AEROSPACE SYSTEMS SURVIVABILITY HANDBOOK SERIES

Volume 2. Survivability and Acquisition

31 May 2001

Joint Technical Coordinating Group on Aircraft Survivability (JTCG/AS)

Arlington VA

JTCG/AS-01-D-003

FOREWORD

This Aerospace Systems Survivability Handbook Series is designed to provide its users with insight into the key activities performed by survivability personnel in support of aerospace systems acquisition. The series is not a specification or standard but rather a "how-to" guide for all survivability managers, engineers, and analysts associated with survivability activities likely to be needed on any program, government or commercial.

Some of the material used in the handbook series has been adapted from various sections of the Department of Defense (DoD) Deskbook, Internet links, and survivability documents produced by the Joint Technical Coordinating Group on Aircraft Survivability (JTCG/AS), under the sponsorship of the Joint Aeronautical Commanders' Group (JACG). The Service laboratories and centers also produced source documents. This handbook series emphasizes the requirement for integrated teamwork of survivability management, engineering, test and evaluation, and systems analysis in order to accomplish a successful systems acquisition.

The handbook series (JTCG/AS Project A-8-01, Acquisition Deskbook Survivability Section Rewrite) was prepared for the JTCG/AS under the sponsorship of the Principal Members Steering Group (PMSG) and directed by LTC Charles R. Schwarz, Director, JTCG/AS. The handbooks were drafted by Hubert (Hugh) Drake, SRS Technologies, under contract to the Naval Air Warfare Center Weapons Division, China Lake, CA. As the Contract Technical Monitor, Dave Hall provided guidance and initial review. The following working group members provided oversight:

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Special recognition goes to Donna Egner and Linda Ryan for providing copies of reference documents from SURVIAC.

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CONTENTS

ACRONYMS AND ABBREVIATIONS

ACAT	Acquisition Category
ACTD	Advanced Concept Technology Demonstration
AIS	Automated Information System
AoA	Analysis of Alternatives
APB	Acquisition Program Baseline
ATD	Advanced Technology Demonstration
CAIV	Cost as an Independent Variable
CCDR	Contractor Cost Data Reporting
CDRL	Contract Data Requirements List
CM	Configuration Management
CRD	Capstone Requirements Documents
DAB	Defense Acquisition Board
DEW	Directed-Energy Weapon
DoD	Department of Defense
DOT&E	Director of Operational Test and Evaluation
DSMC	Defense Systems Management College
DT&E	Developmental Test and Evaluation
DUSD(S&T)	Deputy Under Secretary of Defense (Science & Technology)
IIPT	Integrating Integrated Product Team
ILSP	Integrated Logistics Support Plan
IPPD	Integrated Product and Process Development
IPT	Integrated Product Team
JACG	Joint Aeronautical Commanders' Group
JROC	Joint Requirements Oversight Council
JTCG/AS	Joint Technical Coordinating Group on Aircraft Survivability
JWE	Joint Warfighting Experiment
JWSTP	Joint Warfighting Science and Technology Plan
KPP	Key Performance Parameter
LFT&E	Live-Fire Test and Evaluation
LRIP	Low-Rate Initial Production
M&S	Modeling and Simulation
MAIS	Major Automated Information System
MCCR	Mission-Critical Computer Resource
MDA	Milestone Decision Authority
MDAP	Major Defense Acquisition Program
MNS	Mission Need Statement
MOE	Measure of Effectiveness

MOP	Measure of Performance
OIPT	Overarching Integrated Product Team
ORD	Operational Requirements Document
OSD	Office of the Secretary of Defense
OT&E	Operational Test and Evaluation
P3I	Pre-Planned Product Improvement
P/CAIV	Price or Cost as an Independent Variable
PM	Program Manager
PMSG	Principal Members Steering Group
PSA	Principal Staff Assistant
RAM	Reliability, Availability, and Maintainability
RDT&E	Research, Development Test and Evaluation
S&T	Science and Technology
SE	Systems Engineering
SEIPT	Systems Engineering Integrated Product Team
SIPT	Survivability Integrated Product Team
SURVIAC	Survivability/Vulnerability Information Analysis Center
TEMP	Test and Evaluation Master Plan
T&E	Test and Evaluation
TOC	Total Ownership Cost
USD(A&T)	Under Secretary of Defense (Acquisition and Technology)
USD(AT&L)	Under Secretary of Defense (Acquisition, Technology, and Logistics)
VV&A	Verification, Validation, and Accreditation
WBS	Work Breakdown Structure
WIPT	Working-Level Integrated Product Team

EXECUTIVE SUMMARY

This volume addresses survivability as it relates to the pre- and post-acquisition phases of defense acquisition. The topic is important, since an understanding of defense acquisition from the perspective of the Program Manager (PM) is essential for survivability personnel, who must support the PM in accomplishing a successful acquisition. The interrelationship of management, engineering, test and evaluation, and systems analysis in system acquisition design, development, and deployment is a matter of major importance to survivability.

This Joint Technical Coordinating Group on Aircraft Survivability (JTCG/AS) Survivability Handbook Series relates aerospace systems survivability to the entire acquisition process and its numerous supporting processes. The handbook provides a guide to performing the associated survivability functions required for providing the warfighter with survivable systems.

Programmatically and operationally, survivability is a major component addressed in all phases of military aerospace systems acquisition and therefore receives direct attention in the systems engineering (SE) and integrated product team (IPT) activities critical to a successful acquisition cycle.

This volume begins by making the point that acquisition reform and the accelerated transition of new technology to the warfighter have changed both the acquisition process and its associated survivability activities. To help the PM and other necessary acquisition personnel fulfill survivability acquisition requirements, information is provided on considerations of survivability and how they fit into in the acquisition process and its associated elements.

Also discussed are the requirements for survivability activities in five acquisition elements: (1) concept development and requirements analysis; (2) system design, engineering, and integration; (3) test and evaluation; (4) integrated logistics support; and (5) acquisition and life-cycle management. The types and relationships of Integrated Product Teams are briefly discussed, and necessary types of technical management functions are listed, as are survivability activities to be accomplished during pre-system acquisition, system development and demonstration, and production and deployment.

Paramount to the success of the development program are accomplishment and transition of S&T activities, as well as employment of the concept of IPT/Integrated Product and Process Development (IPPD), also discussed in this volume. Also important are considerations of affordability, and this volume points out the necessity of performing continuous price/cost/schedule/performance trade studies early in the acquisition process.

Subsequent volumes in this series that also support all phases of the acquisition process are Volume 6, which discusses survivability T&E; and Volume 7, which discusses vulnerability analysis.

1.0 INTRODUCTION TO DEFENSE ACQUISITION MANAGEMENT

A basic understanding of defense acquisition begins with the following definition (as given in SECNAVINST 5400.15A):

> *Defense Acquisition System: A single uniform system whereby all equipment, facilities, and services are planned, developed, acquired, maintained, and disposed of by the Department of Defense (DoD). The system includes policies and practices that govern acquisition, identifying and prioritizing resource requirements, directing and controlling the process, contracting, and reporting to Congress.*

Acquisition reform and the accelerated transition of new technology to the warfighter have changed the acquisition process as well as associated survivability activities. To maintain our technological superiority, the Department of Defense (DoD) must field new state-of-the-art systems that must be developed within reduced budgets and at the rapid pace set by the technology revolution. Increasingly, advanced technology is becoming available in international markets, requiring DoD to accelerate the development process as never before. Rapid technology transition from earliest Science and Technology (S&T) concepts to operational forces is crucial.

The following conditions are evidence of the importance of survivability:

- Its emphasis in the system engineering process of the military acquisition cycle.
- The establishment of the Live Fire Test and Evaluation (LFT&E) Law by Congress to ensure, by realistic testing and independent assessment, that battle-damage tolerance (survivability) and/or lethality is known and corrected where necessary, that crew/user casualty issues are adequately addressed, and that such information is available to support acquisition decisions.
- The continued financial support of the JTCG/AS.
- The establishment of the Survivability/Vulnerability Information Analysis Center (SURVIAC) to ensure the availability and timely acquisition of survivability and vulnerability technology, methodology, and information.
- The requirement for survivability that DoD has placed on systems acquisition.

To fulfill survivability acquisition requirements, the PM needs an understanding of the relationship survivability plays in the acquisition process and its associated elements. The defense acquisition system provides the framework for acquisition of weapons, automated information systems, and other materiel used by the armed forces to meet threats to national

security and to support the decision-making process. A weapon system is a system to assist DoD in conducting its mission of deterring (or if deterrence fails, winning) war. Survivability includes not only a combination of hardware and computer software but also data and/or telecommunications that perform functions such as collecting, processing, transmitting, and displaying information the warfighter uses to make decisions during combat. Survivability specifically includes resources, both hardware and software, that are physically parts of, dedicated to, or essential in real time to the mission performance of weapon systems. Such resources are called *Mission-Critical Computer Resources (MCCRs)* and are considered part of the specific weapon system.

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-systems acquisition* (science, technology, and concept development and demonstration). Systems are developed, demonstrated, and produced or procured in *systems acquisition*.

The outcome of systems acquisition is a system that is well-defined and carefully structured to represent 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 performance-based 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 *sustainment and disposal*.

The three major milestone decision points and three phases of the acquisition process, illustrated in Figure 1, typically provide a basis for comprehensive management and the progressive decision making associated with program maturation. These milestones and phases are tailored to support the specific acquisition situation.

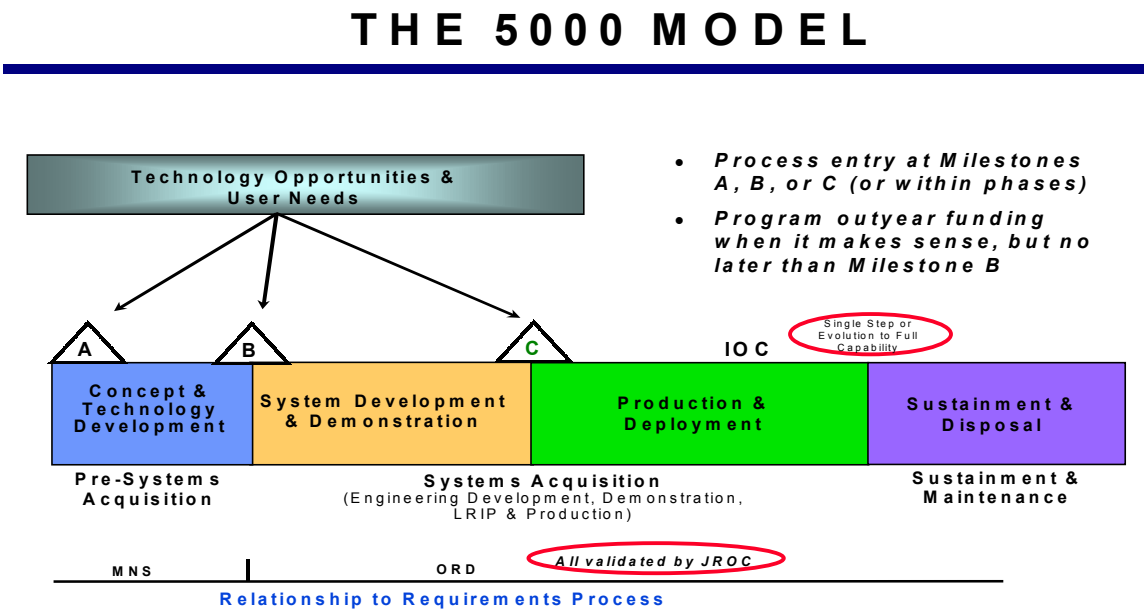


Figure 1. DoD Acquisition Management Framework

Phases and milestone decision points facilitate the orderly translation of broadly stated mission needs into system-specific performance requirements and a stable design that can be produced efficiently. Low-Rate Initial Production (LRIP) may occur during the Production and Deployment Phase if so decided at Milestone C.

The phases and milestones of the acquisition process provide a streamlined structure that emphasizes risk management and affordability. The phases are a logical means of progressively translating broadly stated mission needs into well-defined system-specific requirements and ultimately into operationally effective, suitable, and survivable systems. It is important to remember that the term "system" includes hardware, software, facilities, people, and data. Each phase is designed, among other things, to manage/reduce the risks. The milestones are times that allow the decisionmakers to evaluate the status of the program and determine if the program should proceed to the next phase.

The phases and milestones used to manage the program constitute the program structure, which is a fundamental building block of the program's acquisition strategy. The program structure provides the point of departure for the development of the strategy to acquire the system.

The three major milestone decision points and associated phases of the acquisition process form a basis for comprehensive management and sound decisions as a program matures. The Milestone Decision Authority (MDA) and the Program Manager (PM) tailor milestones and phases so that each milestone decision point allows assessment of program status and the opportunity to review plans for the next phase and beyond. The MDA should explicitly

address program risks and the adequacy of risk management planning during the milestone reviews, then establish exit criteria for progression to the next phase. At each milestone and at other desired points in the process, the MDA reviews each technology project or acquisition program. The MDA reviews the Program Manager's program, as informed by the Integrated Product Team (IPT) process, and the independent assessments required by law or the MDA's judgment.

Additional defense-systems acquisition information is contained in Appendix A.

2.0 SURVIVABILITY SUPPORT TO THE PROGRAM MANAGER

DoD policy calls for the systems acquisition process to be directed by a responsible manager under the concept of program management. The terms program, product, and project are used interchangeably. The role of the PM (or product or project manager), as a minimum, is to direct the development, production, and initial deployment of a system. This management must be done within limits of cost, schedule, and performance objectives approved by the Under Secretary of Defense (Acquisition and Technology) (USD(A&T)) or head of the military department (service) or defense agency, or designee. The PM's role, then, is to be the agent of the service or defense agency in the management of a weapon system or automated information system (AIS) acquisition program within the defense acquisition process. The role of survivability is to provide optimum support to the PM in meeting his or her responsibility in directing the systems acquisition process. This support is accomplished by successful application of dedicated survivability resources.

Survivability activities in acquisition occur within the following five elements:

1. **Concept Development and Requirements Analysis** — Survivability activities required under this element involve making abstract or concept survivability studies and analysis, defining requirements, preliminary planning, and evaluating alternative technical approaches and associated costs for the development or enhancement of high-level general performance specifications of a system, project, mission, or activity. Typical associated tasks include, but are not limited to, survivability requirements analysis, cost/cost-performance trade studies, feasibility analysis, regulatory compliance support, and technology conceptual designs.

2. **System Design, Engineering, and Integration** — Survivability activities in this element involve translating a system (or subsystem, program, project, activity) survivability concept into a preliminary and detailed design (engineering plans and specifications); identifying, analyzing, and mitigating risks; ensuring traceability; and then integrating the various components to produce a survivable, working prototype or model of the system. Typical associated survivability tasks include, but are not limited to, computer-aided design, design studies and analysis, research and development, high-level detailed specification preparation, configuration management and document control, fabrication, assembly and modeling, and simulation.

3. **Test and Evaluation —** This element involves the application of various techniques demonstrating that a prototype system (subsystem, program, project, or activity) performs in accordance with the survivability objectives outlined in the original design. Typical associated tasks include, but are not limited to, prototype and first article(s) testing, environmental testing, independent verification and validation, reverse engineering,

modeling and simulation (to test the feasibility of a concept), testing system safety, quality assurance, education and training, and physical testing of the product or system.

10 USC 2366[i] mandates LFT&E for all covered systems, programs, or product-improvement programs. Systems or programs without decision points mentioned in *10 USC 2366*[ii], but otherwise meeting statutory criteria, are to be considered covered systems for LFT&E planning purposes. The Under Secretary of Defense (Acquisition, Technology, and Logistics) (USD(AT& L)) identifies equivalent acquisition events for such systems or programs, and the PM schedules LFT&E accordingly. In general, Milestone B corresponds to the point at which a system or program "enters System Development and Demonstration," for the purpose of applying the waiver requirements of 10 USC 2366. See Appendix B for information regarding LFT&E legislation, regulation, and guidance.

4. **Integrated Logistics Support —** This element includes the analysis, planning, and detailed design of all engineering-specific survivability-associated logistics support including material goods, personnel and training, and operational maintenance and repair of systems throughout their life cycles. Typical associated tasks include, but are not limited to, analyzing ergonomics and human performance, analyzing feasibility, planning logistics, determining requirements, developing policy standards and procedures, and planning for long-term reliability and maintainability.

5. **Acquisition and Life-Cycle Management —** This element involve all of the planning, budgetary, contract, and system/program management functions required to procure and/or produce, render operational, and provide life-cycle support (maintenance, repair, supplies, engineering-specific logistics) to technology-based survivability systems, activities, subsystems, projects, etc. Typical associated tasks include, but are not limited to, operation and maintenance, program/project management, technology transfer/insertion, and integrated product team support.

Survivability Life-Cycle Management

The survivability of an aerospace system operating in a threat-affected environment depends on the system's design and on the emphasis placed on survivability throughout the system's life cycle. Both the emphasis the U.S. places on minimizing casualties and the limited ability to replace lost systems mandate that survivability of our weapon systems be maximized.

Past and current significant advances in technology provide the potential to increase substantially the survivability of existing and future military aerospace systems in the threat environment. To obtain the maximum payoff from these technology advances, the survivability design discipline must be effectively implemented throughout the life cycle of the aerospace system and the survivability of our weapon systems and their occupants must be maximized.

Management of aerospace systems survivability must be conducted throughout the program life cycle by both the government and the manufacturer. Management is required in all phases of the life cycle, as shown in Figure 2. Survivability products and services must correlate with the system's life cycle. The government (DoD) has the major responsibility in the conceptual and validation phases where basic requirements for the aircraft system are established. While as a minimum the PM directs the development, production, and initial deployment of a system, the contractor has the major responsibility for the full-scale development and production phases. The using military service has the major responsibility for the system's survivability enhancement capabilities in the operational employment phase.

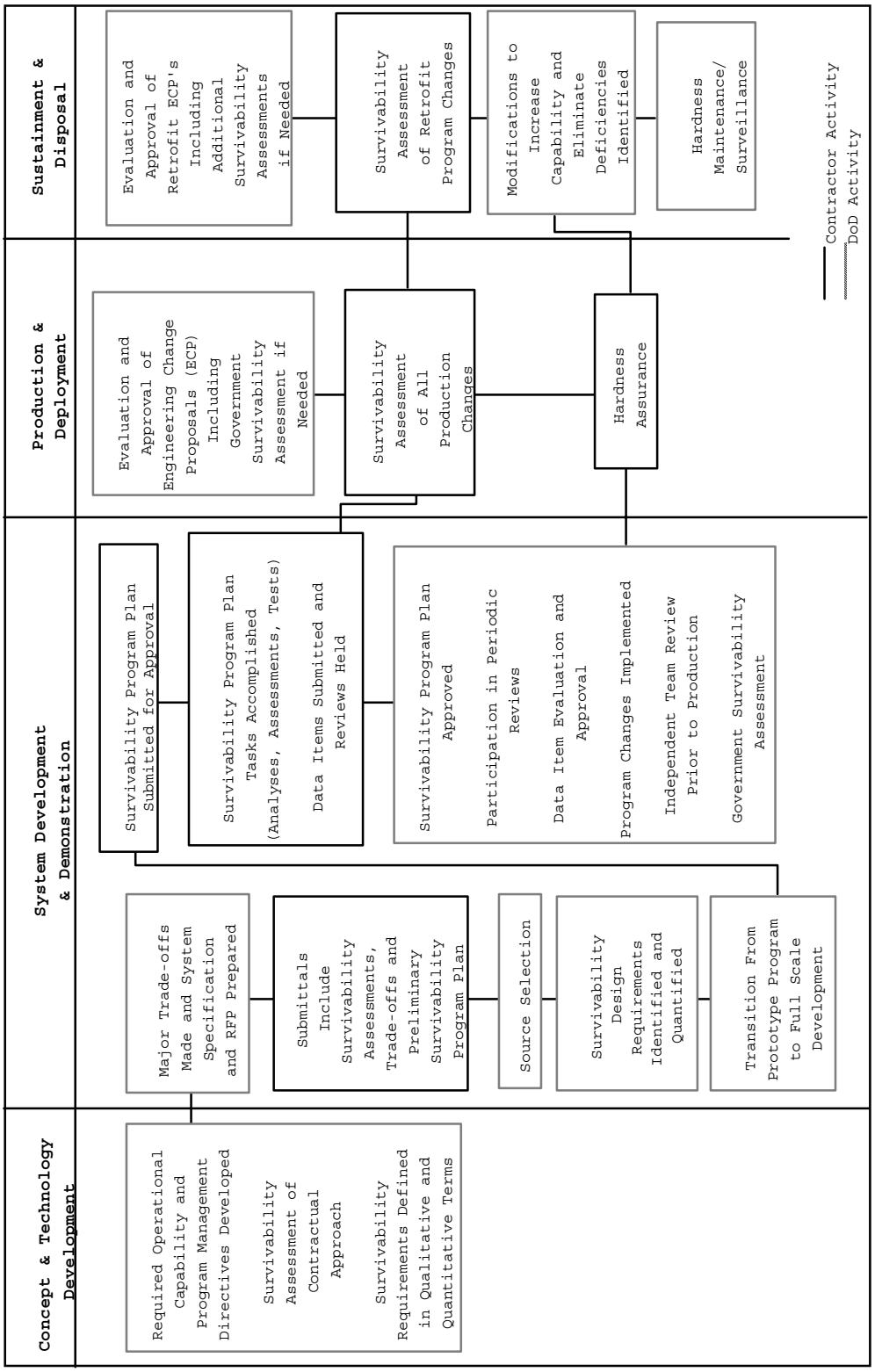


Figure 2. Life-Cycle Survivability

Survivability enhancement procedures are discussed in Appendix C.

During consideration of the operational threat environment, several methods are generally used to meet the survivability requirement. For example, in the initial weapons effects environment, developers can use hardening, avoidance, deception, proliferation, reconstitution, redundancy, or a combination thereof to meet the requirement. For each threat environment, expected mission capabilities should also be considered. Each capability affords the opportunity to formulate multiple alternatives to be considered in determining the most cost-effective and operationally effective solution.

Systems Engineering in Acquisition

The Program Manager is directed by the deskbook as follows: "The Program Manager shall ensure that a systems engineering process is used to translate operational needs and/or requirements into a system solution that includes the design, manufacturing, test and evaluation, and support processes and products. The systems engineering process shall establish a proper balance between performance, risk, cost, and schedule, employing a top-down iterative process of requirements analysis, functional analysis and allocation, design synthesis and verification, and system analysis and control."

The IPT's use of integrated product and process development (IPPD) is paramount to the success of the development program. The survivability process is an integral part of the Program Management/Systems Engineering (SE) activities of the classical military acquisition process. It is pertinent to note that the survivability process supports all phases of the SE program design process to the maximum extent practicable.

As illustrated by Figure 3, systems engineering management is accomplished by integrating three major activities:

- Development phasing that controls the design process and provides baselines that coordinate design efforts.
- A systems engineering process that provides a structure for solving design problems and tracking requirements flow through the design effort.
- Life-cycle integration that involves the customers in the design process and ensures that the system developed is viable throughout its life.

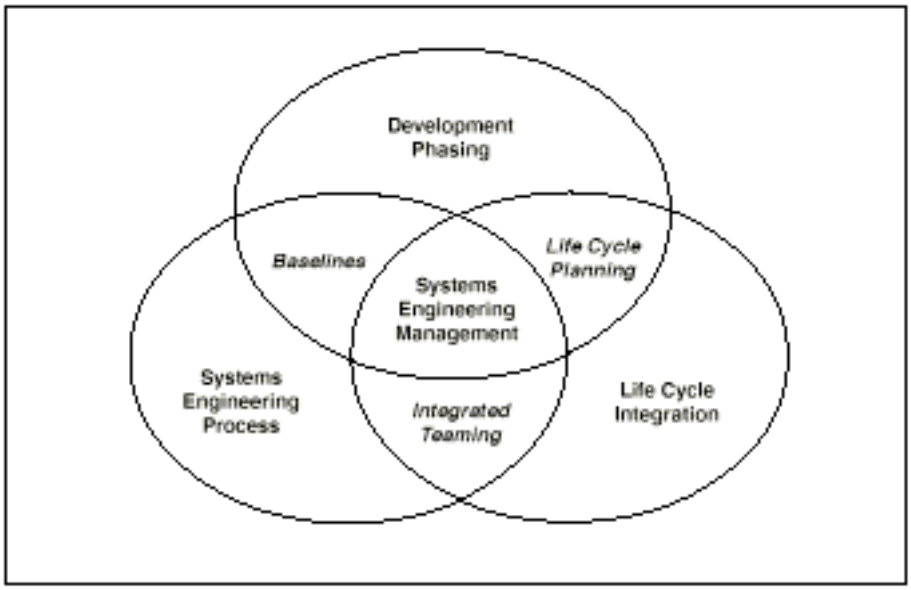


Figure 3. Three Activities of Systems Engineering Management

Integrated Product Teams

Each IPT is composed of representatives from all appropriate functional disciplines (including survivability) working together with a team leader to build successful and balanced programs, identify and resolve issues, and make sound and timely recommendations to facilitate decision-making. Program IPTs focus on program execution. The teams may include representatives from both government and, after contract award, industry.

It is readily apparent that the IPT is key to survivability's inclusion in a program. For that reason, this handbook series is designed to ensure that inclusion by providing "how-to" guidance to the Survivability IPT (SIPT).

The successful application of survivability as a functional discipline within the IPT structure requires not only the close association of the PM and the systems engineer but also the employment of the concept of Integrated Product and Process Development (IPPD) throughout the program design process to the maximum extent practicable. The best way to ensure those procedures is by establishing a Systems Engineering IPT (SEIPT) and ensuring that the systems engineer has a key role in the Integrating IPT (IIPT). A SIPT, established under the SEIPT, will ensure that survivability is properly addressed in all phases of the program.

The best time to address survivability is early in the acquisition process. Survivability objectives may be accomplished through trade studies, which are conducted before an acquisition approach is finalized. To facilitate that process, the Overarching IPT (OIPT) for each ACAT I program

and, as required, ACAT IA program will establish a Survivability IPT (SIPT) as an integral part of the WIPT. The user community should be represented on the SIPT. Industry representation, consistent with statute and at the appropriate time, should also be considered. Prior to each milestone decision, the PM should report the SIPT findings to the OIPT leader. The relationships of IPTs are depicted in Figure 4.

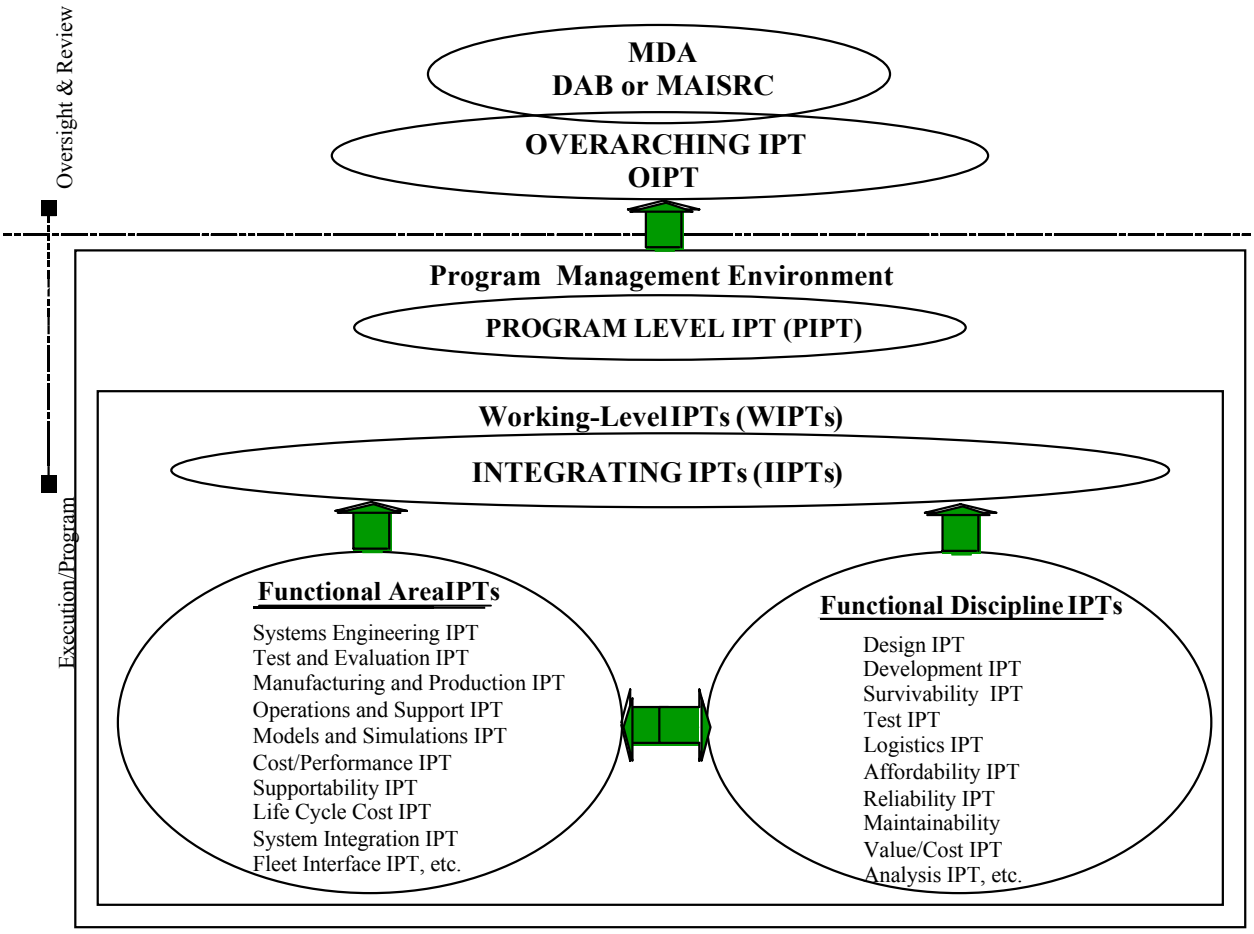


Figure 4. Integrated Product Team Relationships

Program Management Post-Milestone-B Support

All post-Milestone-B survivability acquisition activities support IPTs for major products and associated key sub-products for all levels of the acquisition. At this point survivability activities use resources to meet requirements coordinated with the associated IPT and systems engineering. The supplier supplies and manages the material and services pertaining to survivability, and DoD promulgates the basic top-level acquisition processes (e.g. SE, survivability systems analysis, etc.).

For post-Milestone B activities, the detailed systems engineering process SEP, as shown in Figure 5, is applied throughout the remainder of the acquisition cycle. Survivability must dedicate the necessary SE and IPT resources to ensure that survivability is properly addressed.

The survivability planning correlates directly with the systems engineering process.

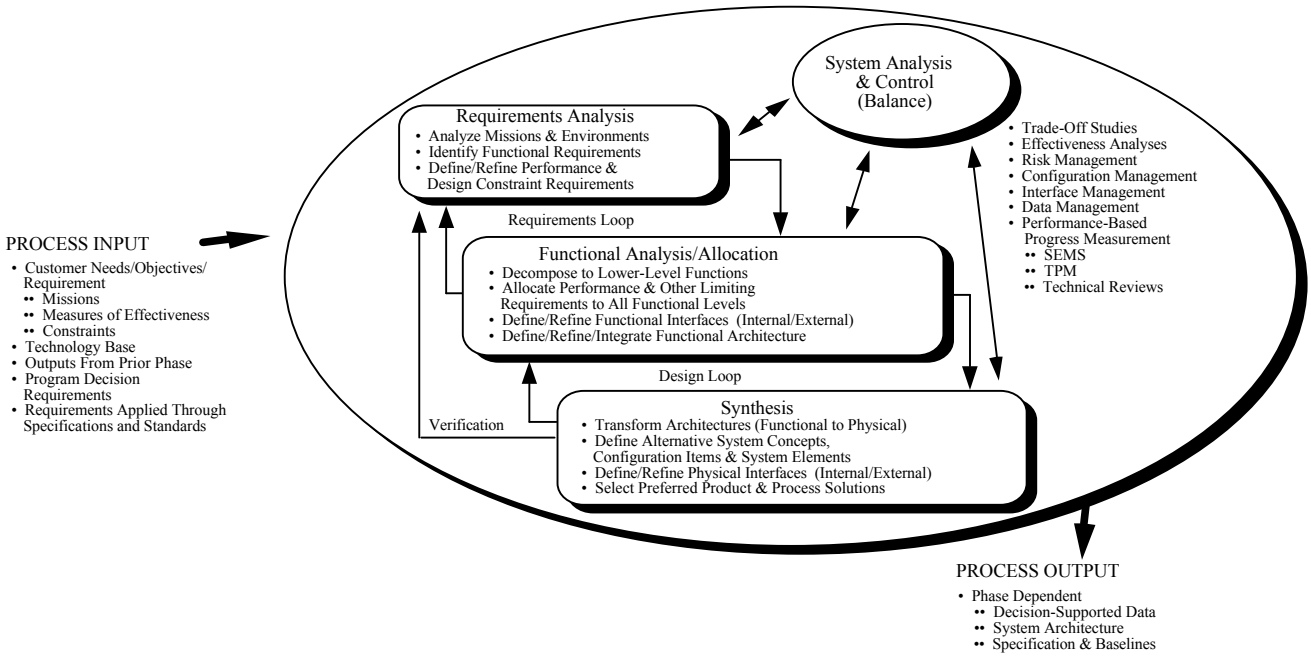


Figure 5. Detailed Systems Engineering Process

It is pertinent to note that, depending on the document being reviewed, survivability is identified as an engineering specialty or functional discipline in classical systems engineering. The definition for an engineering specialty in association with SE is as follows:

- **Systems Engineering** includes the "integration of engineering specialties and the management of a totally integrated effort of design engineering, specialty engineering, test engineering, and production engineering to ensure their influence on design."

- **Engineering Specialty Integration** includes the "timely and appropriate intermeshing of engineering efforts and disciplines such as: reliability, maintainability, survivability, logistics engineering, human factors, safety, value engineering, standardization, transportability, etc., to ensure their influence on design."

Survivability has a role to perform in the majority of acquisition activities. The specific activities performed make up the content of the survivability handbook series and the associated Work Breakdown Structures (WBS).

Technical Management Functions

Technical management is a broad term that encompasses the management of an integrated SE effort — including survivability, T&E, production, and logistics support over the system life cycle. An effective system must be deployed in a timely manner. The system must be sustained, and the need must be satisfied at an affordable cost. Technical management involves balancing a system's cost, schedule, and performance. *Cost* includes all funds required to design, develop, produce, operate, support, and dispose of a system. *Schedule* includes the time it takes to design, develop, produce, and deploy a fully supported system. *Performance* is the degree to which a system can be expected to achieve a set of specific mission requirements, and includes criteria for both effectiveness (i.e., whether it does the job required) and suitability (i.e., whether the user can employ the system). Technical management includes the following:

- Define the system/product (establishing the configuration management baseline).
- Develop the acquisition program baseline (APB).
- Conduct design engineering.
- Perform SE, including cost, schedule, and performance trade studies.
- Develop and/or acquiring computer resources, including software.
- Plan for acquisition logistics.
- Conduct developmental test and evaluation (DT&E).
- Conduct operational test and evaluation (OT&E) and live-fire test and evaluation (LFT&E).
- Identify and track reliability, availability, and maintainability (RAM) requirements.
- Make the transition from development to production.
- Address standardization and specifications (e.g., performance specifications).
- Establish a configuration-management (CM) process.
- Ensure producibility of the final design.
- Define manufacturing processes and controls.
- Plan for system or product disposal.
- Investigate the potential for Pre-Planned Product Improvement (P3I).

Technical management can be described as an input, process, and output. The *input* is the need or requirement. The *process* is how the technical activities are managed. The *output* is the end item. Linking these phases is a feedback loop that improves the end item based on customer (user) comments and recommendations. The Aerospace Systems Survivability Handbook Series

is designed to guide survivability-related personnel in the performance of business, financial and technical functions (management as well as engineering, T&E, and systems analysis).

Performance Specifications

In solicitations and contracts, standard management approaches or manufacturing processes are not required. Performance specifications are used when purchasing new systems, major modifications, and commercial and nondevelopmental items. Performance specifications include DoD performance specifications, commercial item descriptions, and performance-based non-government standards.

If using a performance specification is not practicable, a nongovernment standard is used. There may be cases when military specifications are needed to define an exact design solution because no acceptable nongovernment standard exists or because the use of a performance specification or nongovernment standard is not cost-effective or practical or does not meet the user's needs. As a last resort in such cases, the use of military specifications and standards is authorized with an appropriate waiver or exception from the MDA. Survivability personnel will provide the survivability-related inputs to the performance specification.

The missions and threat systems considered in this mission-threat analysis should be those specified in the aerospace system performance specification, operational requirements, and implementing documentation. Detailed survivability specifications should include or refer to the specific threats, mission profiles and scenarios, and antiaircraft defense situations to be used throughout. The developer should:

- Define each operational mode required by the specified missions. Aerospace system configuration factors (weights, C.G. locations, fuel status, armament loading, etc.) and proposed operational concepts and tactics should contain the maximum possible detail.

- List the threats and threat characteristics applicable to the defined operational modes.

- Analyze aerospace system operational modes and threats and determine encounter conditions.

The derived encounter conditions should be used as a basis for the required survivability assessments and trade studies. These studies, in turn, will permit the aerospace system to operate effectively in the expected threat environment.

3.0 SURVIVABILITY IN THE ACQUISITION PROCESS

Survivability in Pre-Systems Acquisition

The Concept and Technology Development phase focuses on developing alternative concepts and weighing advantages and disadvantages of each of those alternatives, as shown in Figure 6.

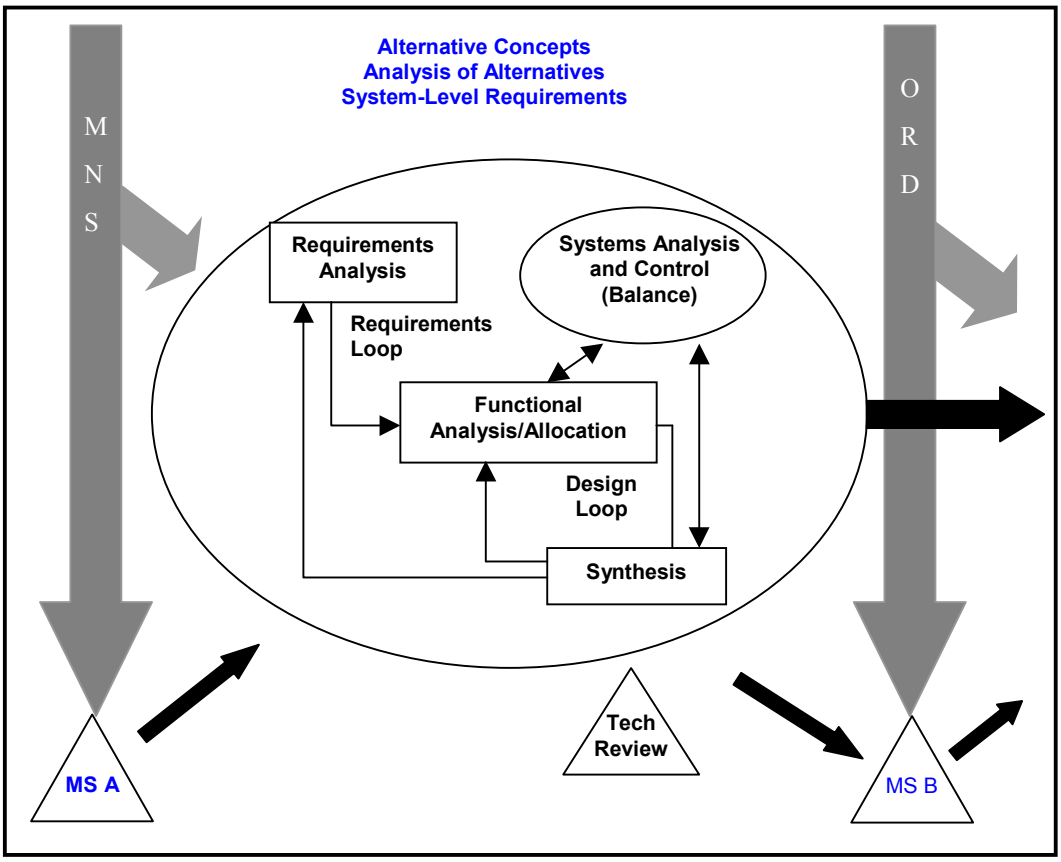


Figure 6. Concept Exploration in Concept and Technology Development Phase

Survivability activities during this phase include cost /performance trade studies, the definition of operational requirements, the setting of realistic but aggressive cost objectives, and development of the operational requirements document (ORD), which leads to draft system specifications and the Test and Evaluation Master Plan (TEMP). Many of the same models employed during the previous phase are reused. Engineering models project performance and trade studies. Engagement and mission/battle-level models determine mission effectiveness and support cost/performance trade studies and ORD development. Theater- and campaign-level models evaluate conflict outcomes in support of the same documents. Human interactive simulations are used to develop tactics; and virtual simulations evaluate concepts, technologies, and tactics in realistic synthetic environments. Throughout this phase, modeling and simulation

(M&S) support the implementation of the Cost as an Independent Variable (CAIV) concept, early risk reduction, and establishment of consistent measures of effectiveness (MOEs) and measures of performance (MOPs).

This phase 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) of these concepts at the next milestone decision point. Analysis of alternatives is to be used as appropriate to facilitate comparisons of alternative concepts. During this phase, the most promising system concepts are defined in terms of initial, broad objectives for cost, schedule, performance, software requirements, opportunities for trade studies, overall acquisition strategy, and T&E strategy.

At this stage, no program or program office exists per se; but alternative concepts are analyzed to satisfy the requirements of the mission need statement (MNS). A major planning effort is under way by a program office cadre to prepare for program initiation at Milestone B. The survivability manager should:

- Develop the acquisition survivability strategy.
- Refine initial survivability planning and LCC estimates.
- Keep in step with emerging design.
- Provide survivability involvement in contract management IPT reviews.
- Prepare survivability section of development contract package.
- Consider support analyses, such as trade studies and analysis of alternatives.

Survivability in the System Development and Demonstration Phase

In this phase, principal program office activity centers on evaluating system alternatives, selecting preferred system alternative(s), defining the critical design characteristics and capabilities, and demonstrating that the required technologies can be incorporated into the system design. The survivability manager focuses on the following tasks during this phase:

- Implement acquisition survivability strategy.
- Refine initial survivability planning and LCC estimates.
- Keep in step with emerging design.
- Provide survivability involvement in contract management and IPT reviews.

- Prepare survivability section of development contract package.
- Consider support analyses, such as trade studies and analysis of alternatives.
- Initiate postproduction planning.

In addition, the following survivability activities are accomplished during this phase:

- Ensure that the system threat assessment specifically addresses the threat categories, making specific statements for or against their expected likelihood.
- Define initial survivability objectives and establish validation criteria. Make sure these objectives are identified in the Operational Requirements Document, with key objectives included in the Concept Baseline.
- Ensure that critical survivability characteristics and issues that require T&E have been identified and included in the Test and Evaluation Master Plan.
- Identify critical survivability technology shortfalls and establish research requirements.
- Identify preliminary facilities characteristics required to support unique survivability characteristics and make plans to track them through the Integrated Logistics Support Plan (ILSP).
- Develop an LFT&E strategy and document it in the Test and Evaluation Master Plan.
- Identify critical survivability characteristics and issues that require T&E and include them in the Test and Evaluation Master Plan.
- If full-up, system-level LFT&E is not planned, ensure that the alternative LFT&E Plan is approved by DOT&E and a waiver granted by the Milestone Decision Authority.
- Include key survivability objectives such as vulnerability reduction and/or damage tolerance in the Development Baseline.
- Incorporate the survivability objectives in the system specification and integrated logistics support plan.
- Address survivability issues in the Integrated Program Summary.

Survivability in the Production and Deployment Phase

The objectives of the Production and Deployment phase are to achieve an operational capability that satisfies mission needs. The production requirement of this phase does not apply to MAISs or software-intensive systems with no developmental hardware components.

The following survivability activities are accomplished during this phase:

- Complete all LFT&E.
- Complete an assessment of how well survivability objectives have been met and include the results in the Beyond Low-Rate Initial Production report.
- Resolve all survivability issues.
- Include key survivability objectives in the Production Baseline.
- Include survivability considerations in major modification or upgrade packages; address the possibility of retrofitting survivability into the system.

4.0 COST AND AFFORDABILITY

An affordability determination is made during the requirements process as part of addressing cost as a military requirement. That determination is 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, which should 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 platform or when the timing of the PPBS cycle dictates, the full funding decision may be made prior to entry into System Development and Demonstration. In no case should full funding be done later than Milestone B.

Price or Cost as an Independent Variable

In establishing realistic objectives, the user treats price or cost as a military requirement. Price is the independent variable, preferred over cost, when market research reveals a reasonable expectation for a high degree of competition, a high confidence that price analysis will yield a fair and reasonable price, and an acceptable technical risk for the acquisition. The acquisition community, including technology and logistics, and the requirements community use the price or cost as an independent variable (P/CAIV) process to develop a total ownership cost (TOC), schedule, and performance thresholds and objectives. These communities address price or cost in the Operational Requirements Document (ORD), and balance mission needs with projected out-year resources.

Cost/Schedule/Performance Trade Studies

The best time to reduce the time needed for the TOC and program schedules is early in the acquisition process. Continuous price/cost/schedule/performance trade studies will accomplish price/cost and schedule reductions.

Maximizing PM and contractor flexibility to make price/cost/performance trade studies is essential to achieving cost objectives. Trade studies within the objective-to-threshold "trade space" do not require higher-level permission, but requires coordination with the operational-requirements developer.

Price or cost, schedule, and performance may be traded within the trade space between the objective and the threshold without obtaining MDA approval. Trade studies outside the trade space (i.e., program parameter changes) require approval of both MDA and ORD approval authorities. Joint Requirements Oversight Council (JROC)- or Principal Staff Assistant (PSA)-validated key performance parameters (KPPs) may not be traded without JROC or PSA approval, as appropriate. The PM and the operational requirements developer jointly coordinate all trade-study decisions.

Life-Cycle Cost Estimates

Life-cycle cost estimates are explicitly based on the program objectives, operational requirements, and contract specifications for the system. For ACAT I programs, life-cycle cost estimates are based on a program DoD WBS; for ACAT IA programs, life-cycle cost estimates are based on a life-cycle cost-and-benefit element structure agreed on by the IPT. Estimates are comprehensive in character. They identify all elements of cost that would be entailed by a decision to proceed with development, production, and operation of the system regardless of funding source or management control. For ACAT I programs, estimates are consistent with the cost estimates used in the analysis of alternatives. The operation and support costs are consistent with the manpower estimate. Cost estimates should be neither optimistic nor pessimistic; they should be based on a careful assessment of risks and should reflect a realistic appraisal of the level of cost most likely to be realized. Survivability staff will provide life-cycle cost estimates for survivability-related elements.

Acquisition Survivability Cost

Acquisition programs establish survivability concepts early in the program and refine them throughout the development process. Life-cycle costs play a key role in the overall selection process. Survivability concepts for new and future systems provide for cost-effective, total life-cycle survivability support. Additional cost information is contained in Appendix D.

Appendix A.

Defense Systems Acquisition Overview

DoD 5000.2 defines acquisition phase as "a time segment in the life of an acquisition program in which all the tasks and activities needed to bring the program to the next major decision point takes place. Based on validated and approved needs, acquisition phases ensure a logical progression of effort designed to mature technologies; demonstrate operational system effectiveness, survivability, and suitability; evolve efficient manufacturing capabilities; ensure affordability; ensure supportability; and provide the needed capability to the warfighter in the shortest practical time."

Pre-System Acquisition

Pre-system acquisition is composed of on-going in development of user needs, science and technology, and concept development work specific to the development of a material solution to an identified need, including survivability.

A Technology Project is a directed, incrementally funded effort designed to provide new capability in response to technological opportunities or a validated 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.

User Need Activities. The Mission Need Statement (MNS) identifies and describe the projected mission needs of the warfighter, including survivability, as a primary need. The user, with the support of operational test and evaluation personnel, develops the needs expressed in the MNS into requirements in the form of Capstone Requirements Documents (CRDs) (if applicable) and Operational Requirements Documents (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

Technological Opportunity Activities. Survivability 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 warfighters 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, coordination, quality, and content of the DoD S&T Program (including software capability).

S &T Program Transition. To ensure the transition of innovative survivability concepts and superior technology to the warfighter and acquisition customer, the DoD Component S&T Executives use three mechanisms -- Advanced Technology Demonstrations (ATDs), Advanced Concept Technology Demonstrations (ACTDs), and Joint Warfighting Experiments (JWEs). The specific plans and processes for these transition mechanisms are described in the Joint Warfighting S&T Plan.

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 and the completion of entrance criteria into Milestone B and System Development and Demonstration Phase.

After the requirements authority validates and approves a MNS, the MDA (through the IPT process) will review the MNS, consider possible survivability technology issues (e.g., technologies demonstrated in ATDs), and identify possible materiel alternatives before making a Milestone A decision.

A favorable Milestone A decision does not yet mean that a new acquisition program has been initiated.

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

- Concept Exploration. 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, including survivability, 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 is used to facilitate comparisons of alternative concepts.

- Component Advanced Development. The project enters Component Advanced Development when the Program Manager has a concept for the needed capability, but does not yet know the system content. Unless otherwise determined by the MDA, the component technology, including survivability, to be developed is to have been proven in concept. The project exits 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 is to be guided by the validated MNS, but during this activity, an ORD is developed. This effort is followed by entry into System Development and Demonstration after a successful Milestone B decision by the MDA.

Systems Acquisition

Systems acquisition is the process of developing concepts, including survivability, into producible and deployable products that provide capability to the warfighter. The concept(s) to exploit in systems acquisition are 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, normally prepares the analysis of alternatives (although the PM or PM's representative may participate in the analysis).

System Development and Demonstration Phase and Milestone B.

The purpose of the System Development and Demonstration phase is to complete the discovery process, develop a system, reduce program risk, ensure system supportability, design for producibility, assure affordability, and demonstrate system integration 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). All modeling, simulation, test, and evaluation activities are integrated into an efficient continuum planned and executed by an integrated test and evaluation product team (T&E IPT). This continuum features 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 is under the direct responsibility of the PM or a designated test agency. All results of early operational assessment and operational assessment is 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 test and evaluation (FOT&E), if required, is the responsibility of DOT&E or the appropriate operational test activity.

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 determines the appropriate entrance point, which is Milestone B. There is only one Milestone B per program, or evolutionary block.

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

System Integration or System Demonstration. Regardless of the approach recommended, PMs and other acquisition managers continually assess program risks.

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

  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).

- System Demonstration. The program enters 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.

This phase ends with a system demonstrated in a relevant environment (e.g., using engineering development models), meets validated requirements, industrial capabilities are reasonably available, and the system that meets or exceeds exit criteria and Milestone C entrance requirements. The completion of this phase is dependent on a successful decision by the MDA to commit to the program at Milestone C or a decision to end this effort.

Production and Deployment Phase and Milestone C

A system must be demonstrated before DoD 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 MDA makes the commitment decision at Milestone C. Milestone C can by reached directly from pre-systems acquisition (e.g., a commercial product) or from System Development and Demonstration phase. The objectives of the Production and Deployment phase are to achieve an operational capability that satisfies mission needs.

The purpose of this milestone is to authorize entry into low-rate initial production (for MDAPs and major systems) or into production or procurement (for non-major systems that do not require low-rate production).

At this milestone, the MDA approves the acquisition strategy, an acquisition program baseline, exit criteria for low-rate initial production (if needed), and the acquisition decision memorandum.

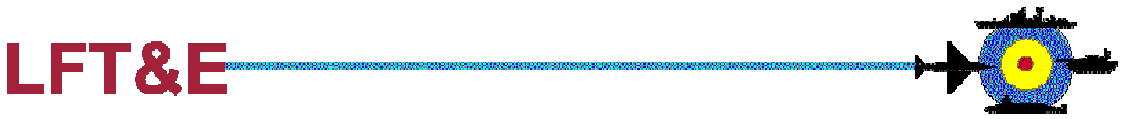
Sustainment and Disposal Phase

The objectives of this activity are the execution of a program of support that meets support performance requirements and sustainment of systems in the most cost-effective manner for the life-cycle of the system.

- Sustain Systems. The sustainment program includes all elements necessary to maintain the readiness and operational capability of weapon and other materiel systems. The scope of support varies among programs but generally includes supply, maintenance, transportation, sustaining engineering, data management, configuration management, manpower, personnel, training, safety, occupational health, C4I, and environmental management functions. This activity also includes the execution of operational support plans.

  A follow-on operational test and evaluation program that evaluates operational effectiveness, survivability, suitability, and interoperability, and that identifies deficiencies isconducted, as appropriate (see DoD 5000.2-R, Part 3).

- Dispose of Systems. At the end of its useful life, a system must be demilitarized and disposed. The PM addresses in the acquisition strategy disposal requirements. During disposal, the Defense Reutilization and Management Office ensures materiel determined to require demilitarization is controlled and ensures disposal is carried out in a way that minimizes DoD's liability due to environmental, safety, security, and occupational health issue.



Appendix B.

Live Fire Test and Evaluation (LFT&E)

Legislation, Regulation, and Guidance

FEBRUARY 2001

Note: *This appendix is included just as it was written. Any references to attachments or appendixes are to those in Appendix B, not to those in the main volume.*

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PREFACE

This document contains reference sources for Live Fire Test and Evaluation (LFT&E) from relevant legislation and conference report language, and from the DoD 5000 Series.
This document will be updated whenever there is a change to the legislation, DoD 5000 Series, or other policy document that would affect the requirement for or conduct of LFT&E. The document has been updated at this time to reflect language adopted in the new DoD Directive 5000.1, DoD Instruction 5000.2, and Interim DoD 5000.2-R. The first two documents were signed on October 23, 2000. The last was signed on January 1, 2001.

Live Fire Test and Evaluation (LFT&E)
Legislation, Regulation, and Guidance

Table of Contents

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I. LIVE FIRE LEGISLATION

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I. LIVE FIRE LEGISLATION

The United States Congress has passed legislation that requires that Live Fire Testing of selected major weapon systems be completed and reported before the program can proceed beyond low-rate initial production. This "Live Fire Law" began in FY 1986 as a modification to Title 10, U.S. Code that addressed only tracked or wheeled armored vehicles (Section 2362). In FY 1987 it was expanded to include major conventional land, air, and sea systems or munition or missile programs (Section 2366). The 1994 Defense Authorization Bill rescinded Section 2362 leaving only Section 2366 currently applicable to LFT&E. The Federal Acquisition Streamlining Act of 1994 (FASA) modified Section 139 to give oversight responsibility of LFT&E to the Director of Operational Test and Evaluation. The following sections contain current Live Fire Test and Evaluation (LFT&E) legislation, supplementary information from Congressional conference committee reports, and system-specific legislation.

A. CURRENT LFT&E Legislation

Title X U.S. Code Section 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.

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(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 defense committees of Congress (as defined in section 2362(e)(3) of this title). 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.

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(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.
Effective Date (from Public Law 99-500): "Section 2366 of title 10, United States Code (as added by subsection (a)), shall apply with respect to any decision to proceed with a program beyond low-rate initial production that is made
(1) after May 31, 1987, in the case of a decision referred to in subsection (a) (1) or (a) (2) of such section; or
(2) after the date of the enactment of this Act, as in the case of a decision referred to in subsection (a) (3) of such section."
TITLE X U.S. CODE SECTION 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 and Technology 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 and Technology 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 shall consult closely with, but the Director and the Director's staff are independent of, the Under Secretary of Defense for Acquisition and Technology and all other officers and entities of the Department of Defense responsible for acquisition. 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.

(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 and Technology, 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. 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.

B. CONFERENCE REPORTS

FY 87 DoD Authorization Act Conference Report

Survivability, lethality and operational testing (Sec. 910)

Section 214 of the House amendment contained a provision that would require all new major conventional systems and weapons to be subjected to realistic, live-fire testing before entering production. A system would be tested for vulnerability and survivability by firing all the conventional threat munitions likely to be encountered in combat at the system configured for combat. A weapon would be tested for lethality by firing it at foreign targets configured for combat. The amendment would also require that independent operational testing be conducted for all new major conventional systems before entering production and that such testing would include a side-by-side test of the system intended to be replaced or the nearest competitor of the system being acquired.

The Senate bill contained no similar provision.

The conferees agreed to a modified version of the House provision contained in section 214. The provision would require that a major conventional weapons system not proceed beyond low-rate initial production until (1) a realistic survivability or lethality test is completed; and (2) an initial operational test and evaluation is completed. Such survivability and lethality tests would be carried out early enough to allow design deficiencies to be corrected before production. Employees of the contractor for the system being tested would not be involved in the conduct of the initial operational test and evaluation.

The conferees direct that the Secretary of Defense conduct, as a matter of high priority, a comprehensive review of testing policy in the Department. The conferees believe that the Secretary's review should include the following issues:

(1) A review of the length of time currently required in the acquisition process and ways to reduce the time devoted to testing;

(2) A review of existing testing policies of the Department and the Military Departments, and a determination of inconsistencies in fundamental testing philosophies and approaches;

(3) A review of the relationship between development testing and initial operational testing, and what role each plays in the acquisition process.

The last issue merits special attention by the Secretary. The conferees believe that developmental testing and initial operational testing are separate, yet complementary, elements in the acquisition process. Developmental testing is designed to support the development of improved weapon systems. Initial operational testing is designed to prevent the production of flawed systems. Initial operational testing can never assume the functions of developmental testing, because the legislative history that established the Office of Operational Test and Evaluation inherently created an independent inspector general-type of function. Similarly, developmental testing (by definition) implies close collaboration with the developers of new systems, which prohibits such testing from performing the role the Congress intended for initial operational testing.

The situation suggests that fundamental review by the Secretary is in order. The conferees invite the Secretary to comment on section 910, as well as section 123 in Public Law 99-145 and other testing statutes. The Committees on Armed Services in both the U. S. Senate and the House of

Representatives intend to conduct comprehensive hearings on testing policies and procedures next year and are prepared to amend section 910 and other statutory testing provisions after thorough consideration of the Secretary's review. The Secretary is invited to offer draft legislation if his review suggests such a course is warranted.
The Secretary shall transmit his report to the Committees on Armed Services of the Senate and the House of Representatives by March 15, 1987 to facilitate early hearings.

FY 88-89 DoD Authorization Act Conference Report

Live-Fire Testing (Sec. 802)

The House bill contained a provision (section 822) that would amend section 2366 of title 10, United States Code governing live-fire testing by the Department of Defense. The provision would require that covered programs not proceed beyond low rate initial production until vulnerability testing is completed, require the Secretary of Defense to designate a civilian official in the Department of Defense responsible for vulnerability and lethality testing, and other actions. The Senate amendment contained a provision (sec. 806) that would repeal section 2366.
The Senate recedes with an amendment that would require covered product improvement programs not proceed beyond low rate initial production until survivability and lethality testing is completed, provide for reports to Congress on such tests, clarify the definition of realistic survivability testing, and clarify contractor involvement during operational testing.
The conferees believe that live-fire testing is a valuable tool for determining the inherent strengths and weaknesses of adversary, U.S. and allied weapon systems. The conferees intend that the Secretary of Defense implement this section in a manner which encourages the conduct of full-up vulnerability and lethality tests under realistic combat conditions, first at the sub-scale level as sub-scale systems are developed, and later at the full-scale level mandated in the legislation.
The conferees intend this type of developmental testing to be performed as part of the responsibilities of the Under Secretary of Defense for Acquisition. Before such testing begins, the office of the Under Secretary should have reviewed the adequacy of the test plans, or alternatives to full-scale testing, prepared by the services concerned. While testing is underway, the Under Secretary should have full access to all test data and reports and should ensure adequate resources are provided for the conduct of realistic tests, including threat munitions and targets, for instruments and facilities, and for adequate staff and funding for the Office of Live-Fire Testing. The conferees realize the Department of Defense, at times, conducts operational tests and developmental tests simultaneously. It is not the intent of the conferees to exclude contractor involvement in the development portion of these tests.

FY 89 DoD Authorization Act Conference Report

Live Fire Testing Programs

Section 236 of the House bill would amend section 2366(b)(3) of title 10, United States Code, to allow the Secretary of Defense to conduct live fire testing and to evaluate such testing using appropriations available for procurement of the systems being tested.
The Senate amendment contained no similar provision.
The House recedes. The conferees agree with the intent of the House provision to allow the Secretary of Defense to reprogram up to one third of one percent of the total funds approved by

Congress for the procurement of a specific system that has been identified as a live fire testing candidate, for the purpose of conducting necessary vulnerability/lethality live fire tests and evaluations in compliance with the fiscal years 1987 and 1988 Defense Authorization Acts (Public Law 99-661 and 100-180). The conferees agree to provide this discretionary authority to the Secretary of Defense through this statement of managers.

Federal Acquisition Streamlining Act of 1994 Conference Report

Responsibility of the Director of Operational Test and Evaluation for Live Fire Testing (Sec. 3012)

The Senate bill contained a provision (sec. 3012) that would amend 10 U.S.C. 139 to assign responsibility for live fire testing in the Department of Defense to the Director of Operational Test and Evaluation. The Senate amendment also would require the Director to include live fire testing activities in the Director's annual report.

The House amendment contained no similar provision.

The House recedes with an amendment that would make it 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. 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 Director's 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 15, 1995, as to whether any statutory reporting requirements should be consolidated.

Survivability and Lethality Testing (Sec. 3014)

The House amendment contained a provision (sec. 3011) that would amend 10 U.S.C. 2366 to modify requirements for survivability and lethality testing. This section would allow a waiver for less than full-up testing if the Secretary of Defense certifies to Congress that such testing would be unreasonably expensive or impractical.

The Senate bill contained no similar provision.

The Senate recedes with an amendment that would make it clear that the certification which must be provided to Congress in connection with such a modification must be submitted before the system enters engineering and manufacturing development. The effect would be to maintain realistic survivability and lethality testing through testing of components, subsystems, and subassemblies in cases where the Secretary waives requirements for full up testing under 10 U.S.C. 2366.

C. SYSTEM SPECIFIC LIVE FIRE LEGISLATION

FY 93 DoD Authorization Act

Live-Fire Survivability Testing of C-17 Aircraft (Sec. 132)

(a) Applicability of Existing Law. – The C-17 transport aircraft shall be considered to be a covered system for purposes of survivability testing under section 2366 of title 10, United States Code.

(b) Authority for Retroactive Waiver. – The Secretary of Defense may exercise the waiver authority in subsection (c) of such section with respect to the application of the survivability tests

of that section to the C-17 transport aircraft notwithstanding that such program has entered full-scale engineering development.
(c) Report Requirement. – If the Secretary of Defense submits a certification under subsection (c) of such section that live-fire testing of the C-17 system under such section would be unreasonably expensive or impractical, the Secretary of Defense shall require that sufficiently large and realistic components and subsystems that could affect the survivability of the C-17 system be made available for any alternative live-fire test program.
(d) Funding. – The funds required to carry out any alternative live-fire testing program for the C-17 aircraft system shall be made available from amounts appropriated for the C-17 program (for fiscal year 1993).

MH-47E/MH-60K Helicopter Modification Program (Sec. 142)

(a) Required Testing. – Notwithstanding the requirements of subsections (a) (2) and (b) of section 2366 of title 10, United States Code, and the requirements of subsection (a) of section 2399 of such title–
(1) operational test and evaluation and survivability testing of the MH-60K helicopter under the MH-60K helicopter modification program shall be completed prior to full materiel release of the MH-60K helicopters for operational use; and
(2) operational test and evaluation and survivability testing of the MH-47E helicopter under the MH-47E helicopter modification program shall be completed prior to full materiel release of the MH-47E helicopters for operational use.
(b) Repeal of Superseded Law. – Section 143 of the National Defense Authorization Act for Fiscal Years 1992 and 1993 (Public Law 102-190; 105 Stat. 1313) is repealed.

FY 94 DoD Authorization Act

Theater and Limited Defense System Testing (Sec. 237)

(a) Testing of Theater Missile Defense Interceptors. – Except for the acquisition of those production representative missiles required for the completion of developmental and operational testing, the Secretary of Defense may not approve a theater missile defense interceptor program proceeding into the Low-Rate Initial Production (Milestone IIIA) acquisition stage until the Secretary certifies to the congressional defense committees that more than two realistic live-fire tests, consistent with section 2366 of title 10, United States Code, have been conducted, the results of which demonstrate the achievement by the interceptors of the weapons systems performance goals specified in the system baseline document established pursuant to section 2435(a)(1)(A) of title 10, United States Code, before the program entered engineering and manufacturing systems development. The live-fire tests demonstrating such results shall involve multiple interceptors and multiple targets in the present of realistic countermeasures.
(b) Advance Review and Approval of Proposed Developmental Tests of Limited Defense System Program Projects. – A developmental test may not be conducted under the Limited Defense System program element of the Ballistic Missile Defense Program until the Secretary of Defense reviews and approves (or approves with changes) the test plan for such developmental test.

(c) Independent Monitoring of Tests. – (1) The Secretary shall provide for monitoring of the implementation of each test plan referred to in subsection (b) by a group composed of persons who–
(A) by reason of education, training, or experience are qualified to monitor the testing covered by the plan; and
(B) are not assigned or detailed to, or otherwise performing duties of, the Ballistic Missile Defense Organization and are otherwise independent of such organization.
(2) The monitoring group shall submit to the Secretary its analysis of, and conclusions regarding, the conduct and results of each test monitored by the group.

FY 95 DoD Authorization Act

Study Regarding Live-Fire Survivability Testing of F-22 Aircraft (Sec. 254)

(a) Requirement. – The Secretary of Defense shall request the National Research Council of the National Academy of Sciences–
(1) to conduct a study regarding the desirability of exercising the authority under subsection (c) of section 2366 of title 10, United States Code, to waive for the F-22 aircraft program the survivability tests required pursuant to subsection (a) of such section; and
(2) to submit to the Secretary and Congress, within 180 days after the date of the enactment of this Act, a report containing the conclusions of the Council regarding the desirability of waiving such tests.
(b) Content of Report. – The report shall contain the following matters:
(1) Conclusions regarding the practicality of full-scale, full-up testing for the F-22 aircraft program.
(2) A discussion of the implications regarding the affordability of the F-22 aircraft program of conducting and of not conducting the survivability tests, including an assessment of the potential life-cycle benefits that could be derived from full-scale, full-up live fire testing in comparison to the costs of such testing.
(3) A discussion of what, if any, changes of circumstances affecting the F-22 aircraft program have occurred since completion of the milestone II program review to cause the program manager to request a waiver of the survivability tests for the F-22 aircraft program that was not requested at that time.
(4) The sufficiency of the F-22 aircraft program testing plans to fulfill the same requirements and purposes as are provided in subsection (e)(3) of section 2366 of title 10, United States Code, for realistic survivability testing for purposes of subsection (a)(1)(A) of such section.
(5) Any recommendations regarding survivability testing for the F-22 aircraft program that the Council considers appropriate on the basis of the study.

II. LFT&E REFERENCES IN DoD 5000 SERIES

Note: *This appendix is included just as it was written. Any references to attachments or appendixes are to those in Appendix B, not to those in the main volume.*

II. LFT&E references IN DoD 5000 SERIES

Department of Defense
DIRECTIVE
NUMBER 5000.1

Note: The following contains relevant LFT&E sections from DoD 5000.1, as signed October 23, 2000.

SUBJECT: The Defense Acquisition System

4. POLICY

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.

4.4. 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,

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occupational health, accessibility, survivability, and security factors; and spectrum management and the operational electromagnetic environment.

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.

Department of Defense
INSTRUCTION
NUMBER 5000.2

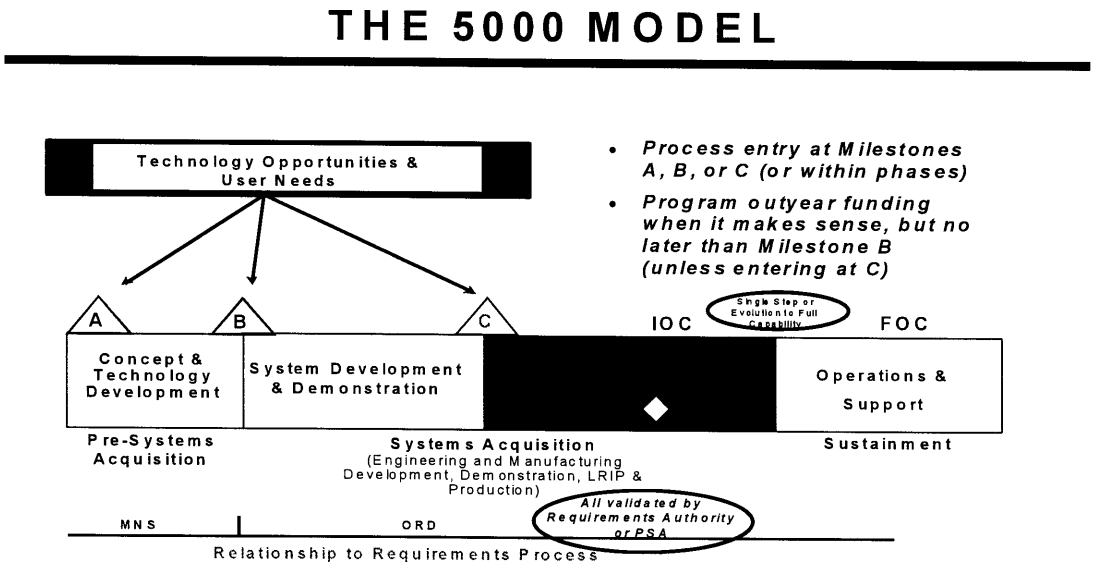
Note: The following contains relevant LFT&E sections from DoD 5000.2, as signed October 23, 2000.

SUBJECT: Operation of the Defense Acquisition System

4. PROCEDURES

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.

Figure F1.



4.7.2.4.3. Concept Exploration

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 trade studies, 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)).

4.7.3.2.3. 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

4.7.3.2.3.1.3. 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

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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)).

4.7.3.3.4. 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.

4.7.3.3.4.5. 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.

4.7.3.3.5. Full-Rate Production Decision Review

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

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

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. Statuatory 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.SC §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

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

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.§1401et seq. (reference (x))	Full-Rate Production DR
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

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

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
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

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Department of Defense
REGULATION
NUMBER 5000.2-R

Note: The following contains relevant LFT&E sections from Interim Regulation, DoD 5000.2-R, as signed January 1, 2001.

SUBJECT: **Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) Acquisition Programs**

- **2.8.3HUMAN SYSTEMS INTEGRATION (HSI)**

The PM shall pursue HSI initiatives (see 5.2.9) to optimize total system performance and minimize TOC. The PM shall integrate manpower, personnel, training, safety and occupational health (see 2.8.4), habitability, human factors, and personnel survivability considerations into the acquisition process. The support strategy shall identify responsibilities, describe the technical and management approach for meeting HSI requirements, and summarize major elements of the training development plan. The following considerations apply:

Personnel Survivability and Habitability. For systems with missions that might expose it to combat threats, the PM shall address personnel survivability issues including protection against fratricide, detection, and instantaneous, cumulative, and residual nuclear, biological, and chemical effects; the integrity of the crew compartment; and provisions for rapid egress when the system is severely damaged or destroyed. If the system or program has been designated by the DOT&E for LFT&E oversight (see 3.3), the PM shall integrate T&E to address crew survivability issues into the LFT&E program to support the Secretary of Defense LFT&E Report to Congress (see 3.10.2) (*10 USC 2366*[iii]). The PM shall address special equipment or gear needed to sustain crew operations in the operational environment (see 5.2.9.2). The PM shall also address habitability requirements (e.g., for the physical environment and support services) that are necessary for meeting and sustaining system performance, avoiding personnel retention problems, maintaining quality of life, and minimizing total system costs.

- **3.1 TEST AND EVALUATION (T&E) OVERVIEW**

T&E reveals information about the program and measures performance of the system against established requirements. The program manager (PM), in concert with the user and test communities, shall coordinate development test and evaluation (DT&E), operational test and evaluation (OT&E), live fire test and evaluation (LFT&E), family-of-systems interoperability testing, and modeling and simulation (M&S) activities, into an efficient continuum, closely integrated with requirements definition and systems design and development. The T&E strategy shall provide information about risk and risk mitigation, provide empirical data to validate

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models and simulations, evaluate technical performance and system maturity, and determine whether systems are operationally effective, suitable, and survivable against the threat detailed in the System Threat Assessment (see 6.2.2). The T&E strategy shall also address development and assessment of the weapons support test systems during the System Development and Demonstration Phase, and into production, to ensure satisfactory test system measurement performance, calibration traceability and support, required diagnostics, safety, and correct test requirements implementation. Adequate time and resources shall be planned to support pre-test predictions and post-test reconciliation of models and test results, for all major test events.
The PM shall design DT&E objectives appropriate to each phase and milestone of an acquisition program. The Operational Test Agency (OTA) shall design OT&E objectives appropriate to each phase and milestone of a program, and submit them to the PM for inclusion in the Test and Evaluation Master Plan (TEMP). Completed, independent OT&E and completed LFT&E shall support a beyond low-rate initial production (LRIP) decision for acquisition category (ACAT) I and II programs for conventional weapons systems designed for use in combat. For this purpose, OT&E shall require more than an operational assessment (OA) 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 USC 2399*[iv] and *10 USC 2366*[v])

- **3.2 T&E STRATEGY**

T&E planning shall begin during the Concept and Technology Development Phase. The PM shall form the T&E Working-Level Integrated Product Team (WIPT). Representatives from the DT&E (contractor and government), OT&E, LFT&E, and intelligence communities shall support the WIPT. If a project or program enters the acquisition process later than concept and technology development, the PM shall form the WIPT prior to entering the acquisition process. A T&E WIPT can be useful for a pre-system acquisition activity (e.g., an advanced concept technology demonstration, an advanced technology demonstration, or joint warfighting experimentation) that have a likelihood of becoming an acquisition program. A continuous T&E WIPT can help ensure a smooth transition, and can be used to prepare the initial TEMP. The early integration of T&E with program management ensures a test strategy consistent with and supportive of the acquisition strategy.

- **3.2.3.2 T&E GUIDELINES**

Early T&E activities shall harmonize measures of effectiveness (MOEs), measures of performance (MOPs), and risk with the needs depicted in the MNS, and with the objectives and thresholds addressed in the analysis of alternatives (AoA), and defined in the ORD, APB, and TEMP, as these documents become available. The user shall establish quantitative criteria for as many MOEs and MOPs as practical. The TEMP shall contain test event or scenario descriptions and resource requirements (including special instrumentation, test articles, ranges and facilities, and threat targets and simulations validated in accordance with a Director, OT&E (DOT&E)-approved process) and test limitations that impact the system evaluation. The Defense Intelligence Agency shall validate the threat information associated with these elements of the T&E process.

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The following T&E guidelines apply:

- Test planning shall consider the use of ground test activities, to include hardware-in-the-loop simulation, prior to conducting full-up, system-level testing, such as flight testing, in realistic environments.

- Planning shall provide for completed DT&E, OT&E, and LFT&E, as required, before entering full-rate production.
- T&E on commercial and non-developmental items shall ensure performance, operational effectiveness, and operational suitability for the military application in the military environment, regardless of the manner of procurement. Test planning for these items shall recognize commercial testing and experience, but nonetheless determine the appropriate DT&E, OT&E, and LFT&E needed to assure effective performance in the intended operational environment.

- Appropriate use of accredited models and simulation to augment DT&E, OT&E, and LFT&E shall be coordinated through the T&E WIPT.
- Planning shall consider a combined DT&E, OT&E, and/or LFT&E approach. The combined approach shall not compromise either developmental or OT objectives. Planning shall provide for an adequate OT period and report generation, including the DOT&E Beyond LRIP Report prior to the decision milestone.
- The DOT&E and the Deputy Director, DT&E, within the office of Strategic and Tactical Systems, Office of the Under Secretary of Defense (Acquisition, Technology, and Logistics) (DD, DT&E/S&TS, OUSD(AT&L)) shall have full and timely access to all available developmental, operational, and live fire T&E information.

3.3 ANNUAL T&E OVERSIGHT LIST

The DOT&E and D, S&TS shall jointly, and in consultation with the T&E executives of the cognizant DoD Components, publish an Annual T&E Oversight List of programs designated for OSD T&E oversight. This list shall identify programs on DT, OT, or LF oversight. Programs can be on oversight for only one of the three areas, or for more than one area. This list is contained in the DoD memorandum entitled "Designation of Programs for OSD Test and Evaluation (T&E) Oversight".

- **3.6 OT&E**

  - OT&E shall use threat or threat representative forces, targets, and threat countermeasures, validated by the Defense Intelligence Agency or DoD Component intelligence agency, as appropriate, and approved by DOT&E. The D, OT&E shall oversee threat target, threat simulator, and threat simulation acquisitions and validation to meet developmental, operational, and live fire test and evaluation needs.

The DOT&E shall assess the adequacy of OT&E and LFT&E, and evaluate the operational effectiveness, suitability, and survivability, as applicable, of systems under DOT&E oversight.

- **3.7 LIVE FIRE TEST AND EVALUATION (LFT&E)***

10 USC 2366[v] mandates LFT&E for all covered systems. The term "covered system" as defined below is the DoD term that is intended to include all categories of systems or programs identified in 10 USC 2366 as requiring LFT&E, along with additional systems or programs as further described below (see definition in Appendix C):

The term "covered system" means a system that the DOT&E, acting for the Secretary of Defense, has determined to be:

(A) a major system within the meaning of that term in *10 USC 2302(5)*[vi] that is --

(i) user-occupied and designed to provide some degree of protection to its occupants in combat; or

(ii) a conventional munitions program or missile program; or

(B) a conventional munitions program for which more than 1,000,000 rounds are planned to be acquired; or

(C) a modification to a covered system that is likely to affect significantly the survivability or lethality of such a system.

Directed energy weapons (DEWs) are considered conventional (i.e., not nuclear, biological, or chemical) for the purpose of applying the law and this Regulation. LFT&E addresses the lethality of U.S. DEWs, and the vulnerability of U.S. systems to threat DEWs.

Systems or programs without decision points mentioned in *10 USC 2366*[v], but otherwise meeting statutory criteria, shall be considered covered systems for LFT&E planning purposes. The USD(AT&L) shall identify equivalent acquisition events for such systems or programs; and the PM shall schedule LFT&E accordingly. In general, Milestone B shall correspond to the point at which a system or program, in terms of *10 USC 2366*[v], "*enters Engineering and Manufacturing Development,*" for the purpose of applying the waiver requirements of *10 USC 2366*[v]. Pre-acquisition projects such as advanced technology demonstrations or advanced concept technology demonstrations shall undergo LFT&E if they are covered systems upon initiation as an acquisition program. Commercial or non-developmental items may be covered systems or parts of covered systems, depending upon their intended use, and shall, upon such determination, be subject to LFT&E requirements. Program funding shall cover all LFT&E costs.

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LFT&E shall begin at the component, subsystem, and subassembly level, and culminate with tests of the complete system, configured for combat. A covered system shall not proceed beyond LRIP (or equivalent point) until LFT&E is completed and the prescribed congressional committees receive the required LFT&E report (*10 USC 2366*[V]). The PM shall conduct LFT&E sufficiently early in the program life cycle to allow time to correct any design deficiency demonstrated by LFT&E. The PM shall correct the design or recommend adjusting the employment of the covered system before proceeding beyond LRIP.
The DOT&E shall approve the adequacy of the LFT&E strategy before the program begins LFT&E. The LFT&E strategy shall include full-up, system-level testing (i.e., realistic survivability or lethality testing as defined in *10 USC 2366*[V]), unless the USD(AT&L) for ACAT ID programs, or the CAE for less-than ACAT ID programs, as delegated by the Secretary of Defense, waives such testing. Waiver requests shall include an alternative LFT&E strategy, jointly reviewed by DOT&E and USD(AT&L), and approved by DOT&E. This alternative strategy shall include LFT&E of components, subassemblies, or subsystems; and appropriate, additional, design analyses, M&S, and combat data analyses. Following waiver approval, the waiver authority shall certify, in writing, to the congressional defense committees, before Milestone B, or entry into System Development and Demonstration (or upon program initiation if entering acquisition at system demonstration or later), that full-up, system-level testing would be unreasonably expensive and impracticable. The certification is required to be accompanied by a report explaining how the Department plans to evaluate the survivability or lethality of the system or program and assessing possible alternatives to realistic survivability testing of the system or program. Therefore, the waiver authority shall include the DOT&E-approved alternative LFT&E strategy with the certification. Essentially, the certification shall explain how the USD(AT&L) or the CAE plans to evaluate the survivability or lethality of the system or program in lieu of full-up, system-level testing. TEMPs shall address waivers and the use of alternative LFT&E, when applicable. The MDA and DoD Component shall consider LFT&E and the LFT&E waiver process when structuring programs and defining acquisition process entry points.
Programs shall submit congressional certifications and reports, required by *10 USC 2366(c)* [V], through the DOT&E and the USD(AT&L).
See Appendix C for additional detail.

* Not applicable to ACAT IA programs.

- **3.10.1 DOD COMPONENT REPORTING OF TEST RESULTS**

ACAT I, selected ACAT IAM programs, and other programs designated for OSD T&E oversight shall provide formal, detailed, reports of results, conclusions, and recommendations from DT&E, OT&E, and LFT&E to the DOT&E and USD(AT&L) (or ASD(C3I), as appropriate). For those reports supporting a decision point, the report shall generally be submitted 45 days before the decision point.

All developmental and operational T&E agencies shall identify test and evaluation limitations. They shall report their assessment of the effect of these limitations on system performance, and on their ability to assess technical performance for DT&E or ORD requirements for OT&E.

- **3.10.2 LFT&E REPORT***

The Secretary of Defense (or the DOT&E if so delegated) shall approve and submit a written LFT&E report to Congress before a covered system proceeds beyond LRIP (*10 USC 2366*[v]). The DOT&E shall monitor and review the LFT&E of each covered system. At the conclusion of LFT&E, the Director shall prepare an independent assessment report describing the results of the survivability or lethality LFT&E and state whether the LFT&E was adequate to provide information to decision-makers on potential user casualties and system vulnerability or lethality when the system is employed in combat; and to ensure that knowledge of user casualties and system vulnerabilities or lethality is based on realistic testing, considering the validated operational requirements of the system, the expected threat, and susceptibility to attack. The DOT&E shall prepare the OSD LFT&E Report within 45 days after receiving the DoD Component LFT&E Report.

* Not applicable to ACAT IA programs.

- **3.10.4 DOT&E ANNUAL REPORT**

The DOT&E shall prepare an annual OT&E and LFT&E activities report, in both classified and unclassified form, summarizing all OT&E and LFT&E activities, and addressing the adequacy of test resources within the DoD during the previous fiscal year (*10 USC 139*[vii]). The report shall include the status of information assurance, E3, and interoperability for each program. The DOT&E shall submit the reports concurrently to the Secretary of Defense, USD(AT&L), and Congress, within 10 days of the President's Budget to Congress.

- **5.2.2.3 RELATIONSHIP OF M&S AND TESTING**

The PM shall use both testing and M&S to evaluate the performance and maturity of the system under development. In addition, the PM shall use M&S to predict the results of operational and live fire testing events prior to the conduct of those tests. The PM shall focus the testing program on those tests with the highest expected payback in information gained. After completing the tests, the Defense Simulation and Modeling Office shall use test results to validate and mature the M&S tools and databases.

- **5.2.9HUMAN SYSTEMS INTEGRATION (HSI)**

For all programs regardless of acquisition category, the PM shall initiate a comprehensive strategy for HSI early in the acquisition process to minimize ownership costs and ensure that the system is built to accommodate the human performance characteristics of the user population that will operate, maintain, and support the system. The PM shall work with the manpower, personnel, training, safety and occupational health (see 5.2.10), habitability, survivability, and human factors engineering (HFE) communities to translate the HSI thresholds and objectives in

the ORD into quantifiable and measurable system requirements. The PM shall include these requirements in specifications, the Test and Evaluation Master Plan, and other program documentation, as appropriate, and use them to address HSI in the statement of work and contract. The PM shall identify any HSI-related schedule or cost issues that could adversely impact program execution.

- **5.2.9.2 HABITABILITY AND PERSONNEL SURVIVABILITY**

The PM shall work with the habitability and survivability representatives (see 2.8.3) to set requirements for the physical environment and, if appropriate, essential personal services (e.g., clergy) and minimum living conditions (e.g., berthing and bathing) that have a direct impact on sustained mission effectiveness and recruitment and retention.

- **5.2.12 SURVIVABILITY**

Unless waived by the MDA, mission-critical systems, including crew, regardless of ACAT, shall be survivable to the threat levels anticipated in their projected operating environment as portrayed in the System Threat Assessment. Design and testing shall ensure that the system and crew can withstand man-made hostile environments without aborting the mission and without the crew suffering acute chronic illness, disability, or death.

The PM shall fully assess system and crew survivability against all anticipated threats at all levels of conflict, early in the program, but in no case later than entering system demonstration or equivalent. This assessment shall also consider fratricide and detection. If the system or program has been designated by the Director, Operational Test and Evaluation, for live fire test and evaluation (LFT&E) oversight (see 3.7), the PM shall integrate the T&E used to address crew survivability issues into the LFT&E program supporting the Secretary of Defense LFT&E Report to Congress (see 3.10.2) (*10 USC 2366*[viii]).

The PM shall establish and maintain a survivability program throughout the system life cycle to attain overall program objectives. The program shall stress early investment in survivability enhancement efforts that improve system operational readiness and mission effectiveness by:

- providing threat avoidance capabilities (low susceptibility);
- incorporating hardening and threat tolerance features in system design (low vulnerability);
- providing design features to reduce personnel casualties resulting from damage to or loss of the aircraft (casualty reduction);
- maximizing wartime availability and sortie rates via operationally compatible threat damage tolerance and rapid reconstitution (repairability) features;
- minimizing survivability program impact on overall program cost and schedule; and,
- ensuring protection countermeasures and systems security applications are defined for critical component's vulnerability to validated threats for systems survivability, including natural or nuclear advanced technology weapons, conventional weapons, biological, chemical contamination, and electronic warfare threats.

- **5.2.13 MISSION ASSUREDNESS**

The PM shall consider survivability and mission assuredness of systems vulnerable to physical and electronic attack. Security, survivability, and operational continuity (i.e., protection) shall be considered as technical performance requirements as they support achievement of other technical performance aspects such as accuracy, endurance, sustainability, interoperability, range, etc., as well as mission effectiveness in general (see 6.7). The PM shall include the considerations in the risk benefit analysis of system design and cost. Users shall be familiar with critical infrastructure protection and space control requirements, and account for necessary hardening, redundancy, backup, and other physical protection measures in developing system and family-of-system requirements.

- **6.2 INTELLIGENCE SUPPORT**

Users shall base acquisition programs, initiated in response to a military threat, on authoritative current and projected threat information. The intelligence, requirements generation, and acquisition management communities shall collaborate early and continuously to ensure the use of timely, valid threat information. This collaboration shall include joint examination of critical intelligence categories (CICs) that could significantly influence the effective operation of the deployed system.

Users shall assess and evaluate information superiority requirements. They shall determine the vulnerability of IT, including NSS, supporting infrastructures, and the effectiveness of risk mitigation methods to reduce vulnerability to an acceptable level. The system threat assessment shall include an intelligence estimate of the potential adversary's ability to exploit potential system vulnerabilities. This estimate shall be available to support any acquisition decision.

- **6.2.1THREAT VALIDATION**

For acquisition programs subject to Defense Acquisition Board (DAB) review, the Defense Intelligence Agency (DIA) shall validate System Threat Assessments and other threat information, including that contained in program documents. For other than DAB programs, the Milestone Decision Authority shall designate the approving agency.

- **6.2.2SYSTEM THREAT ASSESSMENT**

DoD Components shall prepare a System Threat Assessment to support program initiation. They shall keep the assessment current and in a validated status throughout the acquisition process. DIA shall review the assessment prior to all milestone decision points. For Acquisition Category (ACAT) ID programs, the assessment shall be system-specific to the degree of system definition available at the time of the assessment. The assessment shall address the projected threat at Initial Operational Capability (IOC) and at IOC plus 10 years. The Components shall structure threat assessments for ACAT IC programs similarly, but the ACAT IC assessments may address operationally related systems, when practicable.

The System Threat Assessment shall include the following minimum elements:

- An executive summary to include the key intelligence judgments and significant changes in the threat environment;
- The mission need for the U.S. system;

- A system description;
- Discussion of the operational threat environment: the threat to be countered, the system specific threat, reactive threat, and technologically feasible threat; and
- CICs and the intelligence production requirements supporting these CICs, developed by the PM early in the acquisition process.

6.6 INFORMATION ASSURANCE (IA)

PMs shall manage and engineer information systems using the best processes and practices known to reduce security risks, including the risks to timely accreditation. Per DoDI 5200.40ix, they shall address information assurance requirements throughout the life cycle of all DoD information systems. The PM shall incorporate approved Capstone Requirements Document-derived and ORD-derived information assurance requirements into program design activities to ensure appropriate availability, integrity, authentication, confidentiality, and non-repudiation of program information and the information systems themselves, as specified in the applicable System Security Authorization Agreement (SSAA).. PMs shall also provide for the survivability of information systems by incorporating protection, detection, reaction, and reconstitution capabilities into the system design, as appropriate, and as allocated in SSAAs.
Accordingly, for each information system development, PMs shall:

- Conduct a system risk assessment based on system criticality, threat, and vulnerabilities;
- Incorporate appropriate countermeasures;
- Demonstrate the effectiveness of those countermeasures through the certification process conducted in accordance with *DoDI 5200.40*[ix] during development test and evaluation (T&E) and operational T&E;
- Ensure that the responsible designated approving authority accredits the information system; and,
- Incorporate existing, or develop new, protection profiles to consolidate security-related requirements and provide effective management oversight of the overall security program.

Appendix B
Test and Evaluation Master Plan
Mandatory Procedures and Format

Introduction and Purpose

This appendix provides procedures and formats to implement the requirements of 10 USC 2399(b)(1), "Operational Test and Evaluation." The Test and Evaluation Master Plan (TEMP) shall document the overall structure and objectives of the test and evaluation (T&E) program. It shall provide the framework within which to generate detailed T&E plans. It shall document schedule and resource implications associated with the T&E program. The TEMP shall identify the necessary developmental test and evaluation (DT&E), operational test and evaluation (OT&E), and live fire test and evaluation (LFT&E) activities. It shall relate program schedule, test management strategy and structure, and required resources to: (1) critical operational issues (COIs); (2) critical technical parameters; (3) key performance parameters and operational performance parameters (threshold and objective criteria) derived from the Operational Requirements Document (ORD); (4) evaluation criteria; and (5) major decision points.

Preparation and Submittal

The T&E Working-Level Integrated Product Team (WIPT) shall develop the TEMP for acquisition category (ACAT) I programs, selected ACAT IAM programs, and other programs on the OSD T&E Oversight List or otherwise under DOT&E oversight (collectively termed "DOT&E-oversight programs"). The TEMP for an ACAT I program shall be submitted to the OIPT leader, for OSD approval, 30 days prior to the first milestone review. For other DOT&E-oversight programs, the TEMP shall be submitted within 90 days of such designation.

Review and Approval. The Director of Operational Test and Evaluation (DOT&E) and the cognizant Overarching Integrated Product Team (OIPT) leader shall be the Office of the Secretary of Defense TEMP approval authorities for ACAT I programs, selected IAM programs, and those other acquisition category programs designated for Office of the Secretary of Defense test and evaluation oversight. The possible cognizant OIPT leaders are the Director for Strategic and Tactical Systems; the Director, Program Analysis and Integration; and the Director, Information technology, Acquisition and Investment. Formal submission of the TEMP for OSD approval shall be accomplished no later than 30 days before the program decision IPR, unless otherwise agreed to in the IPT. Upon approval, the OSD approval Memorandum becomes part of the TEMP, and shall be attached to the front cover.

Circumstances When a TEMP Is No Longer Required. When a program's development is completed and COIs are satisfactorily resolved, including the verification of deficiency

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corrections, TEMP updates are no longer required. The following attributes are examples for which an updated TEMP submission may no longer be required:

- Fully deployed system with no operationally significant product improvements or block modification efforts.
- Full production ongoing and fielding initiated with no significant deficiencies observed in production qualification test results.
- Partially fielded system in early production phase having successfully accomplished all developmental and operational test objectives.
- Programs for which planned test and evaluation is only a part of routine aging and surveillance testing, service life monitoring, or tactics development.
- Programs for which no further operational testing or live fire testing is required by any DoD Component.
- Program for which future testing (e.g., product improvements or block upgrades) has been incorporated in a separate TEMP (e.g., an upgrade TEMP).

Requesting Cancellation of TEMP Requirement. Written requests for cancellation of a TEMP requirement must be forwarded to the Component TEMP approval authority, or, for TEMPS under OSD T&E oversight, through the Component TEMP approval authority to the cognizant OIPT Leader. Justification, such as applicability of any the above circumstances, must be included in the request. The cognizant OIPT leader will jointly review the request with DOT&E and notify the Component TEMP approval authority of the result.

Mandatory Format

The mandatory TEMP format for all ACAT I programs, for IT, including NSS, programs regardless of ACAT, and for other DOT&E-oversight programs begins on the next page.

Mandatory TEMP Format and Content

PART II--INTEGRATED TEST PROGRAM SUMMARY

a. Integrated Test Program Schedule

(1) Display on a chart (see Figure 1) the integrated time sequencing of the major test and evaluation phases and events, related activities, and planned cumulative funding expenditures by appropriation.

(2) Include event dates such as major decision points as defined in DoDI 5000.2; operational assessments, preliminary and critical design reviews, test article availability; software version releases; appropriate phases of developmental test and evaluation; live fire test and evaluation, JITC interoperability testing and certification date to support FRP Decision Review, and operational test and evaluation; low rate initial production deliveries; Initial Operational Capability; Full Operational Capability; and statutorily required reports, such as the Live-Fire T&E Report and Beyond-LRIP Report.

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4. PART IV--OPERATIONAL TEST AND EVALUATION OUTLINE

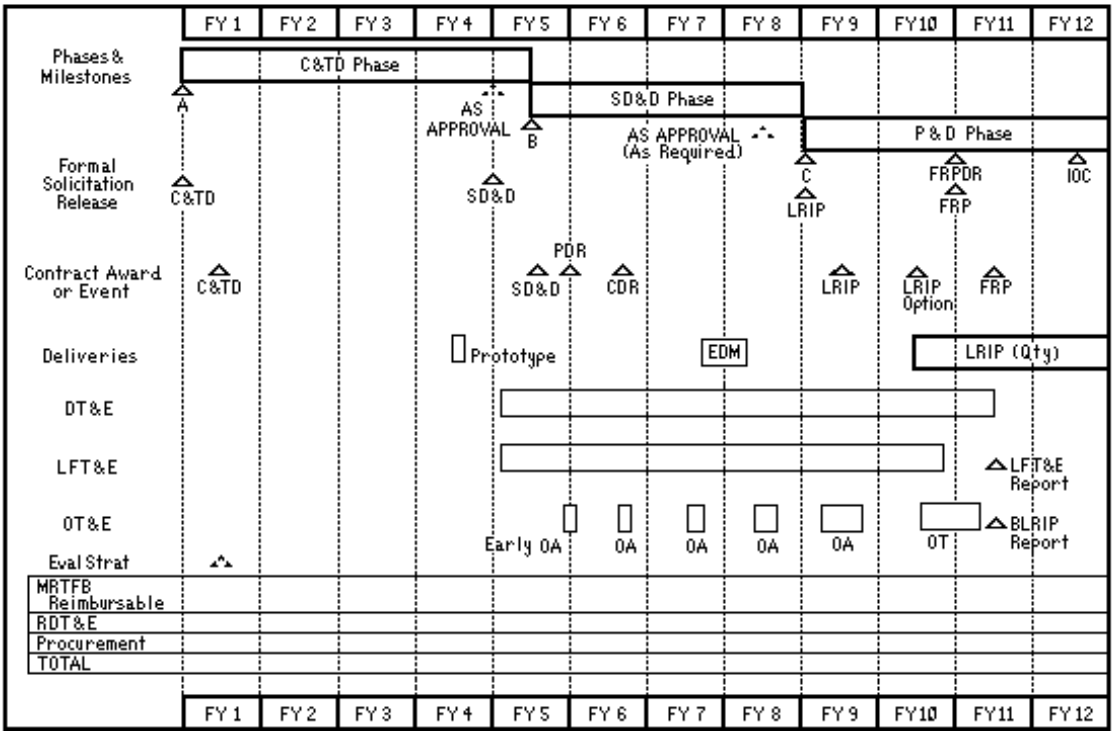
d. Live Fire Test and Evaluation*. See also Appendix C, "LFT&E Mandatory Procedures and Reports". Include a description of the overall live fire test and evaluation strategy for the item; critical live fire test and evaluation issues; required levels of system protection and tolerance to terminal effects of threat weapons and lethality; the management of the live fire test and evaluation program; live fire test and evaluation schedule, funding plans and requirements; related prior and future live fire test and evaluation efforts; the evaluation approach and shot selection process; and major test and evaluation limitations for the conduct of live fire test and evaluation. Discuss, if appropriate, procedures intended for obtaining a waiver from full-up, system-level live fire testing (realistic survivability/lethality testing as defined in Section 2366, Title 10 USC) before entry into the System Development and Demonstration Phase. Live fire test and evaluation resource requirements (including test articles and instrumentation) shall be appropriately identified in the Test and Evaluation Resource Summary.
* Not applicable to AIS programs.

5. PART V--TEST AND EVALUATION RESOURCE SUMMARY

b. The TEMP shall project the time-phased test and test support resources necessary to accomplish development, integration and demonstration testing and early operational assessment. The TEMP shall estimate, to the degree known, the key resources necessary to accomplish development test and evaluation, operational assessment, live fire test and evaluation, and operational test and evaluation. These shall include test and training ranges of the Major Range and Test Facility Base (MRTFB), test equipment and facilities of the MRTFB, capabilities designated by industry and academia, unique instrumentation, threat simulators, targets, and modeling and simulation. As system acquisition progresses, the preliminary test resource requirements shall be reassessed and refined and subsequent TEMP updates shall reflect any changed system concepts, resource requirements, or updated threat assessment. Any resource shortfalls which introduce significant test limitations shall be discussed with planned corrective action outlined.

6. Annex A--BIBLIOGRAPHY
a. Cite in this section all documents referred to in the TEMP.
b. Cite all reports documenting technical, live fire, and operational testing and evaluation.

FIGURE 1 - INTEGRATED TEST PROGRAM SCHEDULE



Appendix C
Live Fire Test and Evaluation Mandatory Procedures & Reports*

* Not applicable to AIS.

Introduction and Purpose

This Appendix provides guidelines to describe a disciplined management approach for the conduct of live fire test and evaluation (LFT&E) within the Department of Defense (DoD), which, if followed, will enable an assessment of a system's vulnerability and lethality and ensure compliance with LFT&E legislation. The legislation, 10 USC 2366, contains requirements for vulnerability and lethality live fire testing of covered systems, as defined in this regulation. The guidelines describe the objective and scope of LFT&E, provide guidance for LFT&E planning, testing, evaluation, and documentation, and discuss the responsibilities of LFT&E principals.

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The objective of LFT&E is to provide a timely and reasonable assessment of the vulnerability/lethality of a system as it progresses through its development and prior to full-rate production. In particular:

- to provide information to decision-makers on potential user casualties, vulnerabilities, and lethality, taking into equal consideration susceptibility to attack and combat performance of the system;
- to ensure that knowledge of user casualties and system vulnerabilities or lethality is based on testing of the system under realistic combat conditions;
- to allow any design deficiency identified by the testing and evaluation to be corrected in design or employment before proceeding beyond low-rate initial production; and
- to assess battle damage repair capabilities and issues (while assessment of battle damage repair capability is not a statutory requirement of LFT&E, test officials should exploit opportunities presented by LFT&E to assess such capabilities whenever prudent and affordable).

Definitions

The legislation covering LFT&E also provides definitions of "covered system," "major munitions program," "covered product improvement programs," "realistic survivability testing," "realistic lethality testing," and "configured for combat." The definitions of "covered system," "major munitions program," and "covered product improvement programs," are encompassed in the single DoD term "covered system."

1. **Covered System**. A system that the Secretary of Defense has determined to be:

(A) a major system within the meaning of that term in 10 USC 2302(5) that is --

(i) user-occupied and designed to provide some degree of protection to its occupants in combat; or

(ii) a conventional munitions program or missile program; or

(B) a conventional munitions program for which more than 1,000,000 rounds are planned to be acquired; or

(C) a modification to a covered system that is likely to affect significantly the survivability or lethality of such a system.

Note: The term "covered system" as defined above is the DoD term that is intended to include all categories of systems or programs identified in 10 USC 2366 as requiring live fire test and evaluation. In addition, non-traditional systems or programs that do not have acquisition points referenced in 10 USC 2366, but otherwise meet the statutory criteria, are considered "covered systems" for the purpose of this regulation.

2. **Live Fire Test and Evaluation**.

(A) testing within a DOT&E-approved LFT&E strategy that includes the firing of actual weapons (or surrogates if actual threat weapons are not available) at components, sub-systems, sub-assemblies, and/or full-up, system-level targets or systems to examine personnel casualties, system vulnerabilities, or system lethality; and

(B) [t]he evaluation of the results of such testing.

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(C) For purposes of this regulation, the term "live fire test and evaluation" does not include an assessment based exclusively on:
(i) computer modeling;
(ii) simulations; or
(iii) analyses of system requirements, engineering proposals, design specifications, or any other information contained in program documents.
Note: 10 USC 2366 requires an LFT&E program to include full-up, system-level testing unless a waiver is granted in accordance with statute and this regulation.
3. **Full-up, System-Level Test**.
(A) vulnerability testing conducted, using munitions likely to be encountered in combat, on a complete system loaded or equipped with all the dangerous materials that normally would be on board in combat (including flammables and explosives), and with all critical subsystems operating that could make a difference in determining the test outcome; or
(B) lethality testing of a production-representative munition or missile, for which the target is representative of the class of systems that includes the threat, and the target and test conditions are sufficiently realistic to demonstrate the lethal effects the weapon is designed to produce.
Note: The term "full-up, system-level testing" is that testing that fully satisfies the statutory requirement for "realistic survivability testing" or "realistic lethality testing" as defined in 10 USC 2366.
4. **Survivability**. The capability of a system and crew to avoid or withstand a man-made hostile environment without suffering an abortive impairment of its ability to accomplish its designated mission. Survivability consists of susceptibility, vulnerability, and recoverability.
5. **Vulnerability**. The characteristic of a system that causes it to suffer a definite degradation (loss or reduction of capability to perform its designated mission) as a result of having been subjected to a certain (defined) level of effects in an unnatural (man-made) hostile environment. Vulnerability is considered a subset of survivability.
6. **Lethality**. The ability of a munition or directed energy weapon to cause damage that will cause the loss or a degradation in the ability of a target system to complete its designated mission(s).
7. **Susceptibility**. The degree to which a weapon system is open to effective attack due to one or more inherent weakness. (Susceptibility is a function of operational tactics, countermeasures, probability of enemy fielding a threat, etc.) Susceptibility is considered a subset of survivability.

Implementation

An active, well-planned, well-managed and well-executed LFT&E strategy is essential to understanding system vulnerability/lethality and shall be an essential element of the information supporting decisions regarding the acquisition of materiel as well as the development of doctrine for its proper tactical employment. The LFT&E strategy for a given system shall be developed as soon as possible after Concept Exploration, and be structured and scheduled so that any design changes, resulting from that testing and analysis, as described in the strategy, may be incorporated before proceeding beyond low-rate initial production. LFT&E considerations must be included in all phases of the weapon system acquisition cycle, beginning with concept

exploration and continuing until Production and Support. Furthermore, the LFT&E strategy must be managed, including planning and programming, in such a manner that all elements of the test and evaluation process are well-integrated and complementary. The availability of facilities, test sites, instrumentation, personnel, threat targets, munitions, and/or directed energy weapons shall be managed throughout all phases of the budget cycle.

LFT&E shall be initiated as early as possible and completed before entry into full-rate production and deployment, to identify and assess possible design deficiencies so that appropriate corrective actions can be taken. Beginning with component-level testing and analysis during component advanced development, live fire vulnerability/lethality test and evaluation continues through system integration and system demonstration with additional components/subsystem testing, and progresses to full-up system level LFT&E of production representative items (unless a waiver from full-up, system-level testing has been approved in accordance with this regulation) before the system proceeds beyond low-rate initial production (or equivalent point).

The LFT&E strategy shall be structured to provide a timely and reasonable examination and understanding of the vulnerability/lethality of U.S. weapon systems and munitions/directed energy weapons to the full spectrum of validated combat threats/targets. Subsequent product improvements to covered systems meeting the statutory criteria are also required to undergo LFT&E if there is a significant impact to vulnerability or lethality. If any doubt exists, the system shall be assumed to be covered and appropriate action taken. This includes waiver action if full-up, system-level testing would be unreasonably expensive and impractical. All LFT&E of covered systems is conducted by the Services with OSD oversight.

LFT&E of all systems shall be predicated upon the DoD Intelligence Community's official assessment of the principal threat systems and capabilities an adversary might reasonably bring to bear in an attempt to defeat or degrade a specific U.S. system as described in the validated threat document.

Pretest predictions are required for every live fire test event. The predictions may be based on computer models, engineering principles, or engineering judgment, and should address a level of detail comparable to the test damage assessment methodology. The DOT&E-approved LFT&E strategy shall address both the nature of the pretest predictions and the schedule of pretest prediction deliverables. The deliverables and supporting documentation should identify basic assumptions, model inputs, and known limitations. If the live fire evaluation plan incorporates the use of vulnerability or lethality models, the pretest predictions should exercise those models, and support the VV&A of those models.

The generation of data to resolve critical LFT&E issues in an efficient and cost effective manner to represent realistic environments shall be of paramount concern in the shot-line selection process for live fire testing. While an element of randomness in shot-line selection is often desirable, total reliance on complete randomness may neither be consistent with the test objectives nor be an efficient use of test resources. Random shot-lines are generated from a realistic distribution of hit points, to include such factors as the weapon system operator, target signatures, and weapon seeker characteristics. In most cases a mixture of random shot-lines (shot-lines generated from likely hit points) and engineering shot-lines (i.e., shot-lines

specifically selected by the evaluator to address specific vulnerability/lethality issues) shall be appropriate. It is required that some portion of the total shots be randomly drawn from a combat distribution of likely hit points, when known.
Although the evaluation of live fire test results will address kill given a hit (i.e., vulnerability or lethality), the outcome of LFT&E shall not necessarily be expressed in terms of probabilities. Rather, live fire testing shall address vulnerability or lethality primarily by examining basic damage and kill mechanisms and their interactions with the target system. Further, the evaluation of vulnerability test results shall address, where possible, the susceptibility of the system.
Although LFT&E programs may differ significantly in scope and timing, the level of maturity at various stages of the acquisition process is basically the following: during Concept Exploration, a decision shall be made whether the system meets the legislative or regulatory criteria for a covered system. Initial draft strategies shall identify proposed issues, existing data in support of the issues, and live fire tests to be conducted throughout the acquisition process. By Milestone B, the TEMP must contain a mature strategy. In particular, the strategy must either commit to full-up, system-level, live fire testing, or a waiver request and alternative LFT&E plan must have been submitted and approved. The entire LFT&E program, to include testing, evaluation, and reporting, must be completed before proceeding beyond low-rate initial production.

Responsibilities

1. Under Secretary of Defense (Acquisition, Technology, and Logistics).

(A) For a covered system acquisition program lacking traditional milestones cited in 10 USC 2366, designates equivalent events for the purpose of applying the schedule requirements for LFT&E.
(B) May waive the requirement for full-up, system-level LFT&E in accordance with the provisions of 10 USC 2366, following DOT&E approval of the alternative LFT&E plan. In such a case, must certify in writing to the Congressional defense committees, before the system enters System Development and Demonstration (or equivalent point), that full-up, system-level testing would be unreasonably expensive and impracticable, and include the DOT&E-approved alternative plan. Note: The waiver decision authority is the CAE for less-than ACAT ID programs.

2. Director of Operational Test and Evaluation (DOT&E).

(A) Serves as the OSD focal point for review, coordination, and approval of LFT&E policy.
(B) Approves LFT&E strategies, as provided in the TEMP or equivalent document, and alternative LFT&E plans, when applicable, in support of a waiver from full-up, system-level testing.
(C) Designates covered systems for LFT&E that meet the regulatory criteria. Annually reviews all potential systems for inclusion or deletion from the OSD T&E Oversight List.
(D) Approves Services' LFT&E planning documents as identified for DOT&E approval in the LFT&E planning matrix included in the TEMP.
(E) Reviews Services' LFT&E planning documents not requiring DOT&E approval, as identified in the LFT&E planning matrix included in the TEMP.

(F) Reviews Services' LFT&E Reports.
(G) Monitors and reviews the Services' LFT&E program during its conduct.
(H) Submits an independent LFT&E report for each covered system (to include LFT&E programs conducted under the waiver provisions of 10 USC 2366) to the Secretary of Defense and, as delegated by the Secretary, to the Congress before a covered system can proceed beyond low-rate initial production.
(I) Describes and assesses the status of LFT&E activities for each system requiring LFT&E as part of the DOT&E annual report to Congress required by 10 USC 139.

3. DoD Components.

(A) Recommend candidate covered systems for LFT&E.
(B) Develop and implement the LFT&E strategy for each affected system and ensures this strategy is fully described in the TEMP.
(C) Plan, program, and budget research, development, test and evaluation and other procurement funds in support of LFT&E including the acquisition of threat targets/munitions or acceptable surrogates.
(D) Identify critical LFT&E issues, prepare and approve required plans, reports and other documentation.
(E) Permit DOT&E to monitor, on-site, all LFT&E tests.
(F) Conduct engineering assessments of possible design changes resulting from LFT&E and develop programs for incorporating cost effective design changes as early as possible commensurate with the system acquisition strategy.
(G) Submit alternative LFT&E strategy for approval to the Director, OT&E, if full-up, system-level testing would be unreasonably expensive and impracticable.
(H) Submit request for waiver from full-up, system-level testing for approval to the USD(AT&L) for ACAT ID programs, or to the CAE for less-than ACAT ID programs, if full-up, system-level testing would be unreasonably expensive and impracticable. Include a copy of the approved alternative plan with the request for waiver.
(I) Manage Service facilities and resources and provide guidance on operating these test facilities to support LFT&E.

LFT&E Documents

Conduct of LFT&E shall require the preparation and submission to OSD of the following listed documents. Additional documentation may be prepared as part of the developmental process to support engineering tests that bear on the live fire test assessment. Review and approval of additional documentation shall be at the Service level.

1. TEMP. The TEMP summarizes where, when, and how the LFT&E issues will be tested/evaluated. Specific LFT&E items considered for inclusion in the TEMP are: a description of the overall live fire test and evaluation strategy for the item; critical live fire test and evaluation issues; required levels of system vulnerability/lethality; the management of the live fire test and evaluation program; live fire test and evaluation schedule, funding plans and requirements; related prior and future live fire test and evaluation efforts; the evaluation plan and shot selection process; modeling and simulation strategy and VV&A; and major test limitations

for the conduct of live fire test and evaluation. Live fire test and evaluation resource requirements (including test articles and instrumentation) shall be appropriately identified early in the development cycle and appear in the Test and Evaluation Resource Summary. The TEMP shall include an LFT&E planning matrix that covers all tests within the LFT&E strategy, their schedules, the issues they will address and which planning documents the Services propose for submission to DOT&E for approval and which are proposed to be submitted for information and reviews only. (See also Appendix B).

2. Detailed Test and Evaluation Plan. This document describes the detailed test procedures, test conditions, data collection, and analysis processes to be used during the conduct of each live fire test. Annex B provides additional detail on the content of the detailed test and evaluation plans required for the full-up, system-level live fire tests. The detailed test and evaluation plan shall be submitted to DOT&E for comment at least 30 days before test initiation. DOT&E shall have 15 days for submission of comments subsequent to its receipt of the detailed test plan/evaluation plan.

3. Detailed Test and Evaluation Report. The results and overall evaluation of all testing, identified in the LFT&E strategy, shall be documented by the Service and submitted to DOT&E no later than 120 days after test completion. The format of the Report(s) is a Service option; however, to facilitate the DOT&E independent report to Congress, each Service report shall include the firing results, test conditions, a description of any deviations approved subsequent to the preparation of the detailed test and evaluation plan, test limitations, conclusions, and the evaluation of live fire vulnerability/lethality based on available information (if applicable). DOT&E shall have 45 days, from receipt of the final Service detailed test and evaluation report, for preparation and transmittal, as delegated by the Secretary, of the Secretary of Defense assessment report to Congress. Service technical review is normally requested prior to transmittal.

Waivers

As delegated by the Secretary of Defense, waivers from full-up, system-level LFT&E are approved prior to Milestone B (or equivalent point) by the USD(AT&L), for ACAT ID programs, or by the appropriate CAE, for less than ACAT ID programs, provided the requirements of Section 3.7 of this Regulation are met. With the exception of the requirements for full-up, system-level, live fire testing, the requirements for waived LFT&E programs are no less stringent than for non-waived programs, to include the inclusion of an LFT&E strategy in the TEMP and an independent DOT&E assessment report to Congress, as delegated by the Secretary of Defense. Waivers from full-up, system-level, live fire testing (realistic survivability/lethality testing as defined in 10 USC 2366), for covered systems, including product improvements that significantly affect survivability or lethality, cannot be granted after Milestone B (or equivalent point), except through legislative relief.

Note: *This appendix is included just as it was written. Any references to attachments or appendixes are to those in Appendix B, not to those in the main volume.*

ANNEX A – REFERENCES

1. Section 2366, Title 10, United States Code, "Major Systems and Munitions Programs: Survivability and Lethality Testing Required before Full-Scale Production".

2. Department of Defense Directive 5000.1, “The Defense Acquisition System”.

3. DoD Instruction 5000.2, “Operation of the Defense Acquisition System”.

ANNEX B -- DETAILED LIVE FIRE TEST AND EVALUATION PLAN

Mandatory Content

The following paragraphs outline the mandatory content of the Detailed Live Fire Test and Evaluation Plan. No standard format is prescribed, but the Plan must contain at least the following information:

1. A cover page providing the name of the system, the activity/agency responsible for preparation of the Plan, date, classification, and applicable distribution statement.

2. A coordination sheet containing signatures of Service approval authorities.

3. Administrative information: name, organization, telephone, and E-Mail addresses of key LFT&E personnel.

4. Description of threat weapons or targets that the system is expected to encounter during the operational life of the system, and the key characteristics of these threats/targets that affect system vulnerability/lethality; a reference to the specific threat definition document or System Threat Assessment; a discussion of the rationale and criteria used to select the specific threats/targets and the basis used to determine the number of threats/targets to be tested and evaluated in LFT&E.

5. If actual threats/targets are not available, then the plan must describe the threat/target surrogate to be used in lieu of the actual threat/target, and the rationale for its selection.

6. A statement of the test objectives in sufficient detail to demonstrate that the evaluation procedures are appropriate and adequate.

7. A description of the specific threats/targets to be tested including a detailed configuration and stowage plan (to include payload configuration) for each shot. Describe the rationale or operational scenarios on which the target configuration/stowage was based.

8. A listing of any differences between the system to be tested and the system to be fielded. As specifically as possible, identify the degree to which test results from the tested

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configuration are expected to be representative of the vulnerability or lethality of the fielded systems.

9. Identification of any test limitations, particularly any potential loss of realism from absence of components, arising from the use of surrogates, from the inserting of fuzes on stowed ammunition, or any other environmental, safety or resource constraints. Identify the impact of these limitations on test results.

10. A description of the shot selection process. Describe the process to be used to establish the test conditions for randomly selected shots, including any rules ("exclusion rules) used to determine whether a randomly generated shot may be excluded from testing. For engineering shots (i.e., shots selected to examine specific vulnerability/lethality issues), describe the issue and the associated rationale for selecting the specific conditions for these shots. List the specific impact conditions and impact points for each shot, and whether it is a random or engineering shot.

11. A detailed description of the test approach, test setup, test conditions, firing procedures, damage assessment and repair process, planned test sequence, instrumentation, data collection and analysis procedures, and responsibilities for collecting and documenting test results. Include any standard forms that will be used to document test results.

12. A prediction of the anticipated results of each shot. These predictions may be based on computer models, engineering principles, or engineering judgment. Detail shall be consistent with the technique used for casualty/damage prediction.

13. A detailed description of the analysis/evaluation plan for the Live Fire Test. The analysis/evaluation plan must be consistent with the test design and the data collected. Indicate any statistical test designs used for direct comparisons or for assessing any pass/fail criteria.

14. A general description, including applicable references, of any vulnerability/ lethality models to be used to support shot-line selection, pre-shot predictions, or the analysis/evaluation. This material shall include a discussion of model algorithm or input limitations, as well as references to the sources of key model inputs.

15. A detailed description of the approach to analyzing and mitigating the potential environmental impacts, consequences, or effects of the test activities, unless adequately described elsewhere.

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III. DoD Policy Memoranda

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OFFICE OF THE SECRETARY OF DEFENSE

1000 DEFENSE PENTAGON
WASHINGTON, DC 20301-1000

4 JAN 96

MEMORANDUM FOR COMPONENT ACQUISITION EXECUTIVES

SUBJECT: Live Fire Test and Evaluation (LFT&E) Policy

There has been some discussion questioning the authority of the Director, Operational Test and Evaluation (DOT&E) to determine what systems and system modifications are covered under the live-fire test legislation (Title 10, United States Code, Section 2366). We want to ensure you understand that DOT&E has the authority to make such determinations, and that USD(AT&L) fully supports DOT&E's decisions on such matters, e.g., C-130 Avionics Modernization Program and C-5 Reliability Enhancements and Re-engining Program.

Please note that DoD 5000.2-R (Interim) specifies that DOT&E must approve the full-up, system-level live-fire test plan. USD(AT&L), for ACAT ID programs, or the Component Acquisition Executive for less than ACAT ID programs, may waive such testing if justified. However, waiver requests from full-up, system-level live-fire testing must be accompanied by alternative live-fire test plans that are jointly reviewed by DOT&E and USD(AT&L) and approved by DOT&E as specified in DoD 5000.2-R (Interim).

The Services need to work with DOT&E to achieve a reasonable and cost-effective alternative live-fire test plan. In the case of major modifications or new production variants, these alternative live fire test plans need to focus on configuration changes which could significantly affect survivability, to include an assessment at the system level. Potential interactions between portions of the configuration that are changed and those which are not changed also need to be assessed. If you are unable to come to agreement with DOT&E on the alternate test plan within a reasonable period of time, and particularly when the plan is needed to support an impending Defense Acquisition Board Milestone review, please notify USD(AT&L).

J. S. Gansler

Philip E. Coyle

FEDERAL RECYCLING PROGRAM PRINTED ON RECYCLED PAPER

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DEPARTMENT OF DEFENSE
OFFICE OF GENERAL COUNSEL
1600 DEFENSE PENTAGON
WASHINGTON, DC 20301-1600

27 November 2000

MEMORANDUM FOR MR. O'BRYON, ODOT&E

Subject: Live-Fire Testing of C-130 Avionics Modernization Program (AMP)/C-5 Reliability Enhancement and Re-Engining Program (RERP)

This is in response to your request for a legal opinion regarding the authority of the Director, Operational Test and Evaluation (DOT&E), to designate the C-130 AMP and the C-5 RERP as covered systems under 10 U.S.C. § 2366. On 17 October 2000, DOT&E issued a memorandum to the Assistant Secretary of the Air Force (Acquisition) determining that the C-130 AMP is a covered system pursuant to 10 U.S.C. § 2366 such that full-up system level (FUSL) testing is required before such system may proceed beyond low-rate initial production. DOT&E further stated that he is willing to support a waiver from FUSL in accordance with the statute subject to approving an alternative live fire test and evaluation (LFT&E) plan as part of the Test and Evaluation Master Plan (TEMP) prior to the Milestone II decision. It is our understanding that the Air Force will not acknowledge that the C-130 AMP, and, in addition, the C-5 RERP, are covered systems such that FUSL testing is required. Although the Air Force may believe it can proceed with these programs and ignore the requirement to conduct LFT&E, it is within DOT&E's purview to designate such programs as covered for the purposes of fulfilling his statutory duties. Further, there is nothing in the LFT&E statute that would exempt from its requirements major upgrades to those platforms that were already in production when the LFT&E law was enacted.

DOT&E's statutory responsibilities are provided in 10 U.S.C. § 139, which provides that DOT&E is the principal advisor to the Secretary of Defense and to the USD(AT&L) on operational test and evaluation. The Federal Acquisition Streamlining Act of 1994 (P.L. 103-355) added LFT&E to DOT&E's responsibilities by requiring that he "monitor and review the live fire testing activities of the Department of Defense provided for under section 2366 of this title." The House Conference Report that accompanied that Act (H.R. Conf. Rep. 103-712) provided:

. . . The House recedes with an amendment that would make it 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). . . .* (emphasis added).

Therefore, it is clearly the intent of Congress that DOT&E fulfill the LFT&E responsibilities of the Department. This includes designation of a program as a "major defense acquisition program" for the purposes of fulfilling his responsibilities (10 U.S.C. § 139(a)(2)(B); 32 C.F.R. §380.2).

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Under 10 U.S.C. § 2366, a "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.

The term "product improvement program" means:

(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.

Attachment 1 to DoD Instruction 5000.2 (the interim DoD 5000.2-R), clearly states that DOT&E approves candidate systems for LFT&E. Therefore, the DOT&E is responsible for determining whether such systems are "covered." The Air Force has argued that since the underlying platforms at issue were not "covered" systems, that exempts all future modifications that would otherwise be considered covered systems or covered PIPs from being subject to LFT&E. Nothing in the law or legislative history shows an intent by Congress to exempt such systems just because the underlying platforms were in production at the time the LFT&E law was enacted. If this were the case, that interpretation would effectively "gut" the LFT&E law to the point of rendering the coverage of PIPs meaningless because there are so many such PIPs to "legacy" systems. Congress specifically strengthened the LFT&E law by adding its application to PIPs, and no congressional intent to exempt PIPs to "legacy" systems is found in the law or legislative history to the LFT&E statute.

Therefore, it is within DOT&E's purview to designate the C-130 AMP and the C-5 RERP as "covered" for purposes of fulfilling his duties under 10 U.S.C. § 2366. In addition, the scope of testing is a matter for DOT&E to determine, i.e., the scope of testing necessary is not addressed in the LFT&E statute and must be worked out on a case-by-case basis.

Douglas P. Larsen
Deputy General Counsel
(Acquisition and Logistics)

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Appendix C.

Survivability Enhancement Procedures

During the concept and technology phase, in studies, prototype programs, RFPs, RFIs, or other pre- System Development & Demonstration efforts, the guidelines of this section are intended to generate proposed solutions to survivability performance requirements; provide realistic signature level requirements; vulnerability requirements; electronic warfare requirements and quantify performance cost and schedule allowances which must be made. Design studies are required.

During System Development & Demonstration, insofar as possible, this section should specify hard performance requirements and specific signature levels which must be met within specified limits for cost, performance, and schedule. If it should become necessary to enter the System Development & Demonstration Phase without sufficient information to specify hard requirements, the CDRL should specify Design Studies to allow developing solutions to survivability performance requirements and developing the associated performance cost and schedule penalties (may be applicable for aerospace system programs begun before publication of this section or for major rework, conversion or service life extension programs).The following survivability factors are to be considered in performance specifications.

Reduction of detection. Levels of radar reflection, infrared, visual and electromagnetic emission and reflection, and aural noise level should be in accordance with the aerospace system performance specification. If no levels are specified, the developer should conduct survivability enhancement trade studies and cost effectiveness analyses for each applicable threat-detectable signature combination defined in the mission threat analysis. The developer should recommend appropriate signature levels, based on effectiveness achievable versus associated cost and penalties, in the survivability plan or supplement thereto. These recommended levels should be supported by test and analysis. Once approved, the recommended levels should become binding system specification requirements.

Radar cross section reduction. The radar cross section (RCS) of the aerospace system, including the mission stores, should be reduced to the levels required to achieve the jamming-to-signal (J/S) ratio specified for each aspect angle-threat frequency combination called out in the aerospace system performance specification and the approved survivability plan. Areas which should be given special consideration include engine inlet ducts and engine front faces, engine exhausts, inherent structural corner reflectors, cavities (crew compartment, radomes, antenna and antenna apertures, radar-visible internal bulkheads, etc.), and external or semi-submerged stores.

Infrared signature reduction. The developer should design to the IR emission requirements specified in the aerospace system performance specification or the survivability plan. Aeronautical system areas to be given special attention are exposed engine hot sections, heated surfaces, engine exhaust, exhaust plume, aerospace system IR reflections from transparencies and metallic or IR reflective surfaces, and internal and external illumination devices.

Visual signature reduction. The developer should design to the aerospace system visibility requirements specified in the aerospace system performance specification and the survivability plan, by reducing the contrast of the aerospace system with its background (both sky and surface), reducing the reflection of light, and reducing smoke or contrail emissions.

Aural signature reduction. The developer should reduce or eliminate noise signature from propulsion and aerodynamic surfaces to the extent practicable and as specified in the survivability plan.

Electromagnetic emission reduction. Inadvertent electromagnetic emissions that can be detected by surveillance devices to locate the aerospace system should be eliminated or reduced, so that no emitter in the standby mode of operation and no other equipment in full operation will emit radiation which exceeds the level specified in the aerospace system performance specification and the survivability plan.

Survivability aids. The survivability of the aerospace system should be enhanced through the use of electronic warfare countermeasures and electronic warfare counter-countermeasures as required by the aerospace system performance specification and the avionics system performance specification. Selection of, and specification for, survivability aids should be based on the survivability enhancement trade studies. The trade studies should consider all aspects of susceptibility reduction for specified threat weapons. The developer should determine the J/S levels required to permit effective operation in the threat environment.

Vulnerability reduction. For aerospace systems whose missions involve exposure to non-nuclear threats, protection of the system should be provided to the extent required by the aerospace system performance specification. Where no specific levels of protection are levied, the developer should, upon approval by the government, provide the most effective combination of protective features that were determined by the aerospace system survivability assessment and system cost effectiveness analyses.

Design configuration. The general design configuration of the aerospace system should be arranged to obtain the highest level of protection practical for the least penalties. Techniques such as: redundancy and separation of system components, lines, and structures; natural masking of essential components; location of fuel cells in relation to engine inlets so as to minimize ingestion of fuel leakage; elimination of fire paths that jeopardize controls; integral armor; and isolation of hazardous elements such as armament, oxygen containers, flammable fluids, etc., from sensitive or susceptible areas. Revisions should be incorporated to prevent or suppress hazardous fires in the isolation where they start (i.e., engine nacelle. fuel tank, dry bay, etc.) to

decrease the possibility of aerospace system kill due to fire. The flying qualities for safe flight after sustaining the specified hostile weapon effects should meet minimum levels specified in the performance specification.

Structures. The aerospace system structure should be of a fail-safe design achieved through the use of multiple load paths and crack stoppers to reduce the probability of catastrophic structural failure due to battle damage with the aircraft in full "g" maneuvering flight. There should be no flight critical structural components or load paths vulnerable to a single detonation, impact or other damage mechanism of threats specified in the implementing documentation that would preclude a safe return and landing (arrested landing in the case of aircraft equipped with an arresting hook). Additional requirements may be listed under Damage Tolerance or Crashworthiness in the performance specification.

Crew station. Protection should be provided for the aircrew as required by the aircraft performance specification or as determined by the government approved, developer conducted Aircraft Vulnerability Analysis. When ballistic protection is required, it should be for the V05 ballistic limit. The crew station design should minimize the generation of hazardous spallation within the crew area and minimize the probability of simultaneous incapacitation of more than one pilot (in multi-pilot aircraft) due to a fragmenting round.

Fuel system. The fuel system should be designed to withstand the specific threats identified in the aerospace system performance specification and in the implementing documentation while providing a specified quantity of protected "get home" fuel. Fire and explosion suppression techniques should be employed throughout the fuel system. Such suppression techniques should include location of fuel tankage and lines away from ignition sources and employment of predictable non- hazardous fuel leakage paths following impact by the specified threats. For carrier-based aircraft, the fuel systems should be designed to contain the fuel with the aircraft engulfed in a fire for the time specified in the aircraft performance specification and in the implementing documentation of this section. Hydraulic ram protection should be provided to meet the requirements of this paragraph. Hydraulic ram protection should be designed to prevent the creation of hazardous secondary damage mechanisms such as fuel ingestion by the engine.

Propulsion system. The engine installation should be designed to be protected from the weapon effects required by the aerospace system performance specification and the implementing documentation of this section. Where multiple engines are employed, design techniques should be used to prevent the combat damage response of one engine from propagating to another engine, causing its failure or degradation. Fire detection and extinguishing should be provided in multiple engine propulsion systems and should be considered in single engine systems. Consideration should be given to a full authority digital engine control (FADEC) to sense and compensate for engine damage in order to keep the engine providing thrust. Responsibility for engine vulnerability reduction and survivability enhancement of the installed engine is vested in the airframe developer.

Power train system. Power train systems, such as those employed by V/STOL or turboprop aircraft, should be designed to be damage tolerant against the level of threats required by the mission specified in the performance specification, the operational requirements, and implementing documentation. Redundancy, reserve capacity, damage tolerance, and ballistically protected elements should be evaluated as methods to obtain the specified or established protection levels. Design techniques to delay failure upon loss of lubrication should be utilized for essential power train elements. Rotating shafts and blade assemblies should be ballistically tolerant to the threats specified in the implementing documentation of this section, and should not be the source of secondary damage mechanisms for other critical components.

Flight control system. The primary flight control system should be designed to minimize failure or malfunction from the non-nuclear weapon effects specified in the implementing documentation of this section. No single hit by the specified threat, on the flight control subsystem should kill the aerospace system. The design of the flight control subsystem should be such that, if the actuating elements of the control surfaces fail, they return the control surfaces to a position to maintain level flight. The design of the flight control subsystem should be such that:

a. Failure of the primary system should not result in a jammed system. For ship-based aircraft, control functions necessary for safe recovery of the aircraft aboard the ship should be as specified in the aircraft performance specification.

b. Secondary controls such as slats, flaps, speed brakes, etc., should be designed so that their response to weapon effects will not result in hazardous flight and recovery operations.

c. Applicable techniques such as redundancy, separation, miniaturization, exploitation of inherent shielding, damage tolerant and damage resistant components, ballistic armor, fly-by-wire, emergency backup subsystems, and integrated power packages should be evaluated as methods to achieve the desired protection levels. Routing and separation should be such that:

(1) Maximum protection against hostile threats is afforded by the aerospace system engines, structure, or other subsystems.

(2) Points where a single hit from a specified threat will result in loss of more than one control axis, or result in an uncontrollable aerospace system, are eliminated.

(3) Damage resulting from multiple fragment hits is minimized.

Fluid power system. Protection for the fluid power systems (hydraulic and/or pneumatic) should be provided to the extent required by the aerospace system performance specification. The following survivability design techniques should be evaluated to achieve the required protection levels:

a. Less flammable hydraulic fluids.

b. Hydraulic circuit monitoring and control.

c. Redundant systems.

d. Shatterproof components.

e. Miniaturization.

f. Separation.

g. High-heat tolerant component or lines.

h. Component manifolding (the combination of several hydraulic functions in a single damage resistant package with concurrent reductions in presented area).

Electrical power system. The electrical power generation and distribution system, including emergency backup systems, should be designed to survive the specified non-nuclear weapon effects. Circuits for essential functions, including active countermeasure devices, should be given priority for protection and should not fail as a result of a single hit by the specified threat. Hazardous circuits should be isolated from potential sources of short circuit actuation or failure from primary or secondary weapon effects. Multiple/cascading failures in electrical bus systems should be avoided.

Armament system. Armament systems should be designed to minimize or prevent hazardous effects upon the aerospace system from hostile weapon effects specified in the performance specification and in the implementing documentation of this section. Provisions should be incorporated to delay the hazardous response of the aerospace system's internal and external armament loadings when subjected to fuel fire, e.g., JP-4, JP- 5, JP-8 and NATO fuels.

Environmental control system. The environmental control system should be designed to minimize creation of hazardous conditions for the aircrew and essential components from the specified weapon effects. This includes conditions such as explosive decompression, shattering of liquid oxygen containers, hot gas line rupture, etc. Protection should be provided when high temperature bleed gases or engine exhaust are routed through or adjacent to compartments containing combustibles or temperature sensitive structure.

Launch/recovery system. The takeoff and landing system of the aerospace system should be designed to allow recovery of the aerospace system when exposed to the weapon effects specified in the aerospace system performance specification and in the implementing documentation of this section.

Avionics system. The installation of government furnished equipment (GFE) and the design and installation of developer furnished equipment (CFE) electronic and weapon delivery systems should include methods to minimize their failure or malfunction from the weapon effects specified in the aerospace system performance specification and in the implementing documentation of this section. This should be a primary design factor in the installation of any such equipment for aerospace system application. Provisions to delay failure from loss of normal environmental conditions should be included so that operations can be performed in degraded modes.

a. The avionics system (including interconnecting wiring) should incorporate design features that minimize, within the limits of practicality, the loss of mission essential functions due to a single hit from a specified threat. Avionics components supporting nonessential functions may be used to provide shielding for components supporting essential functions.

b. Special attention should be given to the reduction of the vulnerability of avionics components that are employed in flight or mission essential functions. These include electronic flight control system components, engine and inlet controls, and any other components in which electronic or fiber optic technology has been substituted for mechanical, electromechanical, or hydraulic power and control. The assessment and design should also consider the degradation in survivability which can result from the loss of countermeasures, navigation, fire control, target acquisition, or communications capabilities.

c. The aerospace system should not be vulnerable to mission kill from non-nuclear EMP.

Laser vulnerability reduction. When laser weapons are included among the specified threats the developer should design the aerospace system to withstand the specified levels of laser radiation. Techniques for laser vulnerability reduction often follow the same guidelines as for ballistic vulnerability reduction, such as providing redundancy, separation, and burnthrough tolerance. These should be supplemented with techniques to reflect or block the laser energy, where required, for crew and airframe survivability. Structural tolerance to low level heating should be incorporated as specified in the implementing documentation.

Appendix D.

Cost in Defense Systems Acquisition

The purpose of this paper is to provide insight in the association of cost in acquisition. The balance between performance, risk, cost, and schedule are of primary importance to the program manager and Office of the Secretary of Defense,

This paper is based on:

- DoD 5000.2-R Final Coordination Copy, dated December 1, 2000 which addresses the subject of cost in detail for defense systems acquisition. It is assumed that no changes Between the coordination copy and the final version will occur that would significantly effect this paper.

- The Defense Acquisition Deskbook (DAD)which provides reference on defense acquisition.

1.0 Information Found in DoD 5000.2-R

A review of DoD 5000.2-R has provided the following price, cost and affordability information. It becomes readily apparent why price, cost and affordability play a major role in the management and oversight of an acquisition. There relationship, taken from DoD 5000.2-R, is discussed below where in establishing realistic objectives, the user is to treat price or cost as a military requirement. Price is the independent variable, preferred over cost, when market research reveals a reasonable expectation for a high degree of competition, a high confidence that price analysis will yield a fair and reasonable price, and an acceptable technical risk for the acquisition, and affordability is a direct function of price/cost.

Price or cost parameters are to identify:

- Total ownership cost (TOC) [broken-out into direct costs: research, development, test, and evaluation costs, procurement costs, military construction costs, operations and support costs (to include environmental and safety compliance costs), and the costs of acquisition items procured with operations and maintenance funds, if applicable; indirect costs attributable to the systems; and infrastructure costs not directly attributable to the system];

- total quantity (including both fully configured development and production units) costs;
- average procurement unit cost (defined as the total procurement cost divided by total procurement quantity);
- program acquisition unit cost (defined as the total of all acquisition related appropriations divided by the total quantity of fully configured end items);
- and other cost objectives designated by the MDA.

Affordability is the degree to which the life-cycle cost of an acquisition program is in consonance with the long-range investment and force structure plans of the DoD or individual DoD Components. There are three types of decision points: milestones, decision reviews, and interim progress reviews. Each decision point results in a decision to initiate, continue, advance, or terminate a project or program work effort or phase. The review associated with each decision point shall typically address program progress and risk, affordability, program trade studies, acquisition strategy updates, and the development of exit criteria for the next phase or effort.

As stated in DoD 5000.2-R – "Every acquisition program shall establish program goals–thresholds and objectives–for the minimum number of cost, schedule, and performance parameters that describe the program over its life cycle." And "The best time to reduce TOC and program schedule is early in the acquisition process. Continuous price/cost/schedule/performance trade studies shall accomplish price/cost and schedule reductions." It becomes apparent that cost is one of the primary parameters used of management oversight during acquisition.

- In establishing realistic objectives, the user shall treat price or cost as a military requirement. Price shall be the independent variable, preferred over cost, when market research reveals a reasonable expectation for a high degree of competition, a high confidence that price analysis will yield a fair and reasonable price, and an acceptable technical risk for the acquisition.
- For performance, "threshold" shall mean the minimum acceptable value that, in the user's judgment, is necessary to satisfy the need. For schedule and cost, "threshold" shall mean the maximum allowable value. If performance threshold values are not achieved, program performance may be seriously degraded, and the utility of the system may become questionable. If schedule threshold values are not achieved, the program may no longer be timely. If cost threshold values

are not achieved, the program may be too costly, and the affordability of the system may become questionable.

In accordance with 5000.2-R the program manager (PM) shall:

3. Use systems engineering and management practices, including affordability, IPPD, and support, to fully integrate total life cycle considerations.
4. Using IPPD, multi-disciplined IPTs simultaneously optimize the product, product manufacturing, and supportability to meet system price or cost and performance objectives.

5. Use Integrating IPT (IIPT) to support the development of strategies for acquisition and contracts, cost estimates, evaluation of alternatives, logistics management, cost-performance trade-offs, etc.

6. Prepare a life-cycle cost estimate (LCCE) for all ACAT I program initiation decisions and at all subsequent program decision points.

Many different disciplines, including survivability, are directly involved in defense systems acquisition. Each disciplines supports the determination of cost associated with their respective disciplines. These engineers and analysts, forming a part of a larger organization, must not only be able to communicate with each other but they must be conversant with such supplemental activities as purchasing, accounting, manufacturing, and legal. The project environment for the design, development, analysis and test and evaluation of a large number of systems is highly dynamic. There are many individuals, including Services centers and laboratories, with different specialties and backgrounds, rotating "on" and "off" of a program at varying times in support of the PM, systems engineering and Integrated Product Teams (IPT)s. The need for communication is essential, as well as having a good understanding of the numerous interfaces that exist. Utilization of the systems engineer in conjunction with the Integrated Product and Process Development (IPPD) /IPT concept and process ensures coordination throughout the life cycle. Service cost centers (component cost agencies) support the PM and associated organizations in determining cost associated with elements of the acquisition.

Systems engineering is responsible for the technical and management efforts of directing and controlling a totally integrated engineering effort of a system or program. It involves design and management of a total system including hardware and software, as well as other system life-cycle elements. The systems engineering process is a structured, disciplined, and documented technical effort through which systems products and processes are simultaneously defined and developed. Systems engineering is most effectively implemented as part of an overall integrated product and process development effort using multidisciplinary teamwork. Systems engineering principles shall influence the balance between performance, risk, cost, and schedule. The systems engineering process shall prepare the WBS in accordance with the WBS guidance in MIL-HDBK-

881.The WBS provides the framework for program and technical planning, cost estimating, resource allocation, performance measurement, technical assessment, and status reporting, and perform trade studies among requirements (operational, functional, and performance); design alternatives and their related manufacturing, testing, and support processes; program schedule; and life-cycle cost; at the appropriate level of detail to support decision making and lead to a proper balance between performance and cost.

The Integrated Product Team (IPT) is composed of representatives from all appropriate functional disciplines (including survivability) working together with a Team Leader to build successful and balanced programs, identify and resolve issues, and make sound and timely recommendations to facilitate decision-making. Program IPTs focus on program execution, and may include representatives from both government, and after contract award, industry. An Integrating IPT (IIPT) supports the development of strategies for acquisition and contracts, cost estimates, evaluation of alternatives, logistics management, cost-performance trade studies, etc and the Cost/Performance IPT (CPIPT) is to ensure that price or cost and benefit data supporting affordability judgments for ACAT IA programs are accurate. ACAT ID and ACAT IAM (as required) programs shall establish a Cost/Performance IPT (CPIPT). The team shall include representatives of the user, costing, analysis, and budgeting communities, at minimum, and include other members as and when appropriate, including industry or contractors. Normally, the PM or the PM's representative shall lead the CPIPT. The PM, supported by the CPIPT, shall conduct and integrate all program cost and performance trade studies.

The following paragraphs provide a synopsis of Price, cost and affordability related organizations, associated processes and pertinent documentation/data identified in 5000.2-R. Price, cost and affordability

1.1 Price, Cost and Affordability Related Organizations

- **Systems Engineering.** Systems engineering shall permeate design, manufacturing, test and evaluation (T&E), and support of the product. Systems engineering principles shall influence the balance between performance, risk, cost, and schedule.

- **OSD Cost Analysis Improvement Group (CAIG).** The CAIG shall prepare an independent LCCE and associated report for the decision authority for all ACAT ID programs, and for ACAT IC programs as requested by the USD(AT&L), for all major decision points as specified in *DoDI 5000.2, Enclosure 3* (reference (b)), or as directed by the MDA.

- **Integrating IPT (IIPT).** An IIPT supports the development of strategies for acquisition and contracts, cost estimates, evaluation of alternatives, logistics management, cost-performance trades, etc.

- **Cost/Performance IPT (CPIPT).** The CPIPT shall ensure that price or cost and benefit data supporting affordability judgments for ACAT IA programs are accurate. Using IPPD, multi-disciplined Integrated Product Teams (IPTs) shall simultaneously optimize the product, product manufacturing, and supportability to meet system price or cost and performance objectives.

- **DoD Components.** DoD components Conduct engineering assessments of possible design changes resulting from LFT&E and develop programs for incorporating cost effective design changes as early as possible commensurate with the system acquisition strategy.

- **Component Cost Agency**. The Component cost agency shall prepare an independent LCCE and associated report for the decision authority for all ACAT IC programs, except those reviewed by the CAIG, for all major decision points as specified in *DoDI 5000.2, Enclosure 3* (reference (b)), or as directed by the MDA. For programs with significant cost risk or high visibility, the Component Acquisition Executive may request an additional Component cost analysis estimate.

- **Component's Manpower Authority .** The Component's manpower authority shall prepare a manpower estimate in support of program initiation for ACAT I programs. They shall update the estimate at subsequent milestones and the full-rate production decision review. The MDA shall consider the manpower estimate before approving entry into system development and demonstration and again before entry into production and deployment (*10 USC 2434*[x]).

- **Program Manager (PM).** For ACAT IA program initiation, the PM shall prepare a life-cycle cost and benefits estimate, often termed an economic analysis (EA). The MDA usually directs an update to the EA whenever program cost, schedule, or performance parameters significantly deviate from the approved Acquisition Program Baseline.

  - The PM shall prepare, and the DoD Component Program Executive Officer, shall approve the CARD. For ACAT IA programs, the PM shall establish the CARD in coordination with appropriate IPT members.

  - PMs shall conduct supportability analyses as an integral part of the systems engineering process, beginning at program initiation and continuing throughout program development. The results of these analyses shall form the basis for the related design requirements included in the system performance specification and logistics support plan. The results shall also support subsequent decisions to achieve cost-effective support throughout the system life cycle.

- The PM, or designee, shall form and lead an IIPT to support the development of strategies for acquisition and contracts, cost estimates, evaluation of alternatives, logistics management, cost-performance trades, etc

- **Principal Staff Assistant (PSA).** The PSA or sponsoring DoD Component shall ensure that the DoD Component also provides a cost analysis for all ACAT IA programs each time an EA is required. The MDA shall determine whether a sufficiency review is appropriate. If appropriate, the Cost Working-Level IPT shall establish the scope of the sufficiency review.

- **Program Analysis and Evaluation (PA&E).** PA&E shall assess the EA, especially the reliability and traceability of the estimated benefits and the ROI calculation. PA&E shall provide results of the assessment to both the PM and MDA. For ACAT IA programs, the MDA shall consider the DoD Component cost analysis and PA&E assessment.

- **Joint Requirements Oversight Council (JROC).** the JROC shall assist the Chairman of the Joint Chiefs of Staff by consider alternatives to any acquisition program that has been identified to meet military requirements by evaluating the cost, schedule, and performance criteria of the program and of the identified alternatives.

1.2 Associated Processes

- **Price or Cost as an Independent Variable (P/CAIV).** The acquisition community, including technology and logistics, and the requirements community shall use the P/CAIV process to develop total ownership cost (TOC), schedule, and performance thresholds and objectives. Upon ORD approval the PM shall formulate a P/CAIV plan, as part of the acquisition strategy, to achieve program objectives.

- **Systems Engineering Process (SEP).** Systems engineering shall permeate design, manufacturing, test and evaluation (T&E), and support of the product. Systems engineering principles shall influence the balance between performance, risk, cost, and schedule. The systems engineering process is responsible for system analysis and control activities that provide the basis for evaluating and selecting alternatives, measuring progress, documenting design decisions, and enabling and managing block deliveries under an evolutionary acquisition strategy. They shall include the following:

  - trade studies among requirements (operational, functional, and performance); design alternatives and their related manufacturing, testing, and support processes; program schedule; and life-cycle cost; at the appropriate level of detail to support decision making and lead to a proper balance between performance and cost.

- Performance metrics to measure technical development and design, actual versus planned; and to measure meeting system requirements in terms of performance, progress in implementing risk handling plans, producibility, cost and schedule. Performance metrics shall be traceable to performance parameters identified by the operational user.

- Systems engineering shall yield a program WBS. The PM shall prepare the WBS in accordance with the WBS guidance in MIL-HDBK-881.

1.3 Pertinent Documentation/Data

- **Acquisition Program Baseline (APB)** Every acquisition program shall establish an APB beginning at program initiation. The PM shall base the APB on users' performance requirements, schedule requirements, and estimate of total program price or cost.
- **Acquisition Strategy (AS).** The acquisition strategy shall evolve through an iterative process and become increasingly more definitive in describing the relationship of the essential elements of a program. A primary goal of the strategy shall be to minimize the time and cost it takes, consistent with common sense and sound business practices, to satisfy identified, validated needs for technologies, products, and services, and to maximize affordability throughout a program's useful life cycle.
- **Analysis of Alternatives (AoA).** Analyzing alternatives is part of the Price or Cost as an Independent Variable process. Alternatives analysis shall broadly examine multiple elements of project or program alternatives including technical risk and maturity, price, and costs. The analysis shall explicitly consider continued operations and support costs of the baseline.
- **Operational Requirements Document (ORD)** shall address price or cost. . The acquisition community, including technology and logistics, and the requirements community shall use the P/CAIV process to develop total ownership cost (TOC), schedule, and performance thresholds and objectives. They shall address price or cost in the Operational Requirements Document (ORD).
- **Life-Cycle Cost Estimate (LCCE).** The estimating activity shall explicitly base the LCCE (or EA for ACAT IA programs) on program objectives; operational requirements; contract specifications; careful risk assessments; and, for ACAT I programs, a DoD program work breakdown structure, or, for ACAT IA programs, a life-cycle price or cost and benefit element structure agreed upon by the IPT. The LCCE (or EA) shall be comprehensive. It shall identify all price or cost elements, including operation and support costs, that affect the decision to proceed with development or production of the system, regardless of funding source or management control. For ACAT I programs, the MDA shall consider the independent LCCE before approving entry into system development and demonstration or into production and deployment (*10 USC 2434*[x]). The LCCE (or EA for ACAT IA

programs) shall be consistent with the price or cost estimates in the AoA, and shall explain major changes that may have occurred.

- **Cost Analysis Requirements Description (CARD).** For ACAT I programs, the DoD Component sponsoring the acquisition shall establish a CARD. The CARD shall describe the salient features of both the acquisition program and the system itself, and provide the basis for the LCCEs. . The teams preparing the program office LCCE, the component cost analysis, if applicable, and the independent LCCE shall receive the CARD 180 days prior to a planned OIPT or Component review, unless the OIPT leader agrees to another due date.
- **Economic Analysis (EA).** The EA shall consist of an LCCE and a life cycle benefits estimate, including a return on investment (ROI) calculation (*CCA)*
- **Component Cost Analysis.** . The Component cost analysis is an independent estimate of life-cycle costs. The DoD Component may request a sufficiency review of the program office LCCE in lieu of conducting a full cost analysis.
- **Work Breakdown Structure (WBS).** The WBS provides the framework for program and technical planning, cost estimating, resource allocation, performance measurement, technical assessment, and status reporting. The WBS shall include the WBS dictionary. The WBS shall define the system to be developed or produced. It shall display the system as a product-oriented family tree composed of hardware, software, services, data, and facilities. It shall relate the elements of work to each other and to the end product.
- **DoD 5000.4-M.** For reporting purposes, the PM shall use life-cycle costs as defined in DoD 5000.4-M.
- **Price or Cost Baseline.** The price or cost baseline shall include the complete set of TOC objectives: research, development, test and evaluation; procurement; military construction; operations and support; and disposal costs; as well as other indirect costs attributable to other systems, and infrastructure costs not directly attributable to the system. The MDA shall re-assess price or cost objectives, and progress towards achieving them, at each subsequent milestone.
- **Defense Acquisition Executive Summary (DAES).** The DAES is a multi-part document, reporting program information and assessments; PM, PEO, CAE comments; and cost and funding data. The DAES shall be an early-warning report to the USD(AT&L) and ASC(C3I). The DAES shall present total costs and quantities for all years, as projected, through the end of the current acquisition phase.
- **Selected Acquisition Report (SAR).** The SAR shall report the status of total program cost, schedule, and performance; as well as program unit cost and unit cost breach information. For joint programs, the SAR shall report the information by participant. Each SAR shall include a full, life-cycle cost analysis for the reporting program, each of its evolutionary blocks, as available, and for its antecedent program, if applicable.
- **Contractor Cost Data Reporting (CCDR).** CCDR is DoD's primary means of collecting data on the costs that DoD contractors incur in performing DoD programs. This data enables reasonable ACAT I program cost estimates and satisfies other analytical requirements. The Chair, CAIG, shall prescribe a format for submission of

CCDRs. The Chair shall prescribe CCDR system policies and monitor implementation to ensure consistent and appropriate application throughout the DoD. CCDR coverage shall extend from Milestone B or equivalent to the completion of production in accordance with procedures described in this section. Unless waived by the Chair, CAIG, CCDR reporting is required on all major contracts and subcontracts, regardless of contract type, for ACAT I programs valued at more than $42 million (FY 2000 constant dollars). Routine reporting shall be at the contract WBS level three for prime contractors and key subcontractors. Only low-level elements that address high risk, high value, or high technical interest areas of a program shall require detailed reporting below level three. The Cost WIPT shall identify these lower-level elements early in CCDR planning.

- **Test and Evaluation Master Plan (TEMP).** The test and evaluation resource summary estimates, by Fiscal Year and appropriation line number (program element), the funding required to pay direct costs of planned testing. It states, by fiscal year, the funding currently appearing in those lines (program elements) and Identifies any major shortfalls.
- **Live Fire Test and Evaluation (LFT&E).** The generation of data to resolve critical LFT&E issues in an efficient and cost effective manner to represent realistic environments shall be of paramount concern in the shot-line selection process for live fire testing.

2.0 Information Found in the Defense Acquisition Deskbook

A cursory examination of the DAD was accomplished to obtain additional cost information regarding methods, techniques and organizations associated with the determination of cost in support of acquisition. The following paragraphs contain the results.

The following Service Cost Centers were identified:

Army
U.S. Army Cost and Economic Analysis Center
5611 Columbia Pike
Falls Church, Virginia 22041
Tel: DSN 761-3336/7/8; Comm (703) 681-3336/7/8
E-Mail: TRMATEER@aol.com
WEB: http://www.asafm.army.mil

Navy
Navy Center for Cost Analysis
1111 Jefferson Davis Highway
Arlington, Virginia 22202-4306
TEL: Comm (703) 604-0293
E-Mail: downsirene@ncca.navy.mil
WEB: www.ncca.navy.mil/ncca.htm

Air Force
Air Force Cost Analysis Agency
1111 Jefferson Davis Highway
Arlington, Virginia 22202
TEL: Comm (703) 604-0387
E-Mail: WEEKS@afcaanet.afcaapo.hqaf.mil
WEB: http://www.saffm.hq.af.mil/SAFFM/

The foregoing information might be dated but the important factor is each Service has an organization to support cost analysis.

The documents discussed below contain cost related information.

2.1 5000.4-M; Department of Defense Manual; Cost Analysis Guide and Procedures; December 1992

This Manual, which the PM is to use for guidance, is issued under the authority of DoD Directive 5000.4, "OSD Cost Analysis Improvement Group (CAIG)," November 24, 1992. This Manual Establishes:

- Guidance On The Preparation Of The "Cost Analysis Requirements Document (Card)". The Card Is To Be Prepared By The Program Office (Or An Office Designated By The Sponsoring DoD Component If The Program Office Does Not Exist) Describing The Complete Program And Will Be Used As The Basis On Which The Program Office And DoD Component Cost Analysis Teams Prepare The Program Life-Cycle Cost Estimates.
- Guidance on the scope of the cost analysis, the analytical methods to be used in preparing cost estimates, and the procedures and presentation of the estimates to the cost analysis improvement group.
- Definitions for seven cost terms and provides an understanding as to how they relate to life-cycle cost categories, work breakdown structure elements, and appropriations.
- The Requirements, Objectives, Uses, And Administration Of The "Visibility And Management Of Operating And Support Costs (VAMOSC) Program."

- This Manual applies to the Office Of The Secretary Of Defense (OSD), the Military Departments, The Chairman of the Joint Chiefs Of Staff and the Joint Staff, and the Defense Agencies (hereafter referred to collectively as "The DoD Components").

- Send recommended changes to the Manual through proper channels to:

  Chairman, Cost Analysis Improvement Group
  Office Of The Secretary Of Defense
  Room 2e-314, The Pentagon
  Washington, Dc 20301-1800

It was interesting that the guidelines for the preparation and maintenance of a Cost Analysis Requirements Description (CARD) include in the outline of the CARD basic structure for system overview the following system characteristics subelements:

- **System Safety.** This paragraph references applicable documents (e.g., MIL-STD-882B (reference (d)), MIL-STD-454M (reference (e)), etc.) and identifies any special or unique system safety considerations (e.g., "fail safe" design, automatic safety, explosive safety needs, etc.).

- **System Survivability.** This paragraph discusses the survivability capabilities and features of the system. It describes the environments (e.g., nuclear, chemical, biological, fire, etc.) in which the system will be expected to operate, and identifies any unique materials incorporated in the system's design that contribute to its survivability.

In Chapter 2, Criteria and Procedures for the Preparation and Presentation of Cost Analyses to the OSD CAIG, Scope of Analysis:

For joint programs, the common program as agreed to by all participating DoD Components as well as all unique program requirements of the participating DoD Components will be documented in the CARD. The DoD CCA team shall verify the following as they are specified in the CARD:

- All resources required (e.g., equipment, software, manpower, facilities) are identified; the complete specifications of these resources (e.g., types, performance and physical characteristics, entire planned program quantities) are included; the full operational and logistic support concepts for the alternative (e.g., deployment plan, activity rates, crew size, crew ratios, stock levels, training, maintenance) are identified; and the requirements for de-commissioning and/or de-militarization and clean-up are fully identified.

- The cost estimates should include all sunk costs and a projection for all categories of the life-cycle costs for the total planned program required to respond to the need as defined in the Mission Needs Statement (MNS), and delineated in the Operational Requirements Document (ORD), System Threat Assessment Report (STAR), Acquisition Program Baseline (APB), and Test and Evaluation Master Plan (TEMP), (DoD 5000.2-M (reference (b))).

5000.4-M also addresses analytical methods as follows:

1. Estimating Approaches. The techniques used to develop the cost estimates shall take into account the stage of the acquisition cycle that the program is in when the estimate is made (such as, demonstration and validation, engineering and manufacturing development, or production). Until actual cost data are available, the use of parametric (statistical) costing techniques is the preferred approach for the development of the cost estimates. It is expected that heavy reliance will be placed on parametric, as well as analog and engineering methods, for Milestone I and II reviews, while projections of cost actuals will be predominantly used for preparing estimates for Milestone III and subsequent reviews. A comparison of several cost estimating methods is encouraged. (See Chapter 6 of "Cost Considerations in Systems Analysis," Fisher, Gene H., op. cit. and Chapter 1 of "Military Equipment Cost Analysis," The RAND Corporation, "Military Equipment Cost Analysis" June 1971. Copies can be obtained from the

Defense Technical Information Center, Cameron Station, Alexandria, Virginia 22314 (DTIC Accession Number AD 901 477L) for a discussion of cost estimating methods).

2. Statistical Estimates. When cost estimating relationships (CERs) already available or newly developed are used to make the cost estimates, the specific form of the CER, its statistical characteristics, the data base used to develop the CER, and the assumptions used in applying the CER are to be provided in the cost estimate documentation. Limitations of the CER shall be discussed. Adjustments for major changes in technology, new production techniques, different procurement strategy, production rate, or business base should be highlighted and explained.

3. Engineering and Analogy Estimates. For estimates made by engineering or analogy costing techniques, the rationale and procedures used to prepare such an estimate must be documented. This should include the cost experience used, and the method by which the information was evaluated and adjusted to make the current cost estimate. If an analog estimate is made using complexity factors, the basis for the complexity analysis (including backgrounds of the individuals making the ratings), the factors used (including the ranges of values), and a summary of the technical characteristics and cost driving elements shall be provided.

4. Actual Costs. Actual cost experience on prototype units, early engineering development hardware, and early production hardware for the program under consideration should be used to the maximum extent possible from CCDR, see Part 20 of DoD 5000.2-M and the CCDR system pamphlet (references (b) and (l)) and other data sources. If development or production units have been produced, the actual cost information will be provided as part of the documentation. Estimates for Milestone III reviews must be based at least in part on actual production cost data for the systems under review.

5. Pass-Throughs. The DoD CCA must treat all costs of the program independently from the program office. However, the DoD CCA may adopt the POE value of the costs of commercial off-the-shelf (COTS) items, or non-developmental items (NDI) that do not require further modification or system integration. The DoD CCA must, in these instances, identify the specific elements of cost in question, and verify in a manner described in the documentation of the estimate, that they arise from COTS or NDI. Pass-throughs, furthermore, should be checked for accuracy (e.g., for currency of cost data and correctness of calculations). Requests to pass through other elements of the POE must be made in writing to the CAIG Chair 60 days in advance of the CAIG briefing.

6. Sufficiency Review. The sufficiency review method may be used, with the approval of the CAIG Chair, for assessing the adequacy of cost elements in the program cost estimate which are determined to be low-risk and low-cost based on an independent analysis of the program assumptions. The review shall include an evaluation of the

techniques and data used to develop the POE and, if available, the use of data from alternative sources to verify the POE. The results of the review will be documented and provided to the CAIG. Requests to use the sufficiency review method must be made in writing, preferably at the CAIG kick-off meeting, but in any case not later than 60 days before the CAIG briefing.

7. Uncertainty Attributed to Estimating Errors (Cost Estimating Uncertainty). Areas of cost estimating uncertainty will be identified and quantified. Uncertainty will be quantified by the use of probability distributions or ranges of cost. The presentation of this analysis should address cost uncertainty attributable to estimating errors; e.g., uncertainty inherent with estimating costs based on assumed values of independent variables outside data base ranges, and uncertainty attributed to other factors, such as performance and weight characteristics, new technology, manufacturing initiatives, inventory objectives, schedules, and financial condition of the contractor. The probability distributions, and assumptions used in preparing all range estimates, shall be documented and provided to the CAIG.

8. Contingencies. If contingency allowance is included, an explanation of why it was required, and a presentation of how the amount of the contingency was estimated, shall be provided. This shall include an assessment of the likelihood that the circumstances requiring the contingency will occur.

9. Sensitivity Analysis. The sensitivity of projected costs to critical program assumptions shall be examined. Aspects of the program to be subjected to sensitivity analysis shall be identified in the DoD CCA of program assumptions. The analysis shall include factors such as learning curve assumptions; technical risk, i.e., the risk of more development and/or production effort, changes in performance characteristics, schedule alterations, and variations in testing requirements; and acquisition strategy (multiyear procurement, dual sourcing, etc.). Use of statistical analysis to describe sensitivity to critical assumptions is encouraged. The results of the analysis will be documented and provided to the CAIG.

10. Multinational Acquisitions. Program estimates involving multinational acquisitions will include the impact on costs to the U.S. Government of coproduction, license fees, royalties, transportation costs, and expected foreign exchange rates, as appropriate.

5000.4-M Chapter 3, Cost Terms, Definitions, and Relationship to Life-Cycle Costs, Work Breakdown Structures, and Appropriations, provides the following:

Under objectives, seven cost terms are standardized by this Manual as follows: development cost; flyaway cost; weapon system cost; procurement cost; program acquisition cost; operating support (O&S); and life cycle cost.

Under references it states "Cost terms can be defined by budget appropriations, and by life-cycle cost categories. They may be further defined by the applicable acquisition elements of equipment (hardware and software); services; data; and facilities (see Work Breakdown Structure (WBS) elements as defined by Military Standard 881A (reference (p)) used on contracts) and by the applicable operating and support (O&S) elements of personnel, training, spares, supplies, maintenance, and fuel."

It specifies the following cost term definitions:

The seven cost terms standardized by this Manual are described as follows:

1. Development Cost.

a. Work Breakdown Structure (WBS). WBS elements of Prime Mission Equipment, System Engineering/Program Management, System Test and Evaluation (except Operational Test and Evaluation funded from Military Personnel or Operation and Maintenance appropriations), Training, Peculiar Support Equipment, Data, Operational/Site Activation, and Industrial Facilities (when provisions of Chapter 251 of DoD 7110-1-M (reference (m)) apply.

b. Budget. Funded from the RDT&E appropriation (i.e. concept exploration and definition, demonstration and validation, and engineering and manufacturing development phases from the point the program and/or system is designated by title as a Program Element or major project in a Project Element).

c. Life-Cycle Costs. The development costs, both contractor and in-house, of the Research and Development cost category, including the cost of specialized equipment, instrumentation, test, and facilities required to support the RDT&E contractor and/or Government installations.

2. Flyaway (Rollaway, Sailaway, etc.) Cost. Flyaway cost is used as a generic term to refer to the cost of producing a usable end item of equipment (hardware and software). Flyaway cost includes:

a. Work Breakdown Structure (WBS). WBS elements of Prime Mission Equipment (such as basic structure, propulsion, electronics (hardware and software), system software, etc.), System Engineering/Program Management, and System Test and Evaluation.

b. Budget. Funded from RDT&E and Procurement appropriations. This would include funding for warranties, engineering changes, pre-planned product improvement (during system acquisition), and first destination transportation (unless FDT is a separate budget line item). Certain acquisition costs funded in the O&M appropriation (e.g. ship installations) are also included.

c. Life-Cycle Cost. The flyaway costs (including Government Furnished Equipment), both contractor and in-house, of the Research and Development and Investment Nonrecurring and Recurring cost categories.

3. Weapon System Cost. Weapon System Cost includes:

a. Work Breakdown Structure (WBS). WBS elements Prime Mission Equipment, System Engineering/Program Management, System Test and Evaluation (if funded by Procurement), plus WBS elements Training, Peculiar Support Equipment, Data, Operational/Site Activation, and Industrial Facilities (unless funded as a separate budget line item or by RDT&E).

b. Budget. Funded from the Procurement appropriation. It includes funding for warranties, engineering changes, pre-planned product improvement (during system acquisition), and first destination transportation (unless FDT is a separate budget line item). Certain acquisition costs funded in the O&M appropriation (e.g. ship installations) are also included.

c. Life-Cycle Cost. The weapon system costs (including Government-Furnished Equipment), both contractor and in-house, of the Investment Nonrecurring and Recurring cost categories.

4. Procurement Cost. Procurement cost includes:

a. Work Breakdown Structure (WBS). The same WBS elements as in Weapon System Cost; i.e., Prime Mission Equipment, System Engineering/Program Management, System Test and Evaluation (if any of this effort is funded by Procurement), Training, Peculiar Support Equipment, Data, Operational/Site Activation, and Industrial Facilities (unless funded as a separate budget line item or by RDT&E), plus the WBS element: Initial Spares and Repair Parts.

b. Budget. Funded from the Procurement appropriation. It includes funding for warranties, engineering changes, pre-planned product improvement (during system acquisition), and first destination transportation (unless FDT is a separate budget line item). For Navy shipbuilding programs, outfitting and post delivery costs are also included when Procurement funded. Certain acquisition costs funded in the O&M appropriation (e.g. ship installations) are also included.

c. Life-Cycle Cost. The procurement costs (including Government Furnished Equipment), both contractor and in-house, of the Investment Nonrecurring and Recurring cost categories.

5. Program Acquisition Cost. Program Acquisition Cost consists of Development Costs, Procurement Costs, and any construction costs that are in direct support of the defense acquisition program. It includes:

a. Work Breakdown Structure (WBS). WBS elements of Prime Mission Equipment, System/Program Management, System Test and Evaluation (except Operational Test and Evaluation funded from Military Personnel or Operation and Maintenance), Training, Peculiar Support Equipment, Data, Operational/Site Activation, Industrial Facilities (unless funded by Procurement as a separate budget line item), and Initial Spares and Initial Repair Parts.

b. Budget. Funded from the RDT&E, Procurement, and MILCON appropriations. It includes funding for warranties, engineering changes, pre-planned product improvement (during system acquisition), and first destination transportation (unless FDT is a separate budget line item). Certain acquisition costs funded in the O&M appropriation (e.g. ship installations) are also included.

c. Life-Cycle Cost. The program acquisition costs (including Government Furnished Equipment), both contractor and in-house, of the Research and Development, and Investment nonrecurring and recurring cost categories.

6. Operating and Support (O&S). O&S costs include:

a. All personnel, equipment, supplies, software, services, including contract support, associated with operating, modifying, maintaining, supplying, training, and supporting a defense acquisition program in the DoD inventory. This includes costs directly and indirectly attributable to the specific defense program; i.e., costs that would not occur if the program did not exist, such as:

(1) Mission Personnel. Pay and allowances for officer, enlisted, and civilian personnel assigned to support a discrete operational system or deployable unit. Includes personnel necessary to meet combat readiness, training, and administrative requirements.

(2) Unit Level Consumption. Fuel and energy resources; operations, maintenance, and support materials consumed below depot level; reimbursement of stock fund for depot level reparables; operational munitions expended in training; transportation of materials, repair parts and reparables between the supply or repair point and unit; and other unit level consumption costs such as purchased services for equipment lease and service contracts.

(3) Intermediate Maintenance. Labor, material, and other costs expended by designated activities and/or units (third and fourth echelons) performed external to the unit. Includes calibration, repair and replacement of parts, components or assemblies and technical assistance to the mission unit.

(4) Depot Maintenance. Personnel, material, overhead support, and depot-purchased maintenance required to perform major overhaul, and maintenance of a defense system, its components, and support equipment at DoD centralized repair depots, contractor repair facilities, or on site by depot teams.

(5) Contractor Support. Labor, materials, and depreciable assets used in providing all or part of the logistics support to a defense system, subsystem, or related support equipment.

(6) Sustaining Support. Procurement (exclusive of war readiness materiel) of replacement support equipment, modification kits, sustaining engineering, software maintenance support, and simulator operations provided for a defense system.

(7) Indirect Support. Personnel support for specialty training, permanent changes of station, and medical care. Also includes relevant host installation services, such as base operating support and real property maintenance.

b. O&S costs are funded from Operation and Maintenance (O&M), Military Personnel, Procurement, Military Construction, stock funds, and other appropriations.

7. Life-Cycle Cost. Life-Cycle Cost includes ALL WBS elements; ALL affected appropriations; and encompasses the costs, both contractor and in house effort, as well as existing assets to be used, for all cost categories. It is the TOTAL cost to the Government for a program over its full life, and includes the cost of research and development, investment in mission and support equipment (hardware and software), initial inventories, training, data, facilities, etc., and the operating, support, and, where applicable, demilitarization, detoxification, or long term waste storage.

2..2 Parametric Cost Estimating Handbook; Fall 1995

This Handbook is intended to be used as a general guide for implementing and evaluating parametric based estimating systems, and as the text material for a basic course in parametric estimating techniques. The information contained in this Handbook complements and enhances the guidance provided by DCAA Cost Audit Manual (CAM), FARs/DFARs, and other government regulations or public laws relating to cost estimating. The Handbook is structured so each chapter can be used as a stand alone guide and reference. If the reader is interested in only one subject, then one chapter can be read without reading any other. Expected users of this Handbook include cost model developers, analysts, auditors, and all levels of cost management.

This Handbook is just one of several by-products of a joint Industry/Government Parametric Cost Estimating Initiative. The Initiative Steering Committee and implementation team includes representation from contractors, buying activities, Defense

Contract Management Command and Defense Contract Audit Agency. The Initiative's far reaching action items include working with pilot contractor sites to test the expanded use of parametric cost estimating techniques and tools, developing parametric cost estimating training, and preparing and distributing this Handbook.

The *Handbook* is intended to be used by both model developers and model reviewers, their management or oversite, either technical or financial. Government and industry cost analysts and auditors who utilize CER's and/or parametric cost models to develop or evaluate an estimate generated with these parametric tools should find the *Handbook* useful. It is also intended to be utilized as a source document by trainees within a generic parametric cost estimating training program.

This *Handbook* includes basic information concerning data collection, Cost Estimating Relationship (CER) development, parametric cost models, and statistical techniques. Parametric techniques are a credible cost estimating methodology that can provide accurate and supportable contractor estimates, lower cost proposal processes, and more cost-effective estimating systems.

An estimating workbench context model is shown in Figure I-1. The model indicates the tools required within the estimating community of contractors, customers and government agencies. Figure I-2 is a graphical representation of the complete parametric cost estimating process. The figure indicates the process from inputs through modeling and into a post processor phase. The post processor allows for the conversion of parametric output into a cost proposal.

QuickTime™ and a
BMP decompressor
are needed to see this picture.

Figure I-1 – Estimating Workbench Context Model

QUICKTIME™ AND A
BMP DECOMPRESSOR
ARE NEEDED TO SEE THIS PICTURE.

Figure I-2 – Parametric Cost Estimating Process

There are several definitions of parametric estimating, but for the purpose of this *Handbook*, the formal one adopted is as follows: A technique employing one or more CER'S and associated mathematical relationships and logic. The technique is used to measure and/or estimate the cost associated with the development, manufacture, or modification of a specified end item. The measurement is based on the technical, physical, or other end item characteristics.

This definition establishes the clear linkage between cost and a product's (or end item) technical parameters. Without this linkage, a product cost cannot be effectively defined. Non-parametric estimating systems generally do not connect technical (parametric) and cost elements with any substantial precision.

Cost Estimate Documentation Guidelines

Specific Elements:

(1) When a Cost-Estimating Relationship (CER) is used, it should be presented and its source must be cited fully, or the model and the set of data with which it was calibrated must be cited. A cost estimator reviewing the cost documentation should be able to obtain enough information either from the document or from the sources cited therein to

reconstruct the CER and evaluate its associated statistics. CER documentation should include descriptive statistics, such as, R-squared, correlation coefficients, T-statistics, relevant range, etc. This information is necessary to adequately assess the applicability of a CER.

(2) Where subjective judgments were used to adjust estimates made by analogy with other systems or components of systems, the professions of those making the judgments must be identified (e.g., cost analysts, engineers, etc.) and full citations for the sources(s) of the costs of the analogous system(s) must be provided. Sources of the costs of each element in an engineering, or "grass roots," estimate must also be cited.

(3) The Component Cost Analysis (CCA), if performed, and the CAIG's independent cost estimate may incorporate (e.g., pass through) elements of the program office estimate if the costs of the elements in question are essentially certain (e.g., catalog prices). Fixed-priced contracts typically will not be treated as certain costs.

Scope of Life-Cycle Cost Estimates

Life-cycle cost estimates should:

a. Include all program costs, regardless of funding source or management control. The estimates should not focus arbitrarily on certain budget accounts or on categories covered by certain lines of authority. "Sunk costs" should be separately identified as such in the program life cycle cost estimate.

b. Cover the entire planned life of a program, not an arbitrary number of years (such as the six years in the FYDP).

c. Include all cost categories (concept exploration, if applicable; demonstration and validation; engineering and manufacturing development; production and deployment; operations and support, and demilitarization and disposal) and all appropriation accounts (RDT&E; procurement; military construction; operation and maintenance; and military personnel).

d. Exclude the cost of "free goods." "Free goods" are assets that have been, or will be, acquired independently of the fate of a program and do not have significant "opportunity costs." To the extent that resources used in a program have other DoD uses, the value of such foregone uses should be estimated and considered as part of a program's cost. This is the opportunity cost of that asset. Significant "opportunity costs" should be separately identified as such in the program life cycle cost estimate.

e. Be structured along the lines suggested by the investment and operating and support categories (prime mission equipment, system test and evaluation, system engineering, program management, etc.) presented in Chapter 2 of DoD 5000.4-M. The work

breakdown structure used in the acquisition phases should be consistent with MIL-HDTK-881.

f. Cover all alternatives that the sponsoring DoD component is considering. The estimate, however, may emphasize the alternative deemed most promising by the sponsor. If alternatives have significantly different timelines, the net present value of each acquisition cost stream should be presented.

2.3 DSMC Acquisition Logistics Guide; Third Addition; December 1997, Part III - Logistics Resources and Tools, Chapter 12 - Logistics Cost Estimating.

12.2 -- Life-Cycle Cost (LCC) Overview

The life cycle of a system begins with the determination of a mission requirement and includes research and development (R&D), production, deployment, operation, support, and eventual disposal or demilitarization by the Department of Defense (DoD). Program phases may overlap considerably; in particular, R&D may not be completed before procurement begins.

12.2.1 -- LCC Analysis Is an Iterative Process

The LCC estimate must reflect program changes as they occur. LCC Management (LCCM) is the program office discipline used to incorporate LCC in program office decision making. The lead acquisition logistics manager will generally be tasked to provide Operating and Support (O&S) cost support for the LCC estimate.

12.2.1.1 -- LCC Breakdown.

For purposes of cost estimating, LCC is typically divided into research and development, procurement, O&S, and disposal. The following descriptions provide a brief summary of the costs associated with each life-cycle phase (see Figure 12-1):

- **R&D.** R&D consists of those costs incurred from program initiation at the conceptual phase through the end of engineering and manufacturing development. R&D costs include the cost for feasibility studies, modeling, tradeoff analyses, engineering design, development, fabrication, assembly and test of prototype hardware and software, system test and evaluation, associated peculiar support equipment, and documentation.

- **Procurement.** Procurement includes the costs associated with producing or procuring the prime hardware, support equipment, training, data, initial spares, and facilities.

- **O&S.** O&S consists of all costs incurred by the DoD to field/deploy the system including personnel, consumable and reparable parts, fuel, shipping, and maintenance.

- **Disposal.** Disposal captures costs associated with deactivating or disposing of a materiel system at the end of its useful life. Disposing of a materiel system can result in additional costs or a salvage value depending on the disposition. This cost is normally insignificant compared to the total LCC. The main exceptions to this include disposal of nuclear waste, missile propellants, and other materials requiring expensive detoxification or special handling.

Figure 12-1: -- Growth in Weapon System Life-Cycle Cost

12.5 -- Determine Cost-Estimating Technique

When estimating the O&S cost of a system, there are several techniques that may be applied. The choice of technique depends on the maturity of the program and the data available. Most O&S analyses are accomplished using a combination of three estimating techniques: analogous system, parametric, and engineering. The latter is sometimes called a "bottoms up" or "grass roots" estimate and uses accounting-type data. As the program progresses from concept development to production, more-detailed cost data become available. Initial estimates are then updated with a prototype test or actual operational data. Regardless of the estimating technique applied, appropriate documentation must accompany the estimate. The following is a summary of each of these estimating techniques.

12.5.1 -- Analogous System

In this technique, a currently fielded system (a comparable system) that is similar in design and/or operation to the proposed system is identified. Taking the fielded system's data and adjusting them to account for any differences then develops the cost of the proposed system. The analogous system may be a composite of several fielded systems. This technique of cost estimation is widely used. One drawback to analogous system estimation is the amount of detailed technical and engineering data required. The analogous system approach places heavy emphasis on the opinions of "experts." Therefore, it is necessary to document clearly the rationale used to determine the composition of the analogous system and the adjustment factors used.

12.5.2 -- Parametric

The parametric approach employs Cost-Estimating Relationships (CERs) to develop estimates using regression analysis. A CER is an equation that relates one or more characteristics of an item to some element of its cost. For example, a study of existing avionics equipment may yield a CER relating avionics unit cost to the weight of the avionics system. This CER could then be used to predict avionics unit cost for a new system, which has weight that needs estimated. Normally analogy or parametric estimating is used early in the life cycle of a system, when item specific data is not known. CERs must be examined to ensure they are current (i.e., reflect acquisition reform), appropriate for the range of data being estimated, and applicable to the system. If they are improperly applied, the result could be serious estimating errors.

12.5.3 -- Accounting Estimates

The accounting method uses engineering estimates of reliability, maintainability, and component cost characteristics (optempo rates) to build estimates from the "bottom-up" for each cost category. Accounting estimates require detailed system data. The system is typically broken down into lower-level components, and estimates of each component are made. Although this method can be complex and time consuming, it is the method of choice when detailed system data is available.

12.6.2 -- Cost Models in Wide Use

Three O&S cost models widely used in the DoD are the Cost Analysis Strategy Assessment (CASA) model, the Air Force's Cost-Oriented Resources Estimating (CORE) model, and the Logistics Support Costs (LSC) model. A sampling of models selected to illustrate the characteristics for a credible O&S cost model follows:

12.6.2.1 -- CASA.

CASA is designed as an engineering estimate or accounting model. No CERs are used. The model conforms to the requirements of the Office of the Secretary of Defense (OSD)

Cost Analysis Improvement Group (CAIG) guidelines for cost elements. The model uses some 90 algorithms and 190 variables to capture all relevant operating and support costs. It is flexible which means most of the inputs are optional so the model's capability can be tailored to the needs of the LCC analyst. Also, the model uses fixed formulas so the analysis is completely repeatable. It is general purpose and has been used in all of the Services to support analysis needs on a wide variety of systems and equipment.

12.6.2.2 -- CORE.

CORE is designed to provide a cost-estimating technique to be used to develop aircraft O&S cost estimates. CORE uses data available from standard USAF data systems (consistency). It allows the estimating techniques to vary as the program progresses through the phases of acquisition (flexibility), and it estimates all common O&S cost elements (completeness). It uses the format, cost element structure, and procedures generally required for milestone briefings (usefulness).

12.6.2.3 -- LSC.

The LSC uses consistent data for comparable systems available from standard USAF data sources (consistency) and also contains built in factors allowing the model to be used when little item-specific data is available. As the program matures and item-specific data evolves, the factors are replaced, which results in an improved O&S cost estimate (flexibility). The LSC model addresses spares, depot maintenance, and transportation in detail. Manpower, support equipment, and training are addressed only superficially; fuel and other costs of operation are not included in the model.

12.9 -- Uses for the O&S Cost Estimate

The O&S Cost estimate is a large part of the total program LCC. O&S cost estimates are required whenever the LCC estimate is prepared. Annual program office estimate requirements vary, but usually include O&S costs.

12.9.1 -- Analysis Of Alternatives (AOA)

The analysis is to aid decision makers in judging whether or not any of the proposed alternatives to an existing system offer sufficient military and/or economic benefit to be cost worthy.

12.9.2 -- Tradeoffs

Once a baseline estimate is complete, the impact of program changes on O&S costs can be evaluated. When combined with schedule and performance data and an objective function, the estimate may support a CAIV-based tradeoff exercise. An example of a design tradeoff is an Engineering Change Proposal (ECP). The ECP analysis is used to assess the cost implications of a proposed design change. The decision to accept or reject

the ECP is made after considering the effect on program costs. Comparing the cost of the baseline configuration with the cost of the proposed configuration assesses the ECP. Areas of uncertainty are identified and appropriate sensitivity analyses performed.

12.9.3 -- Independent Cost Estimate (ICE)

An ICE is a cost estimate prepared by an objective nonprogram office team. The decision makers use the ICE primarily to identify any inconsistencies with the program office estimate. An O&S cost estimate is a major portion of these ICE efforts.

12.9.4 -- Milestone Reviews

During a milestone review, program LCC is carefully scrutinized to determine program readiness to proceed to the next acquisition phase. Both the program office estimate and the ICE are reviewed to determine if the program is still likely to meet requirements and is still cost-effective. A recommendation is provided to the decision makers following this review.

12.9.5 -- Source Selection

O&S estimates should be an integral part of the most probable cost for each proposal under consideration during source selection. These most probable costs are used by the source selection authority in award.

12.9.6 -- Budgeting

Budgeting for O&S cost elements is one use of the estimate. The current DoD trend is to track cost estimating more closely with budgeting. An effort is underway to incorporate the O&S cost estimate into the Acquisition Program Baseline (APB).

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[i] Title 10, United States Code, Section 2366, Major systems and munitions programs: survivability and lethality testing required before full-scale production

[iiii] Title 10, United States Code, Section 2366, Major systems and munitions programs: survivability and lethality testing required before full-scale production

[iii] Title 10, United States Code, Section 2366, "Major systems and munitions programs: survivability and lethality testing required before full-scale production"

[iv] Title 10, United States Code, Section 2399, "Operational test and evaluation of defense acquisition programs"

[v] Title 10, United States Code, Section 2366, "Major systems and munitions programs: survivability and lethality testing required before full-scale production"

[vi] Title 10, United States Code, Section 2302, "Definitions"

[vii] Title 10, United States Code, Section 139, "Director of Operational Test and Evaluation"

[viii] Title 10, United States Code, Section 2366, "Major systems and munitions programs: survivability and lethality testing required before full-scale production"

[ix] DoD Instruction 5200.40, *DoD Information Technology Security Certification and Accreditation Process (DITSCAP)*, December 30, 1997

[ix] Title 10, United States Code, Section 2434, "Independent cost estimates; operational manpower requirements"