There was no tool that could definitively warn operators when a phantom track appeared, so the operators were forced to rely on their judgement in this regard. In the end, the operators tended to discount information derived from the UEWRs.

- The identification of threat objects as leakers for engagements without kill assessments forced operators to speculate on whether the engagement was successful.

The LSI is developing the BMC3 with maximum automation. Inherently, the BMC3 is designed to preclude direct launch control by the operator. Rather, positive control is exercised through Rules-of-Engagement development, battle-planning development, and management by exception. The BPEx, therefore, reflects the outcome of these efforts and can be frustrating to an operator attempting real time control.

MODELING AND SIMULATION

Restrictions on realistic operational flight testing, and the complexity of the operational engagements, require the T&E program to rely heavily on integrated ground testing and the execution of digital simulations for assessing the operational suitability and effectiveness of the NMD system concept. Integrated ground testing was of limited utility in assessing the potential performance of the NMD system. Late delivery of LIDS – a high fidelity, system-level digital simulation of the NMD system – precluded its use for making a credible assessment of potential NMD system performance.

LIDS model development is taking much longer than expected. It was to be the principal digital simulation tool providing DRR support. Modeling and simulation in general and LIDS in particular were supposed to be employed to repeat hypothetical experiments in order to improve the statistical sample and to determine the values of key technical parameters unable to be measured by testing. Boeing released a beta version LIDS Build 4 at the end of April 2000. There was not enough time before the DRR to accredit LIDS and perform the required system analyses. As a result, the Service Operational Test Agencies do not have a simulation that they can use to assess the potential system effectiveness.

LIDS build 4 has serious limitations, so even if it had been released on time there would still be major issues in using LIDS to assess the potential performance of the NMD system. One problem is that LIDS users will not be able to generate their own scenarios. Boeing will provide users with canned scenarios, including fixed launch points, aim points, Inter-Continental Ballistic Missile (ICBMs), debris, and apogees. The Operational Test Agencies had been planning to run hundreds of digital simulation scenarios, varying such parameters as raid size, trajectories, atmospherics, debris, nuclear effects, threat launch and impact points, threat types, and Penetration Aids. LIDS will not have the flexibility to support such studies.

LIDS will allow users some flexibility. They will be able to change the location and number of the various NMD elements. Users will also be able specify such parameters as the reliability of GBI boost phase completion the probability of target acquisition by the EKV sensor, the probability of the EKV correctly identifying the RV, the probability of hitting the RV given correct discrimination, and the probability of killing the target given a hit. Such analyses will be useful but not sufficient to adequately assess the potential performance of the C1 system. LIDS does not simulate any of the element prototypes or surrogates currently used in flight testing. Consequently, use of the IFTs to provide traditional model validation data will not be possible until the actual system elements finally work their way into the intercept flight test program. This limits the confidence that can be placed on LIDS predictions in the foreseeable future.

Boeing is using a number of low-fidelity simulations in their development of the NMD system. One is NMDSim, which estimates the interceptor launch windows for different scenarios. The NMDSim does not simulate discrimination functionality, does not generate weapon task plans, has no interceptor flyout representation, and does not perform kill assessment. It can be a useful tool for planning engagements in higher-fidelity models or simulations, but it is too limited to credibly assess the potential performance of the NMD system.

LETHALITY TESTING

NMD lethality testing and analysis activities before the DRR have focused on the development and accreditation of version 8.1 of the Parametric Endo-Exoatmospheric Lethality Simulation (PEELS). PEELS is the only lethality simulation to be accredited for endgame evaluation of NMD intercepts. In effect, it is the simulation used in both lethality and effectiveness analyses to assess whether an NMD hit on a threat target results in a target kill. To develop an NMD-capable version of PEELS, the database of empirical results that anchors the simulation for theater ballistic missiles had to be expanded to include lethality information for intercepts of NMD-type targets by the EKV in the velocity regime expected for NMD engagements. Because there is no capability to run ground tests at the upper end of NMD intercept velocities, a series of hydrocode analyses were used to generate the bulk of the "empirical data" for NMD EKV intercepts.

A total of 490 hydrocode simulations are planned, covering the quarter-scale Light Gas Gun test projectile, warhead and aeroshell damage, and different threat targets and intercept parameters. Of these, 218 have been completed to date, namely, 178 for the Attitude Control Reentry Vehicle target and 20 for Medium Lethality Reentry Vehicle target. The main purpose of the quarter scale Light Gas Gun series was to generate instrumentation data and damage data, which are used to anchor the hydrocode prediction methodology for varying hit points, velocities, and impact angles.

A series of 20 quarter-scale light-gas-gun impact tests were conducted at the Arnold Engineering Development Center in Tennessee in 1999 against Attitude Control Reentry Vehicle targets, and a second series of 20 shots have begun testing in FY00 against the Medium Size Reentry Vehicle, Long Range Nuclear Threat, and Attitude Control Reentry Vehicle targets. These tests employ a quarter-scale surrogate of the EKV launched against a quarter-scale replica of the target at a nominal velocity of 7 km/s. FY99 test results are described in the U.S. Army

Space and Missile Defense Command Test Report. A report comparing test results to hydrocode predictions, originally scheduled for publication in April 2000, is still pending.

Besides providing a backup for the hydrocode prediction methodology, the 1999 tests provided the following information:

- The damage capability of the EKV against the Attitude Control Reentry Vehicle payload for a variety of intercept conditions (two different impact velocities, five different impact angles, and various hit locations on the target).
- The sensitivity of damage level to impact velocity (two different impact velocities).
- The validity of the lethality criteria used in the NMD-capable version of PEELS for the tested intercept conditions.
- The post-impact debris characteristics.
- The sensitivity of the lethality results to different target fabrication techniques.

Additional testing is being done to improve and validate the hydrocode simulations. Sandia National Laboratory is conducting a set of high-speed impact tests using a three-stage Light Gas Gun to develop the equations of state – the characterization of the physical phenomena that occur during impact – of several aerospace materials present in the test targets and EKV at impact velocities of 5 km/s and 12 km/s. The materials studied are silica phenolic, E-glass, and graphite epoxy. Testing is expected to be completed later this year. If significant differences between the new empirically-derived equations of state and inputs used for the hydrocode runs are found, the hydrocode analysis will be corrected and PEELS modified accordingly. Results to date suggest that such modifications will not be necessary.

Sandia is also performing a series of hydrocode analyses for the Attitude Control Reentry Vehicle and Medium Target Reentry Vehicle targets. Their objective is to characterize the lethal volume for aerothermal structural kills. Aerothermal structural kills could occur if the target incurs sufficient damage from an EKV impact and suffers aerothermal demise during atmospheric reentry. As of March 2000, 93 hydrocode runs had been made. The analyses are expected to continue through 2000.

Based on the accumulated data from lethality tests and analyses, PEELS 8.1 was accredited by the Accreditation Working Group (AWG) on April 4, 2000. In the accreditation report dated April 28, 2000,[11] the AWG recommends accreditation of PEELS 8.1 for the following experiments:

- Determination of RV negation given the parameters that specify the RV, kill vehicle, and intercept conditions.
- Determination of Technical Performance Measures (TPMs) as specified in the Detailed Analysis Plan:
  - **TPM #23.** Probability of Single Shot Kill.

[11] Joint Program Office, National Missile Defense, *The Parametric Endo/Exoatmospheric Lethality Simulation (PEELS) Accreditation Report for the National Missile Defense System (U)*, 14 April 2000, UNCLASSIFIED.

- **TPM #24.** Probability of Hitting Target within Specified Aimpoint Accuracy. Note: This TPM cannot be calculated by PEELS alone, since PEELS can only predict the probability of kill given a hit point and miss distance.
- **TPM #25.** Probability of the NMD System Meeting its Objective.

- Determination of aimpoint selection to support DRR. However, the user should be aware of the disproportionate lethal volumes for the three targets currently modeled. Specifically, the Long Range Nuclear Threat does not contain an expanded lethal volume. In addition the lethal volumes are expected to change in the future when late-time structural effects are included. Therefore, the optimum aimpoint suggested by PEELS 8.1 may change in subsequent versions.

The accreditation report has specified the following caveats under the recommendation for accreditation approval.

- PEELS 8.1 is not suitable for the calculation of endgame maneuvers undertaken by the EKV to achieve intercept.
- PEELS 8.1 lethal volumes contain no velocity dependence.
- PEELS 8.1 provides limited probabilistic outputs. Generally, the user feeds system 6-DOF data into PEELS 8.1 for engagement-by-engagement target negation calculations and then post-processes the data to provide a complete $P_{kill/hit}$ solution.
- PEELS 8.1 does not contain all C1 threats. PEELS 8.1 only contains those threats that have been officially released by the Defense Intelligence Agency (DIA) (Attitude Control Reentry Vehicle, Medium Lethality Reentry Vehicle, and Long Range Nuclear Threat).
- Because of time constraints, hydrocode runs against the Long Range Nuclear Threat have not been performed. Therefore, the expanded lethal volume used in PEELS 8.1 for the Attitude Control Reentry Vehicle and Medium Test Reentry Vehicle are disproportionate to that used for the Long Range Nuclear Threat.
- The EKV model and target models are not user changeable. Any significant change to the EKV design will require review by the Department of Energy to determine any possible changes to the lethal volume data
- PEELS 8.1 does not calculate post-impact damage to an RV that survives impact.

Lethality Assessment

The quarter-scale Light Gas Gun testing conducted to date utilized a low fidelity surrogate of the EKV that matched the average mass properties of both the Raytheon and Boeing EKV concepts but not their precise structure or materials. The results obtained could be representative of the grosser aspects of NMD's direct hit lethality against the Attitude Control Reentry Vehicle target. The tests showed that damage to NMD targets from direct hit by the EKV will depend on the location of the impact within the payload. *Not every hit would necessarily result in a kill.*

The hydrocode analyses provided predictions of expected NMD lethality against threat targets in the hypervelocity regime and supported the development of the lethal volume in PEELS version 8.1 and enabled its use as a tool for DRR analysis.

After DRR, the development of the Live Fire Test and Evaluation (LFT&E) program will be addressed in the NMD Lethality IPT under the joint leadership of the JPO and the LSI. Although the LFT&E strategy is yet to be finalized, it is expected to include three flight tests: reduced-scale light gas gun tests, hydrocode analyses, and PEELS analyses.

FUTURE TEST PLANNING

Under the program-of-record, test results are not likely to be available in 2003 to support a recommendation then to deploy a C1 system in 2005. This is because the currently planned testing program is behind, because the test content does not yet address important operational questions, and because ground test facilities for assessment are considerably behind schedule.

NMD developmental testing needs to be augmented to prepare for realistic operational situations in the Initial Operational Test and Evaluation (IOT&E) phase, and is not yet aggressive enough to keep pace with the currently proposed schedules for silo and radar construction and missile production. The testing schedule, including supporting modeling and simulation, continues to slip while the construction and production schedules have not. Important parts of the test program have slipped a year in the 19 months since the NMD program was restructured in January 1999. Thus the program is behind in both the demonstrated level of technical accomplishment and in schedule. Additionally, the content of individual tests has been diminished and is providing less information than originally planned.

I am especially concerned that the NMD program has not planned nor funded any intercept tests until IOT&E with realistic operational features such as multiple simultaneous engagements, long-range intercepts, realistic engagement geometries, and countermeasures other than simple balloons. While it may not be practical or affordable to do all these things in developmental testing, selected stressing operational requirements should be included in developmental tests that precede IOT&E to help ensure sufficient capability for deployment. For example, the current C-band transponder tracking and identification system, justified by gaps in radar coverage and range safety considerations, is being used to provide target track information to the system in current tests. This practice should be phased out prior to IOT&E. This will ensure that the end-to-end system will support early target tracking and interceptor launch.

There is nothing wrong with the limited testing program the Department has been pursuing so long as the achieved results match the desired pace of acquisition decisions to support deployment. However, a more aggressive testing program, with parallel paths and activities, will be necessary to achieve an effective IOC by the latter half of this decade. This means a test program that is structured to anticipate and absorb setbacks that inevitably occur. The NMD program is developing test plans that move in this direction.

The time and resource demands that would be required for a program of this type would be substantial. As documented in the Congressional Budget Office (CBO) report on the budgetary and technical implications of the NMD program,[12] the Safeguard missile program conducted 165 flight tests. The Safeguard program was an early version of NMD. The SPRINT program conducted 42 test firings in a five-year period between 1965 and 1970, **more than 8 per year**, before its first intercept-like test. Over the next three years, SPRINT flew 23 intercept-type tests before production. The Spartan program fired 15 missile tests between 1968 and 1969 before conducting 24 intercept-type tests over the next five years. Similarly, the Polaris program conducted 125 flight tests, and the Minuteman program conducted 101 flight tests. Rocket science has progressed in the past 35 years, and I am not suggesting that a hundred or more NMD flight tests will be necessary. However, the technology in the current NMD program is more sophisticated than in those early missile programs, and we should be prepared for inevitable setbacks. More recently, in the 1980s, the Peacekeeper (MX) program launched 15 missiles in the four years before its IOC, ramping up from three flight tests per year to five flight tests per year between 1983 and 1986. It is apparent from these test schedules that an extensive amount of work was done in parallel from one flight test to another. Failures that occurred were accepted, and the programs moved forward with parallel activities as flight testing continued.

As in any weapons development program, the NMD acquisition and construction schedules need to be linked to capability achievements demonstrated in a robust test program, not to schedule per se. This approach supports an aggressive acquisition schedule if the test program has the capacity to deal with setbacks. On three separate occasions, independent panels chaired by Larry Welch (General, USAF Retired) have recommended an event driven, not schedule driven, program. In the long run, an event driven program may take less time and cost less money than a program that must regularly be re-baselined due to the realities of very challenging technical and operational goals.

OBSERVATIONS AND CONCLUSIONS

Aggressive flight testing, coupled with comprehensive hardware-in-the-loop and simulation programs, will be essential for NMD. Additionally, the program will have to adopt a parallel, "fly through failure," approach that can absorb tests that do not achieve their objectives in order to have any chance of achieving an FY05 deployment of an operationally effective system. As noted by CBO, the Navy's Polaris program successfully took such an approach 30 years ago.

Deployment means the fielding of an operational system with some military utility which is effective under realistic combat conditions, against realistic threats and countermeasures, possibly without adequate prior knowledge of the target cluster composition, timing, trajectory or direction, and when operated by military personnel at all times of the day or night and in all weather. Such a capability is yet to be shown to be practicable for NMD. These operational considerations will become an increasingly important part of test and simulation plans over the coming years.

[12] CBO Papers, *Budgetary and Technical Implications of the Administration's Plan for National Missile Defense*, April 2000.

In particular, more work is needed in the following areas:

The target sets for the three intercept flight tests conducted so far have only included a single target RV with a single large balloon that did not resemble the target RV in those features which the NMD system might use for discrimination and which an enemy might try to employ. The large balloon is an unrealistic representation of the threat, and operational NMD capability has not yet been demonstrated against the simplest of realistic, unsophisticated countermeasures. No tests against such decoys are planned until IFT-10 now scheduled for the first quarter of FY03, at the earliest when balloons alone may be flown that may have signatures but not shape, or motion, similar to the target RV.

The NMD Program is planning flight intercept tests with different balloon types and sizes which become more difficult to discriminate as the testing program moves forward. In addition, the NMD Program is planning tests with other types of decoys in non-intercept "risk reduction" flights. Eventually, intercept flight tests with such decoys will be needed as well. For example, no flight intercept tests have been conducted or are scheduled with tumbling target reentry vehicles or decoys designed to resemble tumbling RVs, perhaps the easiest RV for an enemy to deploy.

Intercept tests so far have used essentially identical trajectories, where the intercept points were known and planned in advance, as required for range safety. More operationally realistic scenarios will need to be developed, including long range intercepts and multiple simultaneous engagements.

Like the kill vehicles, X-Band Radars should be able to deal with unsophisticated decoys that resemble the target RV in signature, shape, and/or motion. We have not yet determined the operational ability of X-Band Radars to discriminate target RVs from such decoys in an intercept flight test. Also, new sensors may be required on the ground or in space on satellites. Again, these sensors have not been tested as part of the NMD architecture.

In the flight intercept tests so far, GPS or C-band beacon transponders have been used by the BMC3 to create the Weapon and Sensor Task plans which first aim the interceptor and the GBR-P. These sensors will need to be separated from the operational system in future tests prior to IOT&E.

Much of the operational context for assessing NMD is to be provided by end-to-end simulation tools which have not progressed as planned. The Lead System Integrator Integration Distributed Simulation (LIDS) has not achieved the planned level of operability or realism which was to have been available to support the DRR. Other alternative simulations have been pieced together to assess the potential of the NMD system. The Integrated System Test Capability processor-in-the-loop facility is not yet adequate to produce valid Integrated Ground Test results for system effectiveness assessment. Hardware-in-the-loop facilities need to be developed in time to support meaningful testing against countermeasures. Overall, modeling and simulation efforts are considerably behind schedule and also have not yet produced results that would support a recommendation to deploy.

We have no flight intercept test results yet to demonstrate the residual capability of a C1 system to handle the unsophisticated countermeasures that would be expected to be contained in accidental or unauthorized launches.

The test results to date also do not support a recommendation to deploy an <u>expanded</u> C1 capability by 2007 with additional interceptors and radars. Initial capability C1 interceptors may need to be upgraded for the expanded capability, as new test results emerge and as new information becomes available about the threat.

RECOMMENDATIONS

FLIGHT TESTING

Testing Complexity

Testing is currently designed to accommodate an aggressive pace of development. Flight testing, however, needs to aggressively increase in complexity to keep pace with NMD C1 development and to adequately stress design limits, particularly for the missile system.

- Target suites used in integrated flight tests need to incorporate challenging unsophisticated countermeasures that have the potential to be used against the NMD C1 system (e.g., tumbling RV and non-spherical balloons). Use of the large balloon should be discontinued, as it does not mimic in any way the current test RV. True decoys that attempt to replicate RV signatures as well as balloon-type countermeasures that have been examined by the Countermeasures Hands-On Program (CHOP) need to be integrated into flight test target suites.
- Engagement times of day and solar position need to be planned to stress the acquisition and discrimination process by all of the sensor bands. Additionally, the effects of weather on radar, telemetry, and satellite operations need to be tested either during intercept or risk reduction flight tests or other targets of opportunity. Radar discrimination, IFICS transmission/reception, and DSP/SBIRS launch detection may be operating at their technical limits, and heavy rain or dense cloud conditions may have significant effects on their performance.
- Category B engagements are engagements in which an interceptor is launched against a target cluster (based on radar track) before the threat RV is resolved and discriminated. Since such engagements are expected to be common during NMD missions, this capability will need to be demonstrated in an integrated flight test before IOC. Such engagements are currently not included in the defined test plan.
- Multiple engagements will be the expected norm in tactical situations, therefore, simulated extrapolation from 1-on-1 scenarios to M-on-N need to be validated through intercept flight testing. Multiple engagements of at least 2-on-2 scenarios need to be flight tested, as too many technical challenges to the system exist beyond merely the command and control software. Identifying the impact of the interaction of one kill vehicle to another and assessing the performance of ground tracking systems in M-on-N scenarios lead to several questions:
  - How will an EKV respond to another EKV in its field of view, or multiple RVs in its field of view?

– How is the performance of an EKV seeker affected by a thrusting EKV or another EKV intercepting an object in its field of view?

– Can the X-Band radar simultaneously track multiple RVs that require different antenna orientations?

– Can the IFICS communicate with multiple KVs?

- Radar discrimination with limited *a priori* knowledge of the target complex needs to be flight tested prior to the FY01 radar decision. This type of test ("pop quiz" type) of flight test needs to be executed, at least during a risk reduction flight. This test should employ multiple decoys designed to mimic the RV radar signature but should not provide unrealistically detailed target or decoy information to the GBR-P radar prior to the engagement.

Testing Artificiality

Current test range limitations need to be removed to adequately test the NMD system.

- Use of the FPQ-14 range radar as the source of Weapon Task Plan data needs to be phased out. Target trajectories or radar surrogate locations need to be changed to permit the organic NMD system to provide early radar cueing with the appropriate degree of position and velocity accuracy.
- Engagement geometries need to be devised that will provide higher speed engagement conditions for the EKV, as would be expected in the C1 timeframe with the tactical booster.

Operational Realism

Avoidable limitations to operational realism must be removed before conduct of IOT&E.

- Rehearsed engagements with *a priori* knowledge of target complex, target trajectory, and time of launch need to be discontinued during operational testing. Situations employing lack of *a priori* knowledge also need to be examined in Developmental Testing to assure acquisition and discrimination algorithms are properly designed.
- The flight testing artificialities addressed above must be eliminated for IOT&E. Alternative intercept test scenarios must be devised that employ inbound or crossing targets rather than outbound relative to the Early Warning Radar. GPS and midcourse radar tracking using a transponder cannot be used by the NMD system to perform its mission. The Weapon Task Plan must be prepared based on organic NMD tracking systems. Options must be investigated for testing higher speed intercepts and other stressing engagement parameters.
- Deployed element usage needs to be maximized for IOT&E. The X-Band Radar and/or Upgraded Early Warning Radar should be used. Deployed IFICS ground antennas and tactical communications should also be tested as part of the IOT&E.

- Multiple engagements must be accomplished during IOT&E. Furthermore, this type of engagement should be flown in IFTs before IOT&E to maximize the chance of success in IOT&E.

Spares

Plans for providing adequate spares should be developed, especially for targets where current target components can be as much as 30 years old

- Adequate GBI booster spares need to be procured as a risk reduction effort, to preclude further schedule slip should a failure occur in preflight booster testing.
- NMD is currently employing what is referred to as a "rolling spare" concept for its targets. It can take up to six weeks to prepare for and reset the IFT launch date. A "hot spare" approach for which an additional target is prepared at the target launch site would eliminate the need to stand down operations at the interceptor launch site in the event of a failed target launch. This could be more significant as flight testing becomes more complex or critical, such as in the small number of OT shots, when a failed target launch might be much more costly to the program. The delay to the target launch during IFT-5 is a strong example of this potential problem. If the last minute target problems could not have been corrected, IFT-5 would have slipped an additional month.

GROUND TESTING AND SIMULATION

Hardware-in-the-Loop (HWIL)

An innovative new approach needs to be taken towards HWIL testing of the EKV, so that potential design problems or discrimination challenges can be wrung out on the ground in lieu of expensive flight tests.

- HWIL development needs to focus on the EKV, since this is the most challenging technical area for NMD hit-to-kill. Funding and development needs to be accelerated or the required capability in this area will not be available to support C1 testing.
- The HWIL facility and test approach needs to be done at the highest level of EKV system integration achievable, so that all component interaction, from sensors to the divert systems, can be examined simultaneously.
- An innovative approach should be taken that provides an interactive scene generation capability that adapts to changes in EKV and target aspect angles.
- Scene generation should have the capability to challenge target acquisition by the EKV, discrimination and homing algorithms with anticipated or potential countermeasures.

Lethality

Current analysis of exoatmospheric lethality is limited to computer simulations and light gas gun tests.

- New techniques or facilities need to be developed to achieve higher speed intercepts on the ground in full scale to validate hydrocode simulations and ¼ scale light gas gun tests.
- Investments need to be made in the Holloman High Speed Test Track to permit lethality testing of medium to high fidelity representations of the kill vehicle to at least the low end of the range of potential intercept velocities.

Simulation

LIDS development has taken much longer than originally promised. Additionally, it is practically a hard-wired simulation that only the Boeing developers can modify. This precludes independent, government sensitivity analysis and assessment.

- LIDS needs to evolve to a fully validated high fidelity simulation. It should be flexible enough to allow both the Director, Operational Test & Evaluation and Service Operational Test Agencies to examine subsystem drop-outs and graceful degradation or other areas of sensitivity or design margin analysis. There is currently no apparent plan by the LSI to do this.

PROGRAMMATIC ISSUES

Performance Criteria

Discrimination by the radar and weapon system (EKV) should be given more weight in performance criteria. All other aspects of the NMD performance requirements appear to be within the state of the art of technology. Discrimination by the EKV on the other hand will be the biggest challenge to achieving a hit-to-kill intercept. Decoys that provide a close representation of the RV or modify the RV signature have only been minimally investigated.

ORD Reliability Requirements

The NMD requirements for reliability, availability, and effectiveness are specified in the NMD ORD. When these requirements are allocated to the individual elements of the NMD system, the resulting reliability performance standards are unrealistically high as well as difficult to test. As the program develops, it may be necessary to re-examine the overall requirements for NMD reliability and availability.

Risk Reduction Efforts

The following programs can make significant contributions to risk reduction efforts if properly utilized.

- Minuteman Missile Operational Evaluation testing needs to continue to be leveraged, not only for IFT rehearsal, but also to look at the impact of countermeasures to ground radar systems.
- Ballistic Missile Critical Measurements Program tests need to be conducted to examine countermeasure signatures and discrimination algorithms.

Countermeasures Hands-On Program (CHOP

The Ballistic Missile Defense Organization sponsors a red team approach to the possible development of countermeasures. Operated at very modest funding levels, CHOP develops and demonstrates Rest-of-World (ROW) countermeasures that could be challenging for U.S. missile defense systems. By charter, CHOP does not try to develop "sophisticated" countermeasures. However, the unsophisticated, ROW countermeasures they do develop are realistic and challenging and should be included as an integral part of the NMD flight testing and ground test HWIL simulation programs.

- The CHOP program needs to be supported for aggressively examining the potential of states of concern to develop more sophisticated countermeasures.
- The Defense Intelligence Agency needs to begin tracking CHOP experiments. They should then investigate and bound the ability of states of concern to develop and apply the technologies that the CHOP teams use in their experiments to counter an NMD system. This information should then be fed back to CHOP management for planning and executing CHOP developments.

Operations in a Nuclear Environment (OPINE)

The NMD Program Office chartered a red team to look at OPINE testing and facility requirements for the EKV. The red team found the Raytheon-proposed test and parts screening program to be inadequate.

- OPINE testing needs to be conducted at the EKV system level in nuclear environments that replicate expected operational conditions, including expected flux levels.
- OPINE test facilities at Aberdeen Proving Ground and Arnold Engineering Development Center need to receive appropriate and timely funding to support EKV OPINE testing required to begin in FY02.

Hit to Kill

The NMD Program Office should investigate lethality enhancement options for dealing with potential countermeasures, using relatively simple techniques, that try to alter the effective RV size or shape in an attempt to foil discrimination and aimpoint selection.

Mr. Chairman, I want to thank you again for the opportunity to discuss these matters today. There are many important issues which justify the oversight of this Committee.

Much progress has been made, and much remains to be learned and accomplished.

A key to success will be a vigorous and robust testing program.

ACRONMYS

ABM	Anti-Ballistic Missile
AWG	Accreditation Working Group
BMC3	Battle Management Command, Control, and Communications
BMD	Ballistic Missile Defense
BPEx	Battle Planning Exercise
C1	Capability 1
C2Sim	Command and Control Simulation
CBO	Congressional Budget Office
CHOP	Countermeasures Hands-On Program
CINC	Commander-In-Chief
COTS	Commercial Off The Shelf
DAB	Defense Acquisition Board
DIA	Defense Intelligence Agency
DoD	Department of Defense
DOT&E	Director, Operational Test and Evaluation
DRR	Deployment Readiness Review
DSP	Defense Support Program
EKV	Exoatmospheric Kill Vehicle
FY	Fiscal Year
GBI	Ground Based Interceptor
GBR-P	Ground Based Radar-Prototype
GPS	Global Positioning System
HIC	Human-in-Control
HWIL	Hardware in the Loop
ICBM	Inter-Continental Ballistic Missile
IFICS	In-Flight Interceptor Communications System
IFT	Integrated Flight Test
IFTU	In Flight Target Update
IGT	Integrated Ground Test
IMU	Inertial Measurement Unit

IOC	Initial Operational Capability
IOT&E	Initial Operational Test and Evaluation
IPT	Integrated Product Team
IR	Infrared
ISTC	Integrated System Test Capability
ITW/AA	Integrated Tactical Warning / Attack Assessment
JPO	Joint Program Office
KMR	Kwajalein Missile Range
LFT&E	Live Fire Test and Evaluation
LIDS	LSI Integration Distributed Simulation
LSI	Lead System Integrator
MBE	Management-by-Exception
MRV	Medium Reentry Vehicle
MSE	Multiple Simultaneous Engagement
NCA	National Command Authority
NMD	National Missile Defense
NMDSim	National Missile Defense Simulation
NORAD	North American Aerospace Defense Command
OPINE	Operations in a Nuclear Environment
ORD	Operational Requirements Document
OTA	Operational Test Agency
PEELS	Parametric Endo-Exoatmospheric Lethality Simulation
PLV	Payload Launch Vehicle
ROW	Rest-of-World
RRF	Risk Reduction Flight
RV	Reentry Vehicle
SBIRS	Space Based Infrared System
TEMP	Test and Evaluation Master Plan
TPM	Technical Performance Measure
UEWR	Upgraded Early Warning Radar
USSPACECOM	U.S. Space Command
VAFB	Vandenberg Air Force Base
XBR	X-Band Radar

B

Major Reports to Congress

The Director, Operational Test and Evaluation is responsible for preparing and submitting three types of reports to the Secretary of Defense and the Congress. Each type of report is briefly described below. In addition, a list of reports provided to the Congress during fiscal year 2000 and the beginning of fiscal year 2001 and those to be provided during the remainder of the fiscal year is provided.

Beyond Low-Rate Initial Production Report

The Director, Operational Test and Evaluation is responsible for reporting to the Secretary of Defense, the Under Secretary of Defense (Acquisition, Technology and Logistics), and the Congress the operational test results for all major defense acquisition programs (Title 10 U.S. Code). At the conclusion of the initial operational test and evaluation, the Director, Operational Test and Evaluation prepares the required report stating his opinion as to whether the test and evaluation performed was adequate and whether the results of such test and evaluation confirm that the articles tested are effective and suitable for combat. This report is commonly known as the Beyond Low-Rate Initial Production Report because a final decision on whether a weapon system acquisition program is to proceed beyond low-rate initial production may not be made until the Director has submitted this report to the Secretary of Defense and the congressional defense committees have received this report.

Live Fire Test and Evaluation Report

The Office of the Director, Operational Test and Evaluation is also responsible for the oversight of live fire test and evaluation programs in accordance with Title 10 U.S. Code Section 139. A covered system may not proceed beyond low-rate initial production until realistic survivability testing of the system is completed and the Secretary of Defense has submitted a report on the results of the testing to the congressional defense committees (Title 10 U.S. Code Section 2366). Similarly, a major munitions program or a missile program may not proceed beyond low rate initial production until realistic lethality testing of the program is completed and the Secretary of Defense has submitted a report on the results of the testing to the congressional defense committees. Product improvement programs for covered systems, major munitions and missile programs are also subject to the same testing and reporting requirements (10 U.S. Code 2366).

Department of Defense regulation uses the term "covered system" to include all categories of systems or programs identified in 10 U.S. Code Section 2366 as requiring live fire test and evaluation. In addition, systems or programs that do not have acquisition points referenced in 10 U.S. Code Section 2366 but otherwise meet the statutory criteria, are considered "covered systems" for the purpose of D, Operational Test and Evaluation oversight.

Director, Operational Test and Evaluation Annual Report

Title 10 U.S Code Section 139 requires the Director, Operational Test and Evaluation to prepare an annual report summarizing the operational test and evaluation activities and live fire test and evaluation activities of the Department of Defense during the preceding fiscal year (10 U.S. Code 139). This report is to include such comments and recommendations as the Director considers appropriate, including comments and recommendation on resources and facilities available for operational test and evaluation and levels of funding made available for operational test and evaluation activities. This report is to be submitted concurrently to the Secretary of Defense, the Under Secretary of Defense for Acquisition, Technology and Logistics, and the Congress not later than 10 days after the transmission of the budget for the next fiscal year.

Major Reports Sent to the Congress

Below if a list of reports transmitted by the Director, Operational Test and Evaluation to the Congress from October 1999 through December 2000.

Coastal Mine Hunter (MHC 51) Beyond Low-Rate Initial Production Report	Dec-00
Special Operations Aircraft (SOA) Live Fire Test & Evaluation Report	Dec-00
V-22 Osprey Live Fire Test and Evaluation and Operational Test and Evaluation Report	Nov-00
F-15E TEWS AN/ALQ 135 Band 1.5 Operational Test and Evaluation Report	Nov-00
XM1001 40mm Canister Cartridge Live Fire Test and Evaluation Report	Sep-00
MH-47E and MH-60K Special Operations Aircraft Live Fire Test and Evaluation Report	Sep-00
Joint Surveillance Target Attack Radar System (JSTARS) Operational Test and Evaluation Report	Aug-00
Standoff Land Attack Missile- Expanded Response (SLAM-ER) Operation Test and Evaluation Live Fire Test and Evaluation Report	May-00
F/A-18E/F Hornet Operational Test and Evaluation Report /Live Fire Test and Evaluation Report	Mar-00
Director, Operational Test and Evaluation Annual Report	Jan-00
Rolling Airframe Missile (RAM) Block Upgrade Operational Test and Evaluation Report / Live Fire Test and Evaluation Report	Jan-00
SH-60B and HH-60H Live Fire Test and Evaluation Report	Jan-00

Minuteman III Operational Test and Evaluation Report	Dec-99
Voice Communications Switching System (VCSS) Operational Test and Evaluation Report	Oct-99
Fighter Data Link (FDL) Operational Test and Evaluation Report	Oct-99

Upcoming Reports

In addition to the Director, Operational Test and Evaluation Annual Report to be transmitted to the Secretary of Defense and the Congress in January 2001, the following major test reports are to be completed and sent to the Congress during the remainder of fiscal year 2001.

Advanced Medium Range Air-to-Air Missile (AMRAAM) Live Fire Test & Evaluation Report	Dec 00
Amphibious Transport Dock Ship (LPD-17) Operational Test-IIA	Jan 01
Joint Primary Aircraft Training System (JPATS) Beyond Low-Rate Initial Production Report	Jan 01
Advanced Deployable System (ADS) Operational Test-1C Operational Assessment	Jan 01
Predator Beyond Low-Rate Initial Production Report	Jan 01
Integrated Defensive Electronic Counter Measures System (IDECM) Block I Beyond Low Rate Initial Production Report	Feb 01
Joint Direct Attack Munition (JDAM) Beyond Low-Rate Initial Production Report	Feb 01
B-2 Live Fire Test & Evaluation Report	Feb 01
Bradley Fighting Vehicle System (BFVS) A3 Beyond Low-Rate Initial Production Report	Mar 01
SEAWOLF Attack Submarine (SSN-21) Operational Test Report	Apr 01
Arliegh Burke (DDG-51) Live Fire Test & Evaluation Report	Jun 01
National Airspace System (NAS) (Radar Automation) Beyond Low-Rate Initial Production Report	Aug 01
Joint Stand-Off Weapon (JSOW) BLU-108 Beyond Low-Rate Initial Production Report	Sep 01

Seawolf SSN-21 Class Attack Submarine Live Fire Test & Evaluation Report	Sep 01
CH-60S Fleet Combat Support Helicopter Upgrade Live Fire Test and Evaluation Report	Sep 01
CH-60S Fleet Combat Support Helicopter Upgrade Beyond Low-Rate Initial Production Report	Sep 01
Minute Man III Product Reliability Program (PRP) Beyond Low-Rate Initial Production Report	Sep 01
Patriot PAC-3 Missile Live Fire Test & Evaluation Report	Oct 01
Sensor Fused Weapon (SFW) P3I Live Fire Test & Evaluation Report	Oct 01
Cooperative Engagement Capability (CEC) Beyond Low-Rate Initial Production Report	Oct 01

C

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Pending Legislative Issue Number 1 on the F-22

Background

Section 219 of National Defense Authorization Act for Fiscal Year 2001 requires the Director of Operational Test and Evaluation to submit to the Congressional defense committees a certification that a one and one half percent relief on the Engineering and Manufacturing Development cost cap of the F-22 aircraft program is required for testing. The certification is to be made after consultation with the Under Secretary of Defense for Acquisition, Technology, and Logistics. [The National Defense Authorization Act for Fiscal Year 2001, Conference Report, 106-945, Section 219, pages 46 and 720.]

After the Defense Acquisition Board reviews the Exit Criteria for Calendar Year 2000 and determines whether the program is ready to enter Low Rate Initial Production, a letter of certification reference the above language will be sent to each Chairman of the Defense Committees.

Director, Operational Test and Evaluation Position

DOT&E has stated in the last two years in testimony before the Senate Armed Services Committee, AirLand Forces Subcommittee, programmatic efforts to reduce costs to stay within the cost cap almost always results in less testing and increased development risks. These development risks become greater with elapsed time as the cost reduction options become harder to implement. At this point, since the test budget is essentially the only remaining uncommitted Engineering and Manufacturing Development budget item, cost reductions become test reductions. Any reduction of testing tasks increases the risk of not being ready to start or successfully complete Initial Operational Test and Evaluation.

Recommendation

The F-22 test program has fallen considerably behind schedule again this year due to various problems that have caused program delays and occasional flight test stoppages. Based on the current status of the test program and the System Program Office estimates, which show that the initial operational test and evaluation cannot be started in August 2002 (current schedule) without clearly unacceptable risks, the planned test program cannot be completed as currently scheduled. A reasonable test schedule would certainly require an extension of Engineering Manufacturing Development, probably a delay of up to one year for initial operational test and evaluation (from 2002 to 2003) and Milestone III. The one and one-half percent budget is certainly needed for testing.

Pending Legislative Issue Number 2 on the F-22

Background

Section 8124 of the Defense Appropriation Act for Fiscal Year 2001 requires the Director of Operational Test and Evaluation, upon completion of the requirements that the first flight of an F-22 incorporating Block 3.0 software was conducted and the Secretary of Defense certifies to the Congressional defense committees that all Defense Acquisition Board exit criteria for Low Rate Initial Production have been met, to submit to the Congressional defense committees a report assessing the adequacy of testing to date to measure the performance of the F-22 avionics systems, stealth characteristics, and weapons delivery systems. [Fiscal Year 2001 Defense Appropriation CONFERENCE REPORT 106-754, Section 8124, page 48.]

After the Defense Acquisition Board reviews the Exit Criteria for Calendar Year 2000 and determines whether the program is ready to enter Low Rate Initial Production, a report of assessment reference the above language will be sent to each Chairman of the Defense Committees.

Director, Operational Test and Evaluation Position

By the time the Defense Acquisition Board meets in early January 2001, the Director, Operational Test and Evaluation expects that the exit criteria for low-rate initial production will have been met. The Director, Operational Test and Evaluation has determined that testing to date has been adequate to measure the performance of the avionics systems, stealth characteristics, and weapons delivery systems. The optimistic plans to significantly increase the test flying rate during 2000 were not achieved. The flight test points completed during this year also were well below planning expectations, about 40% of the planned testing. Test flying was constrained primarily by late delivery of flight test aircraft, canopy transparency cracks, aileron hinge ping problems, flaperon repairs, environmental control system problems, and inlet delamination inspections. Based on the current status of the test program and the System Program Office estimates, which show that the initial operational test and evaluation cannot be started in August 2002 (current schedule) without clearly unacceptable risks, the planned test program cannot be completed as currently scheduled. A reasonable test schedule would certainly require an extension of Engineering Manufacturing Development, probably a delay of up to one year for initial operational test and evaluation (from 2002 to 2003) and Milestone III.

2

Interim Armored Vehicle Comparison Plan

Background

The Secretary of the Army is required to submit to the congressional defense committees a report on the process for developing the objective force in the transformation of the Army. One of the requirements of this report is for the Secretary of the Army to develop a plan comparing: (1) the costs and operational effectiveness of the infantry carrier variant of the interim armored vehicles selected for the infantry battalions of the interim brigade combat teams; and (2) the costs and operational effectiveness of the troop-carrying medium armored vehicles currently in the Army inventory for the use of infantry battalions. The Secretary of the Army may not carry out this comparison until the Director, Operational Test and Evaluation approves the plan.

No funds appropriated or otherwise made available to the Department of the Army for any fiscal year may be obligated for the acquisition of medium armored combat vehicles to equip a third interim brigade combat team until the plan for a comparison of costs and operational effectiveness as approved by the Director, Operational Test and Evaluation is carried out, and the Secretary of Defense submits a certification to the congressional defense committees. (Defense Authorization Conference Report 106-945 Section 113, pages 29-231)

Director Operational Test and Evaluation Position

The planned operational effectiveness comparison must include a live event involving infantry units equipped with both the Interim Armored Vehicle and a currently fielded medium armored vehicle. This event must take place in a realistic operational setting. This event should include at least company-size units (14 vehicles) for both types of armored vehicles. Modeling and simulation will be used to provide additional information to support this comparison, but will not be used as the primary source.

Current Initiatives

The Director, Operational Test and Evaluation has met several times with Army test and evaluation representatives responsible for developing the above plan for the Army and staff members of the Congressional Armed Services committees to ensure a clear understanding of the congressional requirement and to develop a satisfactory comparison plan. To date the Army has not yet submitted a plan to the Director, Operational Test and Evaluation for approval. The question of which currently fielded medium armored vehicle to use for the comparison, i.e., either the Bradley Fighting Vehicle or the M113 armored personnel carrier, has not as yet been resolved. The Director, Operational Test and Evaluation is next scheduled to meet with congressional staff members on January 0, 2001

3

Radio Frequency Integration and Testing Environment

Background

The House Committee on Armed Services Report on the National Defense Authorization Act for FY 2001 included the following:

> "The committee notes that the proliferation of antennas and radio frequency emitters on board Navy ships results in potentially severe electromagnetic interference among communications and sensor systems, which compete for bandwidth in the electromagnetic spectrum, unless careful attention is given to electromagnetic compatibility. While research and development continues to pursue the use of common aperture antenna arrays to reduce shipboard "antenna farms," the requirement to resolve potential electromagnetic compatibility issues can only grow as demands for communication channels and bandwidth increase and new sensors which use the electromagnetic spectrum are deployed to counter new threats. The committee believes that the requirement may exist for a testing environment for radio frequency integration and ship electronic interoperability that would address the electromagnetic compatibility of ships in the demanding radio frequency environment of modern, joint littoral warfare. Such a testing environment would provide the capability for instrumented electronic testing for ship-based equipment to identify and resolve electromagnetic interference problems, before the deployment of the equipment to the fleet. The committee believes that a fully instrumented, electromagnetic simulation environment, similar to that currently used in aircraft and telecommunications system testing, would be reconfigurable for different ship classes and capable of participating in distributed interactive simulations. This capability could enable fleet analysis, technology evaluation, and development of new tactics, techniques, and procedures." The report language then directed "The Secretary of the Navy, in coordination with the DOT&E, shall conduct an assessment and provide recommendations on requirements for electromagnetic compatibility testing of ship-based equipment and the potential need to establish a radio frequency integration and ship interoperability testing environment. The committee further directs the Secretary to submit the results of the assessment and any recommendations to the congressional defense committees with the submission of the FY 2002 budget request." (House Armed Services Committee Report 106-616, p. 221)

DOT&E Position

The Director, Operational Test and Evaluation fully supports the need for electromagnetic environmental effects and interoperability testing of all military equipment as essential to demonstrating operational effectiveness and suitability. In fact, the Director, Operational Test and Evaluation published two policy memoranda on these requirements within the last year. The

Navy and the Director, Operational Test and Evaluation will study the need for a new testing environment for radio frequency integration and ship electronic interoperability.

Current Initiatives

The Director, Operational Test and Evaluation has participated in an ongoing study of interoperability infrastructure testing requirements over the last several months, in conjunction with the Under Secretary of Defense (Acquisition, Technology and Logistics and the Assistant Secretary of Defense (Command, Control, Communications and Intelligence). This study, when complete, should help define deficiencies and the investments necessary to address any deficiencies interoperability testing.

In addition, the Director, Operational Test and Evaluation's Central Test and Evaluation Investment Program sponsors an electromagnetic environmental effects project, managed by the Navy, but oriented toward aircraft testing. Also, the Director, Operational Test and Evaluation and the Under Secretary of Defense (Acquisition, Technology, and Logistics) jointly charter the Joint Test and Evaluation program titled Joint Ship Helicopter Integration program, which will investigate electromagnetic environmental effects and interoperability characteristics of helicopter operations in the ship electromagnetic environment.

2

Section II. Budget

Tab D. Budget Overview

Tab E. Budget Details

Tab F. Budget Trends

Tab G. Budget Issues

D

Budget Overview

The Operational Test and Evaluation, Defense Appropriation is an annual appropriation provided by Congress to provide for the independent activities of the Director of Operational Test and Evaluation (DOT&E) in the direction and supervision of operational test and evaluation. The Appropriation currently consists of four program elements: the Central Test and Evaluation Investment Program, Operational Test and Evaluation, Live Fire Testing, and Test and Evaluation.

The Central Test and Evaluation Investment Program element provides the funds for the Department of Defense to invest in the required test and evaluation capabilities needed to test new technology in the latest generation of weapon systems or modified fielded systems. The program is a corporate management tool that provides a coordinated process for making joint investments to meet critically needed capabilities in the National Test Capabilities Base in six areas: 1) Test Mission Command, Control, Communication, and Instrumentation; 2) Electronic Warfare Systems; 3) Weapons Effects Test Capabilities; 4) Range Internetting; 5) Improved Targets; and 6) Improved Environmental and Physical Test Capabilities.

The Director of Operational Test and Evaluation's program element provides the funds for the Director to carry out his responsibilities required by Title 10, for policy and procedures for all aspects of operational test and evaluation within the Department, with particular focus on operational test and evaluation that supports major weapon system production decisions. The Director's oversight list contains approximately 200 Major Defense Acquisition Programs that cannot proceed beyond Low Rate Initial Production until operational test and evaluation of the program is completed and a report is provided to the Secretary of Defense and the Congress. Preliminary figures indicate the Director, Operational Test and Evaluation approved 46 Test and Evaluation Master Plans, 34 operational test plans, and submitted 8 reports to the Secretary of Defense and the Congress during fiscal year 2000

The Live Fire Testing program element funds technical assessment support necessary to Title 10 responsibilities for oversight of live fire testing. The primary objective is to ensure that the vulnerability and survivability of the Department's crew-carrying weapons platforms and the lethality of conventional munitions are known and acceptable before entering full-rate production. Preliminary figures for fiscal year 2000 indicate that the Director, Operational Test and Evaluation approved five Live Fire Test and Evaluation Plans, and submitted five Live Fire Test and Evaluation Reports (three of these reports were included as part of an Operational Test and Evaluation Report). In addition, this program element supports the Joint Live Fire program that tests fielded United States and threat combat aircraft and armor systems for vulnerabilities and lethality against their respective targets.

The Test and Evaluation program element includes the funds for the Director, Operational Test and Evaluation to provide oversight of the Department's threat simulators and targets carried out by the Threat Systems Office, and test of precision guided weapons systems for susceptibility in a countermeasures environment carried out by the Center for Countermeasures.

Funds are also used o coordinate, plan, a nd conduct Defense-wide aeronautical vehicle survivability activiti es conducte d by the Joint Tec hnic al Coordinating Group for Aircraft Survivability. The d velopmen and publ cation o Jo nt Munitions Effectiveness Manuals by the Joint Technical Coo dinating Group for Munition Effectiveness are also funded here. The Manuals provide the authoritative data or weapor s employment and effectiveness for use by the operational forces ir planning missions. Support for he oversight of the Department of Defense's major test and evalu tion facil ties and all other Department of Defense test and evaluation resources are includ d in this program elel ent.

Other Funding

As with all (ffice of Secretary D fense comp nents, funds for civilian personnel salaries, administrative trave , and training are Op rations and Maintenance and controlled by the Director for Administration a nd Managem ent. Military pay ar d benefits are paid out of the Military Personnel appropria ion.

E

Budget Detail

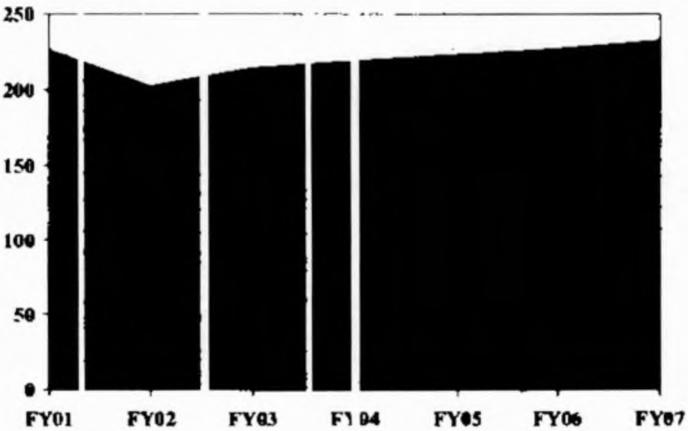
Program Element	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007
Central Test and Evaluation Investment Program	134,4[illegible]3	116,642	125,719	128,243	130,733	133,348	136,015
Operational Test and Evaluation	21,0[illegible]4	17,379	17,542	17,791	18,097	18,459	18,828
Live Fire Test and Evaluation	17,0[illegible]2	9,887	10,032	10,204	10,417	10,625	10,838
Test and Evaluation	52,9[illegible]2	58,347	60,692	62,316	63,348	64,501	65,777
Appropriation Total	225,471	202,255	213,985	218,554	222,595	226,933	231,458

F

Budget Trends

Congress continues to add funds to the Director, Operational Test and Evaluation Appropriation. Congress added $7M in fiscal year 2000 and $25.5M in fiscal year 2001.

DOT&E APPROPRIATION FUNDING TRENDS ($M)



NOTE: The FY2001 includes congressional adds and, otherwise, the trends reflect year-to-year inflation adjustments.

As shown in the chart, the out-year funding remains relatively flat except for inflation adjustments.

6

Budget Issues

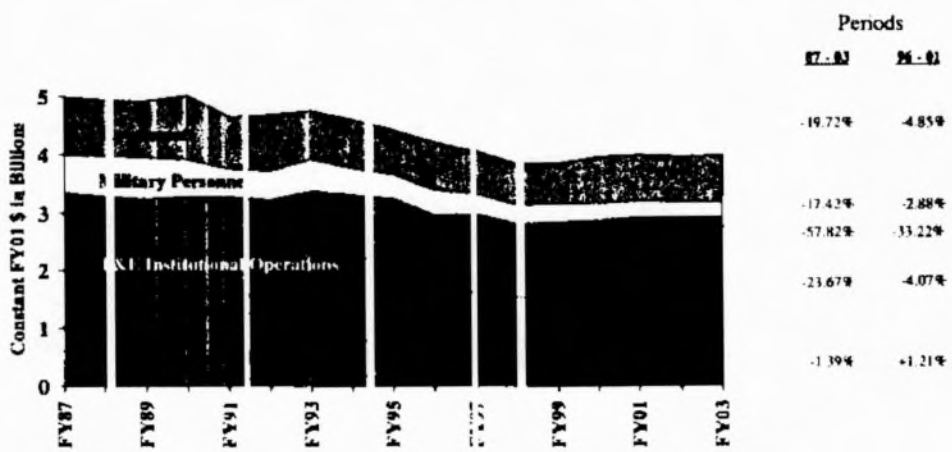
Department Wide Test and Evaluation

The Director, Operational Test and Evaluation continues to be concerned over the Department of Defense's ability to meet future test and evaluation requirements with the shrinking resources available.

- Resources supporting operational test and evaluation continue to decline while workload increases. The lack of resources available for operational test and evaluation has been limiting our ability to conduct operational test and evaluation for all required systems. This shortfall may result in (1) delay of acquisition programs, (2) diverting funds from other planned activities, (3) fielding of systems with increased risk or waivers of appropriate operational testing, or (4) delay of production until operational test is performed. All of the Operational Test Agencies are short of funding to comply with initiatives for earlier involvement. Adequate manning and funding at the Operational Test Agencies are imperative, particularly if the acquisition process is to benefit from operational perspectives when changes in design, tactics, or doctrine are most easily accomplished.

- Major Range and Test Facility Base operating and investment funding has been reduced each year since 1990. The annual funding is now $1 billion below the 1990 level, about a 30 percent reduction. The sum of the reductions over the decade totals $8 billion.

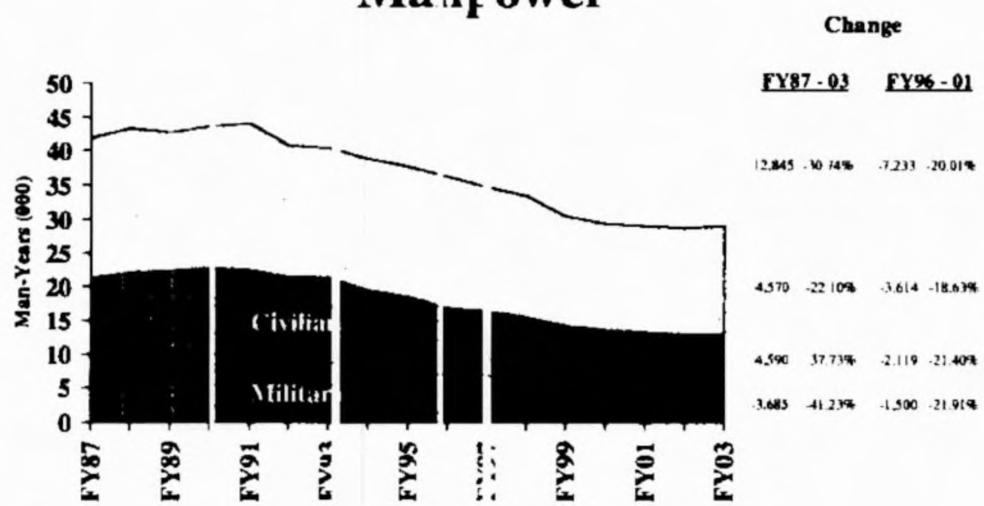
Major Range and Test Facility Base Funding Trends



It is increasingly difficult for the present test and evaluation infrastructure to support testing of future needs (i.e., high-performance, high-technology-content weapon systems). Technology such as directed energy, precision guidance and control, "brilliant" weapons, data and signal processing capabilities, multi-spectral sensors, stealth, and information warfare challenge our current measurement capabilities; even more advanced technologies are under development in the laboratories or are being incorporated into emerging systems and weapon system upgrades. Our physical infrastructure averages over 40 years of age—far older than the physical infrastructure of comparable high-technology industrial concerns—and is inefficient and increasingly obsolete in significant technical areas.

- The decline in test and evaluation personnel at the Major Range and Test Facility Base over the past 10 years continues unabated throughout our programming horizon. By 2001, test and evaluation personnel will be down about 14,000, a 32 percent decrease, from the 1990 level. In addition, the number of military personnel in developmental and operational testing has declined dramatically. Army military personnel directly involved in developmental testing fell 99 percent from 1990 to 2001. Military personnel involved in Air Force developmental testing were reduced 40 percent in the same period. Between 1993 and 1999, the number of military personnel involved in operational testing decreased by 35 percent.

Major Range and Test Facility Base Manpower



- In the category of Military Construction, the low rate of investment for test and evaluation facilities continues to be a critical problem. The Military Construction (MILCON) appropriation funds new facilities and major facility upgrades for test and evaluation. In recent years, this funding has also been seriously reduced. From 1990 to 2001, overall investment in test and evaluation was reduced by 35 percent, while the funding for military construction decreased by over 90 percent. These declines occurred in conjunction with reductions in operations and maintenance funding and the test and evaluation workforce. The level of funding for improvement and modernization is a small fraction of the level of funding that would be invested by private industry.

Efforts to respond to Joint Visions 2010 and 2020 will yield new systems and new concepts for warfighting. These systems and concepts must be tested to validate designs, to identify problems while they can still be remedied relatively inexpensively, and to determine military utility, suitability, lethality, and vulnerability. Not only must we test these systems and concepts on a schedule responsive to the needs of the acquisition community and the warfighters, but we must invest in more modern, efficient facilities that address new technologies, reduce operations cost, reduce the number of personnel required to perform the test and evaluation mission, and accept the realities of constrained infrastructure resources—both personnel and funding.

3

Section III. Persoı nel

H

Director, Operational Test and Evaluation
Personnel Summary Statistics

CIVILIAN:

Executive Level IV	01
Senior Executive Service: SES	05
Scientific Advisor: ST 103	01
GM-15	19
GS-12	02
GS-11	01
GS-09	01
GS-08	03

MILITARY: Rank 06

Army	04
Navy	06
Air Force	06
TOTAL AUTHORIZED POSITIONS	**49**

Section III. Personnel

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Key Congressional Committees

Over the past several years, six key congressional committees have supported the work of the Director, Operational Test and Evaluation. These committees are the:

1. Senate Committee on Armed Services
2. Senate Committee on Appropriations, Subcommittee on Defense
3. Senate Committee on Governmental Affairs
4. House Committee on Armed Services
5. House Committee on Appropriations, Subcommittee on Defense
6. House Committee on Government Reform

Calendar Year 2000 Congressional Testimony

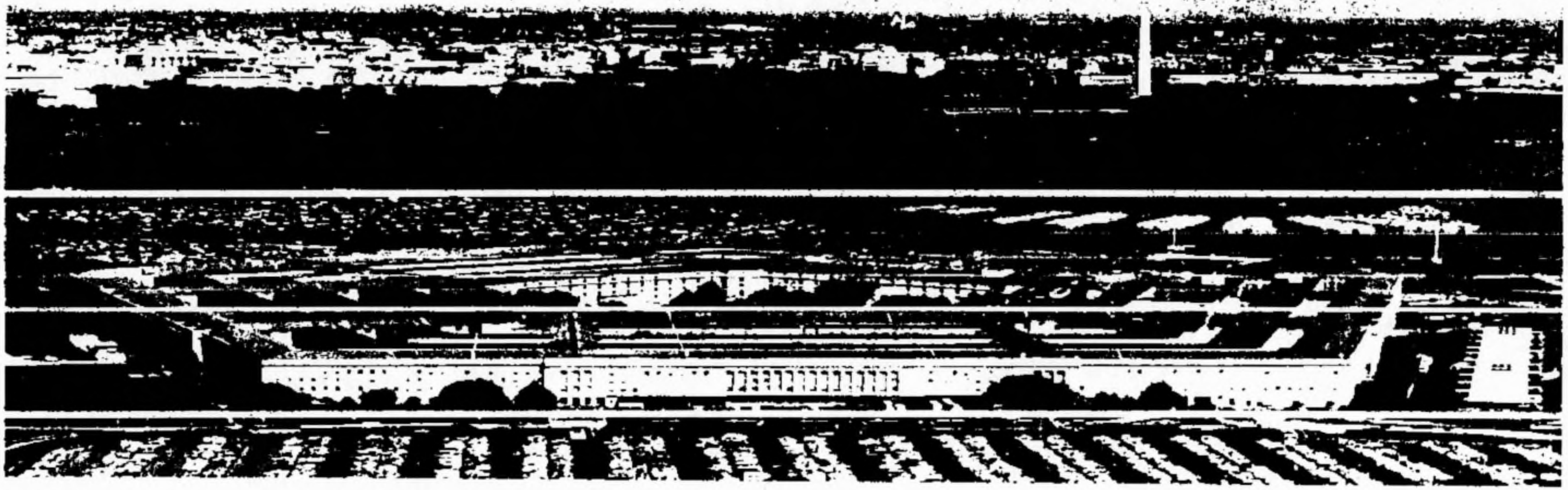
On March 22, 2000, The Honorable Philip E. Coyle, Director, Operation Test and Evaluation testified before the Senate Committee on Armed Services, AirLand Forces Subcommittee on the topic of tactical aviation. Specifically, Mr. Coyle was invited to appear before the subcommittee to discuss the testing and evaluation programs for the F/A-18E/F, the F-22, and the Joint Strike Fighter. This was Mr. Coyle's third appearance before this subcommittee during his tenure as the Director, Operational Test and Evaluation. A copy of the statement and full testimony can be found in the subordinate tabs.

On September 8, 2000, The Honorable Philip E. Coyle, Director, Operational Test and Evaluation testified before the House Committee on Government Reform, Subcommittee on National Security, Veterans Affairs, and International Relations on the topic of National Missile Defense. Specifically, Mr. Coyle was invited to discuss the testing of the National Missile Defense system and focus on the impact of the test results to date on technology maturity and deployment schedules. This was Mr. Coyle's first appearance before the Subcommittee. A copy of the statement and full testimony can be found in the subordinate tabs.

Current Programs and Activities of Special Congressional Interest

- Interim Armored Vehicle (Army)
- V-22 Osprey (Marine Corps)
- F-22 Raptor (Air Force)
- National Missile Defense (Ballistic Missile Defense Organization)
- Test and Training Range Sustainment (Department-wide)

10



T&E Workforce Issues

ICOTE, Marietta, GA
December 13-14, 2000

Mr. Parker Horner
Office of the Director, Operational Test And Evaluation

Briefing Outline

- Purpose
- Background
- Workforce Issues
  - Aging of Workforce
  - Retirement Eligibility
  - Separations
  - Accessions and Recruitment
- What next?

Purpose

Share information on workforce issues and discuss possible courses of action

Background

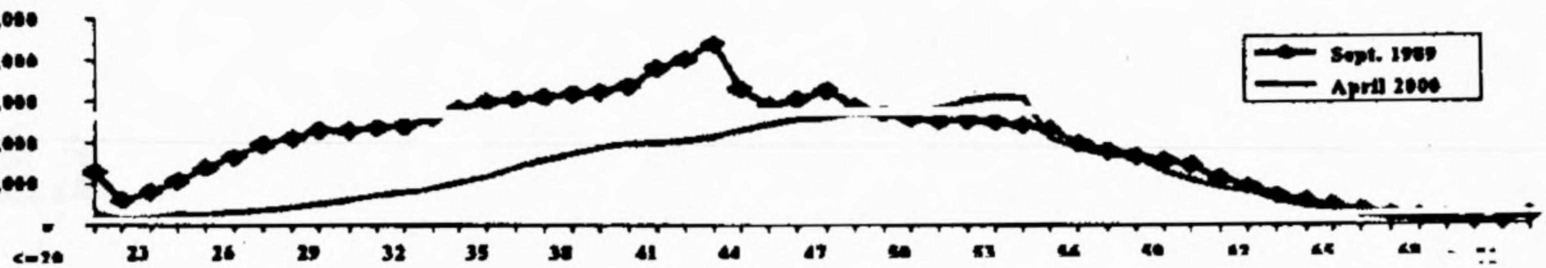
- DoD T&E workforce
  - Downsized 32 percent since FY90
  - Increasing average age
  - Increasing percentage will be retirement eligible within five years
  - Minimal infusion of junior professionals
  - Increased recruiting competition from civilian "Dot Com" technology industry

Viewgraphs selected from other briefings to provide insight into data on the total DoD, DoD Science and Engineering (S&E), and the T&E workforce.

Aging of the Workforce

Distribution of Age, DoD Civilians

Distribution of DoD Civilians by Age, September 1989 and April 2000



Shift in age distribution of civilian employment

- Increase in median age from 41 to 46 since start of drawdown
- Three-fourths drop in civilians under age of 31
- 2% increase in ages 51 to 60
- Consequent decline in choice for higher-level positions and shortage of people at entry- and journey levels

Source: DASD (CPP)

What Demographic Shifts Occurred Among DoD S&E Civilians?

Category	S&E Civilians Employed in: Total DoD		RDT&E Activities		Remarks
	Sep 90	Sep 97	Sep 90	Sep 97	
End Strength	129.9K	103.6K	38.9K	34.5K	• 20% drop in total DoD S&E end strength • Down 11% in RDT&E activities
Education Level - percent w/ doctorate	4.0%	5.5%	9.4%	10.9%	• Twice as many have doctorates in RDT&E activities (10.9 vs. 5.5% for total DoD)
Race-Ethnic Mix - percent non-White	19.0%	22.3%	13.9%	16.4%	• Percent of non-Whites increasing • Less diversity in RDT&E activities
Gender Mix - percent females	23.4%	25.0%	11.3%	12.4%	• Slightly higher percent of females • Only half as many in RDT&E activities
Average Grade - GS	10.9	11.3	12.0	12.6	• Higher-graded S&E positions in RDT&E activities
Average Age - Years	40.7	43.5	39.4	42.6	• S&E workers getting older: average age rose 3 years between Sep 90-Sep 97
Average Years of Service	13.2	15.8	13.9	16.8	• Older workforce is more experienced
Retirement Eligible - percent eligible*	19.2%	24.0%	21.8%	26.1%	• About one-fourth of S&E workers are eligible to retire

* Based on optional and discontinued service retirement

Source: Defense Manpower Data Center

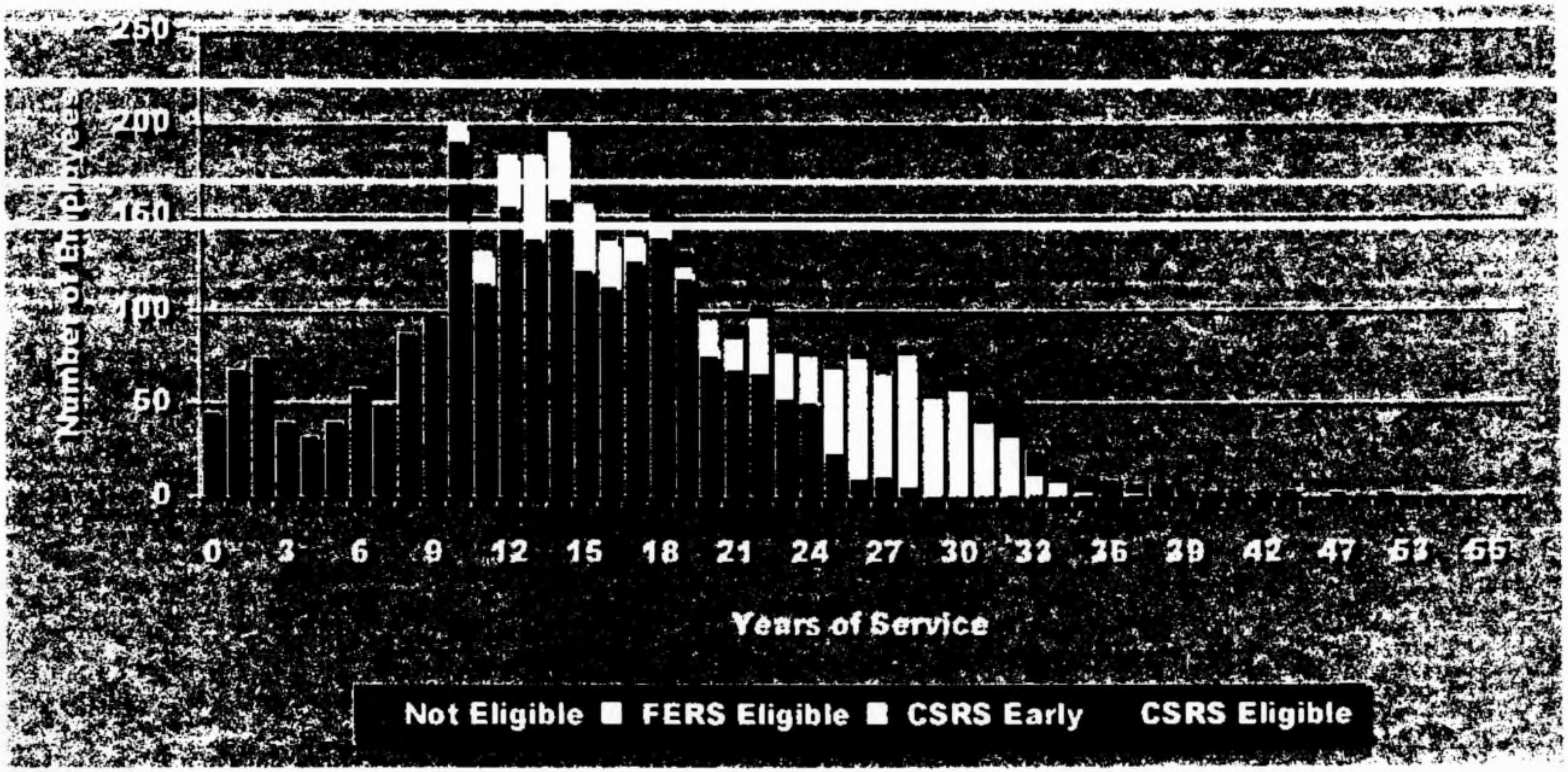
Retirements

Operational T&E Agency Civilians Retirement Eligibility (FY99)

CIVILIAN WORKFORCE RETIREMENT PROFILE (FY99)							
ALL SERVICES		RETIREMENT ELIGIBLE					
Total Civilians (FY99)		FY99		FY 00-04		5 YEAR TOTAL	
Category	No.	No.	Percent	No.	Percent	No.	Percent
GS-7/GS-15	681	84	12.3%	148	21.7%	232	34.1%
GS-6 & Under	447	41	9.2%	71	15.9%	112	25.1%
Total	1,128	125	11.1%	219	19.4%	344	30.5%

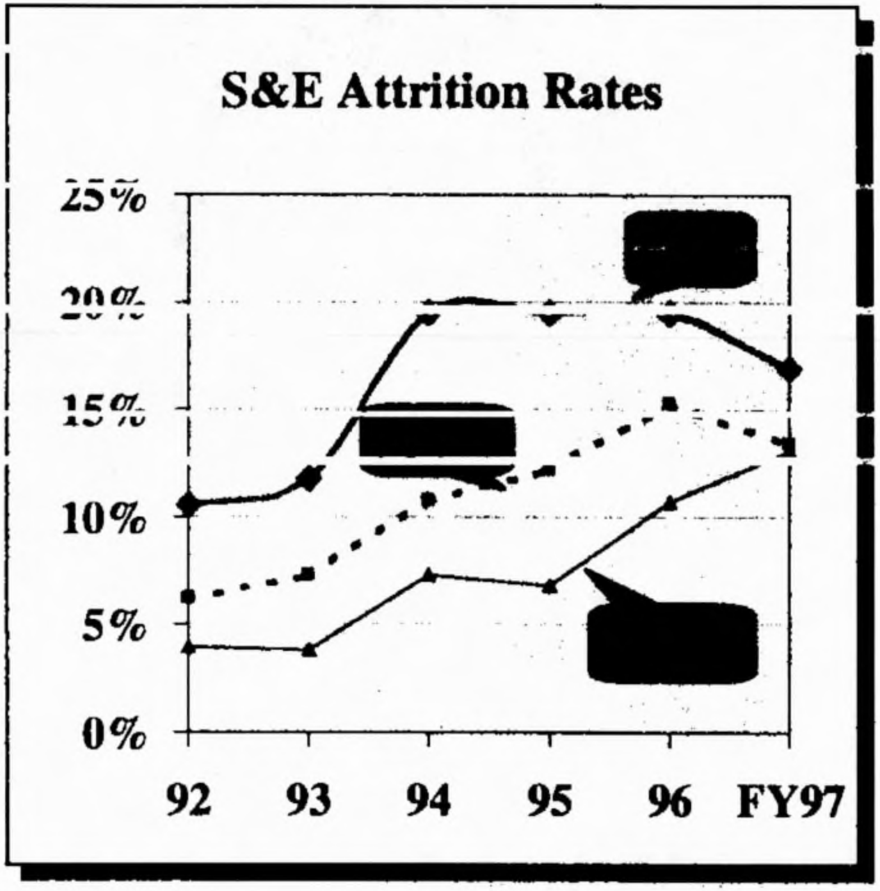
Air Force T&E Workforce Challenges

- Aging Workforce
  - 10 year hiring freeze resulted in shortage of journeyman testers
  - Many eligible retire
- Competition from Industry



Separations

What are Attrition Rate Trends (FY92-97) for RDT&E Civilians in S&E Occupations?



Source: Defense Manpower Data Center

SIGNIFICANT GROWTH IN TOTAL ATTRITION BY ALL YEAR OF SERVICE (YOS) GROUPS

- **Rose from 10.6 to 16.9% for 1 YOS, with some exceptions**
  - *General Engineering...from 22 to 14.3%*
  - *Chemistry*...7.7 to 5.3%
- **Overall growth in other YOS groups?**
  - 2-5 YOS...from 6.2 to 13.4%
  - 6-10 YOS...from 3.9 to 13.1%

Attrition By Years Of Service

Fiscal Year	1 YOS #	1 YOS %	2-5 YOS #	2-5 YOS %	6-10 YOS #	6-10 YOS %
1992	204	10.6	615	6.2	436	3.9
1993	93	11.8	633	7.3	449	3.8
1994	69	19.5	781	10.8	810	7.3
1995	74	19.5	551	12.2	765	6.8
1996	129	19.5	402	15.3	1,068	10.7
1997	111	16.9	229	13.4	1,184	13.1

Why are Scientists & Engineers Leaving RDT&E Activities?

REASONS DOCUMENTED IN OFFICAL PERSONNEL FILES

- Federal repository? National Personnel Records Center, St. Louis, MO

- Three step research technique:
  - Identified 1,505 S&E civilians in RDT&E activities who separated from federal work, Oct 96-Mar 98
    - Excludes retirees and deaths
  - Conducted file by file examination of random sample of 489 of these separatees
  - Consolidated findings into 11 "reasons" categories

Source: Defense Manpower Data Center

Why Did S&E Civilians Depart RDT&E Activities, by Age*?

Reason for Departing		Age Groups < 30	30-39	40+
Join private sector	Greener Pastures	39.5%	43.5%	24.6%
Promotion opport/more $	Greener Pastures	3.7	6.5	2.6
Career goals/opport's	Greener Pastures	8.7	10.2	2.6
Base closure/RIF	Defense Downsizing	0	3.7	15.8
Separation incentive	Defense Downsizing	6.2	14.3	11.4
Transfer of function	Defense Downsizing	4.9	3.7	18.4
Family/personal reasons		9.9	2.4	8.8
Moving		7.4	5.8	0
Expiration of appointment		2.5	1.4	6.1
Back to School		8.6	1.4	0.9
Other/no reason given		8.6	7.1	8.8
TOTAL		100.0%	100.0%	100.0%

Source: Defense Manpower Data Center

INTEREST IN PRIVATE SECTOR DECLINES WITH AGE

- Stated reason for 52% of those under 30, vs. 30% of those age 40 and above

- Opposite situation in face of DoD downsizing
  - Stated reason for only 11% of those under age 30, vs. almost half (46%) of those 40 and older

* Based on a random sample of 489 who departed between Oct 96-Mar 98: 81 (17%) were under 30, 294 (60%) were 31-40, 114 (23%) were 40+.

Why Did S&E Civilians Depart RDT&E Activities, by Education Level*?

Reason for Departing		Education Level			
		H.S.	BA/BS	MA/MS	Ph. D.
Join private sector	*Greener Pastures*	31.0%	37.5%	42.5%	36.9%
Promotion opport/more $	*Greener Pastures*	6.9	3.6	6.7	8.7
Career goals/opport's	*Greener Pastures*	0	7.1	11.2	10.9
Base closure/RIF	*Defense Downsizing*	6.9	6.4	3.7	8.7
Separation incentive	*Defense Downsizing*	10.4	15.0	9.7	4.3
Transfer of function	*Defense Downsizing*	0	6.4	10.5	8.7
Family/personal reasons		3.5	5.7	3.0	8.7
Moving		10.3	4.7	4.5	2.2
Expiration of appointment		0	3.6	2.2	0
Back to School		10.3	2.5	1.5	0
Other/no reason given		20.7	7.5	4.5	10.9
TOTAL		100.0%	100.0%	100.0%	100.0%

Source: Defense Manpower Data Center

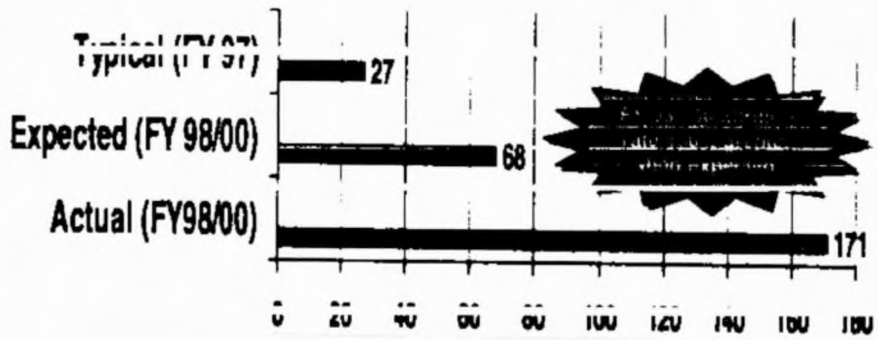
EDUCATION LEVEL AFFECTS PROPENSITY TO JOIN PRIVATE SECTOR

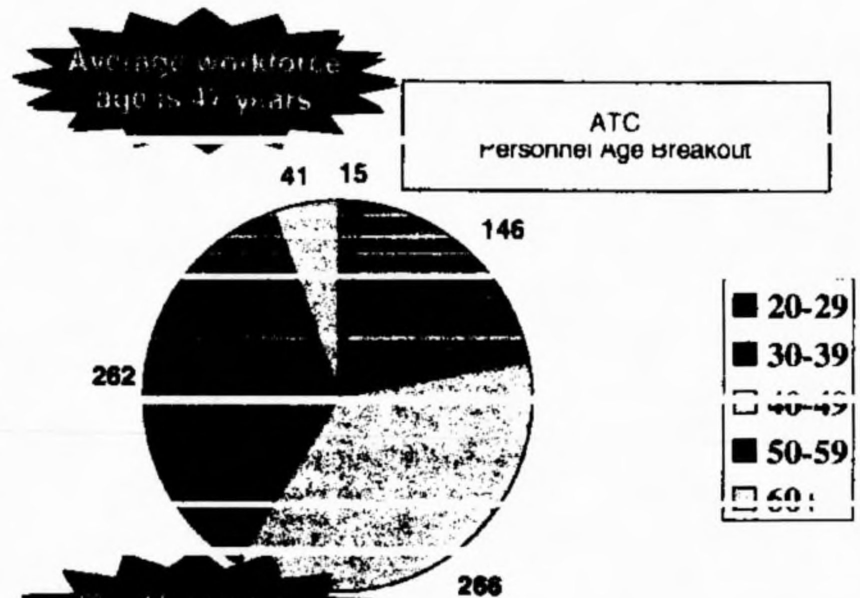
- **Main reason for 57% of doctorates vs.48% of BA/BS degree holders**
- **DoD downsizing affected all groups about the same**
  - **28% for BA/BS, 22% for doctorates**

* Based on a random sample of 489 who departed between Oct 96-Mar 98: 57% had BA/BS, 27% had MA/MS, 9% had doctorate.

Aberdeen Test Center Manpower Indicators

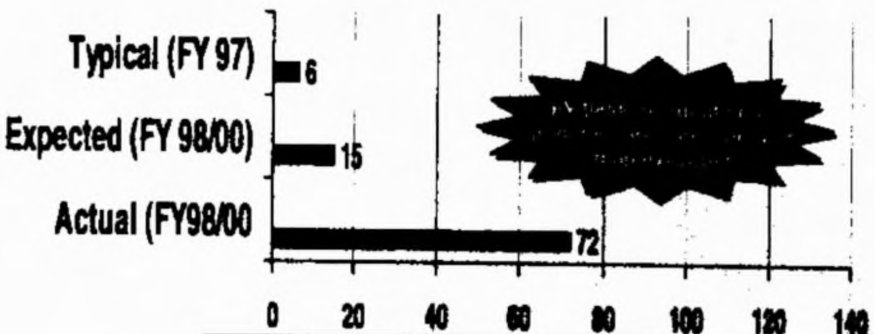
Attrition Rate





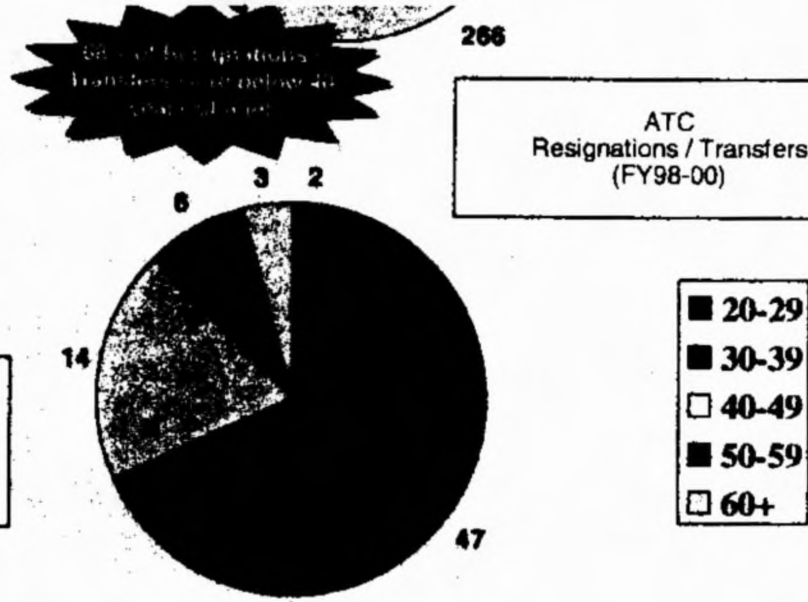
ATC
Personnel Age Breakout

Resignations / Transfers



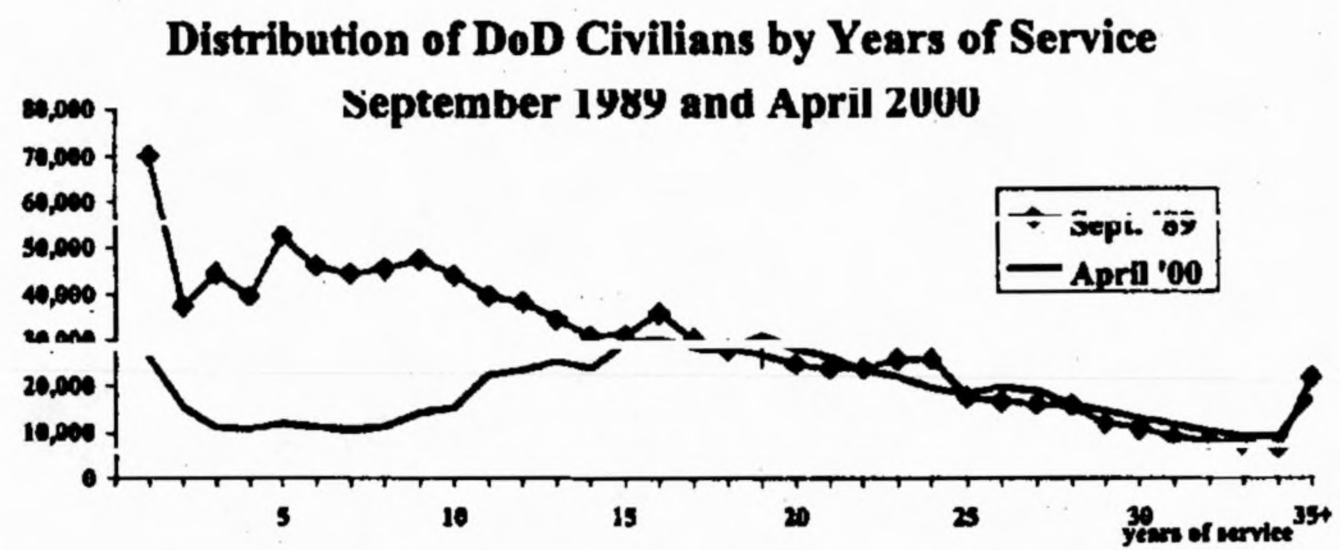
FY97 last year where downsizing effects were considered to be minimal at ATC

ATC
Resignations / Transfers
(FY98-00)



Accessions and Recruiting

Distribution of Years of Service, DoD Civilians



Shift in length of service distribution of civilian employment

- Increase in median years of service (YOS) from 11 to 17 since start of draw down for US appropriated fund employees
- Sixty-nine percent drop in civilians with under 5 YOS and 67 percent drop in 5 to 10 YOS; only 4 percent drop in 11 to 30 YOS
- Older workers' mobility constrained by defined benefit retirement plan.

Source: DASD (CPP)

What's Next?

- **Jointly examine the problems and potential solutions**
  - **Host a joint meeting to exchange experience, initiatives, and lessons learned**
  - **Form a joint working group to examine the situation**
- **Continue to work the problems separately, but readdress the issues at future meetings**

11

Military Personnel in Test and Evaluation

Background

Military personnel assigned to testing organizations bring an operational perspective to the conduct of testing on new weapons systems. This occurs at both the operational and developmental test organizations. An operational perspective is important in the conduct of testing because it helps to identify deficiencies in design that are not necessarily covered by system specifications.

There has been a steady decline in the number of military personnel assigned to both operational and developmental test organizations over the last ten years. Overall, the operational test organizations have reduced military manpower by over 30 percent and the major test ranges have reduced military manpower by 44 percent. The Army has made even greater reductions with 60 percent reductions in the operational test organizations and 91 percent in the test ranges. This has occurred even though the number of new or modified systems being developed has not gone down. Procurement quantities of these systems may be reduced, but the number of tests to develop and verify the military capability has held steady and in some cases has actually increased.

The loss in military perspective in the developmental test process has resulted in design deficiencies showing up later in the operational tests. These deficiencies could have been detected earlier had developmental tests been conducted with more operational realism. In one case of an aircraft radar jammer the designer had included a very robust fault recovery and alignment process to ensure optimum system performance after a fault was detected by the built-in-test system. However, although this recovery and alignment tried to optimize post-recovery performance the jammer was not functional during the extended recovery period leaving the aircraft without jamming protection for an unreasonable time. This deficiency was not discovered until operational testing, resulting in a failed test and the expense for redesign and additional operational testing. The flaw could have been discovered by more realistic developmental tests, but such realism requires the availability of operationally experienced military personnel at the developmental test facilities.

Director, Operational Test and Evaluation Position

This office continues to recommend to Service leadership that all test organizations be appropriately manned with sufficient military personnel. The savings from military personnel reductions are more than offset by the costs of later discovery of weapons system deficiencies. Additionally, later discovery means some of these deficiencies cannot be affordably corrected and will plague the operating forces with reduced capability cumbersome workarounds.

Recommendation

Each test organization should undergo a military manpower review to identify the positions that require a military perspective or experience to plan, conduct, or evaluate weapons systems testing. This review should be conducted by personnel with broad test experience, as well as typical manpower review personnel.

J

Overview of the Policy Development Process

Operational Test and Evaluation Policy

By law, the Director of Operational Test and Evaluation is responsible for setting policy and procedures for the conduct of operational test and evaluation within the Department of Defense. As a result, the Director, Operational Test and Evaluation plays a key role in the development of the 5000 series acquisition regulations and is a signatory of Department of Defense Instruction 5000.2, "Operation of the Defense Acquisition System" and Department of Defense Regulation 5000.2-R, "Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) Acquisition Programs." During any policy deliberations, the Director, Operational Test and Evaluation works closely with the Office of the Secretary of Defense staff, the Services' headquarters testing staffs, and the Service Operational Test Agencies.

Over the last few years, certain technology advances and revised acquisition approaches have made it necessary to issue selected policy memorandums. The increased reliance on software with its multiple releases has moved the whole department towards an acquisition process that stresses incremental development versus the final system. This required the operational test and evaluation process to adapt and the Director, Operational Test and Evaluation to generate a policy for "Software Intense Systems." Likewise, with the increased emphasis on interoperability, the Director, in conjunction with the Assistant Secretary of Defense (Command, Control, Communications and Intelligence, the Under Secretary of Defense (Acquisition, Technology, and Logistics) and the Joint Staff, recently issued a policy focusing on this difficult area. The operational test and evaluation policies for information assurance and electromagnetic environmental effects promulgated last year are just starting to impact how operational test and evaluation is conducted and how systems are viewed as operationally effective and suitable.

K

Section IV. Policy/Issues

Tab K. Major Policy Issues requiring attention in the next few months.

12. Major Range and Test Facility Base Funding Policy
13. Frequency Spectrum Encroachment
14. Sustainable Ranges

12

Major Range and Test Facility Base Funding Policy

Background

The Major Range and Test Facility Base is a single entity—the aggregate of activities we regard as our most critical national test assets. The Major Range and Test Facility Base is sized, operated, and maintained primarily for Department of Defense test and evaluation support missions. It consists of a broad base of test and evaluation activities managed and operated under uniform guidelines to provide test and evaluation support to Department of Defense components responsible for developing or operating materiel and weapon systems. Overall policy for management and operation of the Major Range and Test Facility Base is contained in Department of Defense Directive 3200.11, Major Range and Test Facility Base. Funding policy for the Major Range and Test Facility Base is contained in Department of Defense 7000.14-R, the Financial Management Regulation, Volume 11A, Chapter 12.

Under existing policy, Major Range and Test Facility Base activities are financed via a combination of funds appropriated specifically to operate the organizations (referred to as institutional funds) and funds from customers—programs that are being tested. Department of Defense customers pay for the direct costs of their testing, excluding military labor. Other customers must pay for direct costs including military labor, plus some portion of the indirect as determined by the installation commander. All of the Military Services use job-order cost accounting systems to allocate test-related costs to specific customers or to the institutional funding accounts. The Navy also uses a Working Capital Fund to support their Major Range and Test Facility Base accounting operations. However, the Navy still follows the funding policy outlined above.

During the Fiscal Year 2000 National Defense Authorization Act enactment cycle, the Senate Committee on Armed Services proposed statutory language that would have required all research, development, test and evaluation activities to be financed via Working Capital Funds. It is our understanding that the Committee was concerned over what it perceived as a lack of cost visibility into operations and activities. The Committee's proposal did not survive the conference process, where the statutory requirement to implement a Working Capital Fund was replaced with a requirement to "evaluate the potential for financing (research, development, test and evaluation) activities through a working capital fund financing mechanism, and provide a report…not later than September 30, 2000."

During the summer of 2000, the Director, Operational Test and Evaluation met with Senate Committee on Armed Services staff members and demonstrated that Major Range and Test Facility Base activities had excellent cost visibility via existing cost accounting methods and reports (called Major Range and Test Facility Base Exhibits). The Senate Committee on Armed Services Report on the National Defense Authorization Act for FY 2001 included language that directs the Department to develop a plan and schedule to implement a cost-based management system. It further directed that the Department do this by developing a schedule for extending the Major Range and Test Facility Base exhibits to all test and evaluation activities. Efforts to respond to this direction are underway.

Current Initiatives

Responsibility for the report on the potential for financing research, development, test and evaluation activities through a Working Capital Fund, required by the National Defense Authorization Act for Fiscal Year 2000, was assigned to the Revolving Fund Division of the Department of Defense Comptroller. The required evaluation was conducted and a draft report prepared during the summer of 2000. This was done wholly within the Comptroller organization, with virtually no input from test and evaluation customers, the Director, Operational Test and Evaluation, the Under Secretary of Defense (Acquisition, Technology and Logistics), or test activities. As a consequence, a large number of Department of Defense staff offices non-concurred with the report, and the report has not been forwarded to Congress.

During the Department's Fiscal Year 2002 Program Budget Decision cycle, the Department of Defense Comptroller prepared draft Program Budget Decision 411C that directed the implementation of Working Capital Funds for the Army and Air Force research, development, test and evaluation activities (i.e., laboratories and test and evaluation centers). The draft Program Budget Decision recommends the transition of Army and Air Force research, development, test and evaluation activities to a Working Capital Fund over a number of years, and makes $80 Million available to implement the change.

Director, Operational Test and Evaluation Position

The Director, Operational Test and Evaluation believes that the use of a Working Capital Fund for test and evaluation activities would increase the cost of test and evaluation to acquisition programs and lead to a decline in the amount of testing, which is unacceptable. There is absolutely no evidence that we are currently doing too much testing, and considerable evidence that we have not been doing enough, early enough, with sufficient vigor and realism.

The Director, Operational Test and Evaluation believes that the Working Capital Fund alternative offers no advantage over the current Major Range and Test Facility Base funding policy.

The Director, Operational Test and Evaluation non-concurred on draft Program Budget Decision 411C, stating that moving test and evaluation centers into working capital funds represented a major policy change with far-reaching ramifications that require thoughtful study and coordination with all interested parties, and was not appropriate for Program Budget Decision action. No such study has occurred.

Recommendations

The Department should defer any significant policy changes on how the Major Range and Test Facility Base is funded until it has conducted a thorough and impartial study that allows input by those most affected by the change including the Service and Office of the Secretary of Defense acquisition and test and evaluation principals and the results are available.

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Frequency Spectrum Encroachment

Background

Weapon systems testing relies heavily on use of the radio spectrum. This usage includes radar, target control systems, location and positioning (referred to as "TSPI" - time and space positioning information), telemetering, scoring, video data links, meteorology, range safety, test control and coordination, electronic warfare threat simulation, beacons, and other uses. The growth of consumer communications devices since the 1980s has resulted in pressure from the telecommunications industry for the reallocation of radio spectrum from government to non-government. As a result, since 1992, the Department of Defense has lost approximately 27 percent of the total spectrum allocated for aircraft telemetry, with varying degrees of impact on the Department of Defense test community. Some of the reallocations have resulted in operating restrictions at specific test locations. Others have resulted in the complete loss of access to specific bands by the Department of Defense. We expect the telecommunications industry to gain more spectrum at the Department's expense in the future.

Many of the reallocations of the past ten years will only begin to be felt in the next few years because of the timetables contained in the rulemakings. Major flight test programs such as the F/A-18 E/F, F-22, Joint Strike Fighter, Airborne Laser, and National Missile Defense will experience increased competition for spectrum from other Department of Defense programs. Compromises will be required, and some programs may have to reduce the number of tests or compromise their schedules. The immediate response to this problem is to increase the efficiency of our use of the spectrum. As the demand for spectrum grows and further incursions on spectrum occur, we have to devise new methods of spectrum utilization.

Impacts to Mission

Encroachment increases the cost of testing or, alternately, leads to decreased readiness if those costs are not fully incurred. Spectrum encroachment causes increased cost of testing through various mechanisms, and exact cost figures are extremely difficult to project and may not be identifiable prior to actual occurrence. Estimates provided to Congress by the test ranges vary from the hundreds of millions to over $2 billion. The cost of not conducting a test because of the non-availability of spectrum is not quantifiable. Some examples follow.

The lack of a large, contiguous block of frequencies assigned to test and training in the lower portion of the microwave band has contributed to the large number of Service "stove piped" data link and telemetry solutions. The small fragments of available spectrum have forced applications such as target control to be in the 902-928 MHz band on the east coast for the Air Force and 4.4 to 4.8 GHz band on the west coast for the Navy. The most immediate result has been the lack of system interoperability; but as Service budgets have decreased, the impact associated with asset sharing and reuse is becoming more apparent. The lack of a Department of Defense-wide contiguous allocation of frequencies has meant that each available fragment has to be defended on its regional impact as opposed to Department of Defense-wide.

Since 1992, we have lost access to over 275 megahertz of shared or dedicated radio frequency spectrum. Test and evaluation depends on radio frequency spectrum for the large volume of telemetry, communications, and command and control needed to support almost all test programs. During the same period, the data rates needed by test programs, which directly affect spectrum usage, have continued to increase. For example, in 1970, testing the F-15 required telemetry instrumentation capable of data rates of only 100 Kbits. Adequate test of the F/A-18E/F now requires the transmission of data at rates of 10 Mbits, an increase of over two orders of magnitude. A review of Advanced Technology Demonstrations, Advanced Concept Technology Demonstrations (ACTDs), and other DoD technology programs confirms that this trend is accelerating. The bottom line: demand is increasing while the available spectrum is decreasing.

Ongoing Efforts/Initiatives

The Defense Test and Training Steering Group charters the Range Spectrum Requirement Working Group, which consists of Office of the Secretary of Defense, Military Service, Aerospace Industry, and National Aeronautics and Space Administration (NASA) representatives. The group was formed to promote a united defense against the threat of increasing demand by commercial interests for government spectrum being used by the Department of Defense. Specifically, the Range Spectrum Requirement Working Group was chartered to:

- Develop a framework for ensuring the U.S. research, development, test and evaluation community continues to have access to sufficient radio frequency spectrum to meet future requirements.
- Conduct studies and impact assessments.
- Foster interagency and industrial cooperation.
- Provide information to support testimonies and decision briefings.

In order to meet the challenges posed by radio frequency spectrum encroachment, the Range Spectrum Requirement Working Group follows a three-pronged plan:

1. Improve responses to decision makers and educate decision makers.
2. Foster the development of technologies to meet near-term requirements.
3. Identify far-term radio frequency spectrum requirements and sponsor technology development efforts to provide solutions necessary to combat encroachment.

At a recent Senior Readiness Oversight Committee meeting, the Assistant Secretary of Defense (Command, Control, Communications and Intelligence) was directed to work with the Range Spectrum Requirement Working Group to address frequency spectrum issues.

Recommended Courses of Action

A. Mitigate future encroachment through cooperative initiatives to ensure adequate spectrum for weapon systems testing and training through the next 20 years.

B. Establish a new Office of the Secretary of Defense science and technology (6.2/6.3) program for the development of spectrum efficient technologies with the following objectives:

   1. Increase bandwidth efficiency (bits/Hz) by a factor of three over the next five years.

   2. Increase frequency availability by 100 percent over the next ten years.

   3. Increase information capacity of telemetry range data systems by a factor of seven over the next 15 years.

C. Use existing statutory mechanisms to ensure that the Department of Defense gets cost reimbursement and access to other comparable spectrum when forced to relocate to accommodate commercial users.

14

Sustainable Ranges

Background

In June 2000, the Military Services told the Senior Readiness Oversight Council that the obligations of environmental stewardship, urban growth, public concerns over noise, and competition for airspace and radio frequency spectrum were increasingly affecting their ability to conduct realistic testing and training. The Senior Readiness Oversight Council directed the Defense Test and Training Steering Group, chaired by the Director, Operational Test and Evaluation, to develop a comprehensive plan to address the factors that threaten the Department's access to the land, sea, and airspace necessary for testing and training.

Department of Defense Policy

Current Department of Defense policy is:

- To test weapon systems under realistic operating conditions.
- To train our forces as they would fight.
- To be good environmental stewards.
- To comply with all applicable environmental laws and regulations.
- To be good neighbors to those that live and work in proximity to our installations and ranges.

Current Initiatives

On November 27, 2000, the Defense Test and Training Steering Group presented its analysis of test and training range encroachment issues along with a proposed range sustainment strategy to the Senior Readiness Oversight Committee. The Senior Readiness Oversight Council approved the overall findings and recommendations presented.

The following key actions were directed by the Senior Readiness Oversight Council:

- The Defense Test and Training Steering Group is to:
  - Coordinate individual range sustainment action plans within the Department.
  - Prepare text addressing sustainable range requirements for inclusion in the next planning, programming and budgeting guidance.
  - Draft a Department of Defense Directive to address range sustainment that embraces the concept of "working outside the fence."
  - Draft a legislative proposal to amend the Sikes Act to recognize Department of Defense integrated natural resource management plans as suitable substitutes for critical habitat designations.
- The Joint Requirements Oversight Council is to update its policy to ensure consideration of environmental, safety, and health performance parameters during requirements definition.

- The Under Secretary of Defense (Acquisition Technology and Logistics) is to designate the Navy as executive agent for maritime sustainability and update defense acquisition regulations to ensure environmental, safety, and health considerations are integral to the acquisition process.
- The Assistant Secretary of Defense (Command, Control, Communications and Intelligence) is to task the Policy Board on Federal Aviation to convene at the principal level and engage with the Department of Transportation to establish a Flag-level Joint Department of Defense/Department of Transportation Oversight Group for national airspace redesign.

Recommendations

1. Continue to emphasize the importance of protecting access to the land, sea, and airspace necessary for training and testing
2. Ensure that the Department is able to articulate its requirements for land, sea, and airspace and the importance of access to these resources to maintain readiness and adequately test weapons systems.
3. Encourage the Military Service and Defense Agencies to address issues that impact the ability to conduct training and testing at the appropriate level to ensure that any components response to issues with national implications is properly coordinated.
4. Recognize that many of the issues affecting our ability to test and train are not politically driven at the national level and as such regulatory or legislative relief is usually not a viable option for addressing these challenges.