



AEROSPACE SYSTEMS SURVIVABILITY HANDBOOK SERIES

Volume 1. Handbook Overview

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**Joint Technical Coordinating Group on
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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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ACRONYMS AND ABBREVIATIONS

ACAT	Acquisition Category
AIS	Automated Information System
AoA	Analysis of Alternatives
CONOPS	Concept of Operations
CPAT	Critical Process Assessment Tool
DEAD	Destroy Enemy Air Defenses
DoD	Department of Defense
DOT&E	Director of Operational Test and Evaluation
EW	Electronic Warfare
IPPD	Integrated Product and Process Development
IPT	Integrated Product Teams
IST	Information Systems Technology
IW	Information Warfare
JACG	Joint Aeronautical Commanders' Group
JECSIM	Joint Electronic Combat Test Using Simulation
JTCG/AS	Joint Technical Coordinating Group on Aircraft Survivability
LFT&E	Live Fire Test and Evaluation
LO	Low Observables
M&S	Modeling and Simulation
MANPADS	Man-Portable Air Defense System
MASTER	Modeling and Simulation Test and Evaluation Reform
MDA	Milestone Decision Authority
PM	Program Manager
PMSG	Principal Members Steering Group
RDT&E	Research, Development, Test, and Evaluation
S&T	Science and Technology
SBA	Simulation-Based Acquisition
SE	Systems Engineering
SEAD	Suppression of Enemy Air Defenses
SEP	Systems Engineering Process
STEP	Simulation Test and Evaluation Process
SURVIAC	Survivability/Vulnerability Information Analysis Center
T&E	Test and Evaluation
V&V	Verification and Validation
VV&A	Verification, Validation, and Accreditation
WBS	Work Breakdown Structure

REFERENCES

The following documents form the initial reference list used in conjunction with the deskbook and DoD and associated websites to develop the Survivability Handbook Series. Note the AIAA Education Series textbook by Robert E. Ball, which provides the basis for the academic foundations of survivability. The information in the textbook is correlated with the handbook series. The textbook is focused on fundamentals, and the handbooks are focused on acquisition.

- ADS-11B, *Aeronautical Design Standard, Survivability Program, Rotary Wing*, May 1987.
- ADS 11B, *Aeronautical Design Standard, Survivability Program Rotary Wing*, December 1985.
- Air Force Manual 99-112, *Test and Evaluation, Electronic Warfare Test and Evaluation Process — Direction and Methodology for EW Testing*, 27 March 1995.
- *Analysis Plan for Assessment for the Joint Electronic Combat Test Using Simulation (JECSIM)*, 13 May 1996.
- Ball, Robert E., *The Fundamentals of Aircraft Combat Survivability Analysis and Design*, AIAA Education Series, New York, 1985.
- DoD Directive 5000.1, “The Defense Acquisition System,” April 2000.
- DoD Instruction 5000.2, “Operation of the Defense Acquisition System,” April 2000.
- DoD Regulation 5000.2-R, “Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) Acquisition Programs,” 11 May 1999.
- MIL-HDBK-268 (AS), *Military Handbook, Survivability Enhancement, Aircraft, Conventional Weapon Threats, Design and Evaluation Guidelines*, 5 August 1982
- MIL-HDBK-273 (AS), *Military Handbook, Survivability Enhancement, Aircraft, Nuclear Weapon Threat, Design and Evaluation Guidelines*, 30 December 1983.
- MIL-HDBK-336-1, *Military Handbook, Survivability, Aircraft, Nonnuclear, General Criteria, Volume 1*, 25 October 1982.
- MIL-HDBK-336-1A, *Military Handbook, Survivability, Aircraft, Nonnuclear, General Criteria, Volume 1A*, 1 May 1995.
- MIL-HDBK-336-2, *Military Handbook, Survivability, Aircraft, Nonnuclear, Airframe, Volume 2*, 26 August 1983.
- MIL-HDBK-336-3, *Military Handbook, Survivability, Aircraft, Nonnuclear, Engine, Volume 3*, 4 February 1983.

- MIL-HDBK-2069, *Military Handbook, Aircraft Survivability*, 10 April 1997
- MIL-STD-1629A, *Military Standard, Procedures for Performing a Failure Mode, Effects and Criticality Analysis*, 24 November 1980.
- MIL-STD-1799 (USAF), *Military Standard Survivability, Aeronautical Systems (for Combat Mission Effectiveness)*, 1 December 1986
- MIL-STD-2069, *Military Standard Requirements for Aircraft Nonnuclear Survivability Program*, 24 August 1981.
- MIL-STD-2072 (AS), *Military Standard Survivability, Aircraft; Establishment and Conduct of Programs for*, 25 August 1977.
- MIL-STD-XXXX (USAF), *Military Standard Aeronautical Systems Survivability (for Combat Mission Effectiveness)*, Draft: 30 November 1985.
- MIL-STD-2089, *Military Standard, Aircraft Nonnuclear Survivability Terms*, 21 July 1981.

EXECUTIVE SUMMARY

This summary volume is designed to provide an overview of the Survivability Handbook Series. The series includes, in addition to this overview volume, 11 volumes that give descriptions of the key process activities performed by survivability managers, engineers, and analysts. These volumes correlate the survivability process and its management, engineering, test and evaluation, and systems-analysis functions with the processes and procedures of acquisition. Each volume describes in some detail the purpose for each process activity, what needs to be done, and how it can be done.

The intended audience is primarily new survivability personnel, personnel in another discipline who need to perform some related functions, or more experienced survivability personnel who need a convenient reference. The intent is to provide enough information for users to determine whether given process activities are appropriate in supporting the objective(s) of their program or project. Information is also included on how to go about implementing those process activities.

This volume contains definitions of the major concepts addressed in the series, as well as an overview of changing requirements necessitating consideration of survivability processes during all phases of the systems acquisition cycle and in all areas of the battlespace. An outline is given of the processes and procedures necessary to accomplish a survivability assessment in an effective, timely manner, taking into account the advances needed to effectively link live, virtual, and constructive simulations.

The structure of each handbook in the series is briefly discussed, along with the approach, scope and primary topics considered during creation of each volume. Initially, the handbook series concentrates on conventional threats, but it will also include additional volumes covering all major systems and threats.

Comments and recommendations for subsequent issues in this handbook series are solicited. Please provide your inputs to the JTCG/AS Central Office, 1213 Jefferson Davis Highway, Suite 1103, Arlington, VA 22202, phone (703) 607-3509.

1.0 INTRODUCTION TO THE HANDBOOK SERIES

The intent of this handbook series is to address the activities of the survivability community in response to the changing needs of the warfighter. Survivability personnel need to assist acquisition managers in establishing aggressive but realistic survivability objectives for all programs, as well as in considering tradeoffs of cost, performance, and schedule, beginning early in the program.

The series is designed to show what each survivability activity entails, including considerations of designing for affordability and performance. The survivability process activities described are applicable to most projects when survivability is a consideration. Such projects can range from the loosely managed project where a given activity may be performed informally (e.g., on the back of an envelope, or in an engineer's notebook) to the highly structured project, with interim products under formal baseline control. The series advocates a close association with the program manager (PM) and his acquisition team where the level of formality is the level required by the PM.

Changes in a New Era of Warfighting

The survival of our forces (warfighters and their tools) is a crucial aspect of full-spectrum dominance of our enemy — an aspect that increases in complexity as the battlefield arena becomes more complex. The field of view of warfare has also changed significantly, requiring that survivability be considered in all elements of joint warfare. This change requires the survivability process to be responsive to new threats, challenges, demands, and opportunities. Survivability must provide the capability to maximize materiel survivability and assess the survivability of our forces based on how and where we fight.

DoD Regulation 5000.2-R states, “Unless waived by the MDA, mission-critical systems, including crew, regardless of ACAT, shall be survivable to the threat levels anticipated in their operating environment. Design and testing shall ensure that the system and crew can maximally 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.”

Survivability has for years been defined as the combination of two elements: vulnerability (or “damage tolerance”) and susceptibility (or “threat avoidance”). To address vulnerability, lethality has also been considered. The survivability community has even ventured into engagement, mission, and theater assessments in support of systems analysis where electronic warfare (electronic combat) was applied. Efforts to address these warfare factors independently and shoehorn them into assessments have been inefficient at best. An integrated application of

survivability assets and processes is necessary to accomplish a survivability assessment in an effective, timely manner. The survivability process contained in this handbook series defines and documents that continuum and the associated management requirements.

Definitions

The Live Fire Test and Evaluation Mandatory Procedures & Reports Section of DoD Regulation 5000.2-R contains the following definitions for survivability, vulnerability, lethality, and susceptibility:

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.

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.

Lethality. The ability of a munition or directed-energy weapon to cause damage that will cause a loss or degradation in the ability of a target system to complete its designated mission(s).

Susceptibility. The degree to which a weapon system is open to effective attack because of 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.

Survivability Topics in Systems Acquisition

The complexity of joint warfare today requires the survivability discipline to approach acquisition as a multidimensional challenge. The survivability community must continue to press forward, with emphasis on such areas as modeling and simulation, test and evaluation (T&E), visualization, distributed collaboration, and systems analysis. The survivability process must develop and maintain the capability for addressing information superiority for the warfighter throughout the battlespace.

The following topics need to be considered in conjunction with systems acquisition. Each topic has an effect on how survivability is addressed throughout acquisition.

- Suppress/Avoid/Deceive/Persist (Integrated Warfare System)
- Lethality/Survivability/Supportability
- Threat-Driven Requirement
- Performance Balance With Affordability/Supportability
- Electronic Warfare (EW)/Low Observables (LO) Effectiveness – Combined Concept
- Technology Driven Action-Reaction Cycle

- Increasing Reliance on Integrated Assets
- The Technology/Development/Support Triangle
- Legacy and Future Systems Integrated To Maximize Effectiveness — LO, EW, Information Warfare (IW)
- Lethality, Survivability, and Supportability Attributes Balanced With Affordability
- Dominance of Technology in the Battlefield
- CONOPS/Tactics Development/T&E

Integrated warfare requires that survivability address the entire battlespace, taking the following aspects into account:

- Situation Awareness
- Information Warfare
- Correlation/Assessment/Response
- LO/EW/IW Mix
- LO/EW/Suppression of Enemy Air Defenses (SEAD)
- SEAD/Destroy Enemy Air Defenses (DEAD) Campaign

Models and simulations (M&S) are being used to reduce the time, resources, and risks of the acquisition process and to increase the quality of the systems being acquired. The use of M&S requires new representations of proposed systems where virtual prototypes are embedded in realistic, synthetic environments to support the various phases of the acquisition process, from requirements determination and initial concept exploration to manufacturing and testing of new systems and related training. The survivability process takes into account the advances needed to effectively link live, virtual, and constructive simulations.

The activities identified with survivability are some of the specific tasks that must be performed to ensure that the required program management, engineering, test and evaluation, and systems analyses are accomplished. To effectively assess survivability of all aerospace combat weapon systems throughout their life cycle, the survivability process must be structured in a way that allows entry into the process at any point and exit at any subsequent point. The process must be easily tailored to meet the specific requirement. For instance, the development of a new weapon system requires exercising all parts of the process. Other entry and exit points would be needed for a preplanned product improvement; an appraisal; research, development, test and evaluation (RDT&E) of an existing weapon system component; development of tactics; or evaluation of a training exercise or readiness assessment.

All activities performed in systems acquisition, including survivability, are encompassed in four categories:

- Management
- Engineering
- Test and Evaluation

- Systems Analysis

This handbook series correlates the survivability process and its management, engineering, test and evaluation, and systems analyses functions with all elements of acquisition, including, as appropriate, the following processes and procedures:

- Service Science and Technology (S&T) Planning Processes
- Systems Acquisition Process
- Integrated Product and Process Development (IPPD)/Integrated Product Teams (IPT)
- Live Fire Test and Evaluation (LFT&E)
- Systems Engineering Process (SEP)
- Systems Analysis Processes
- Analysis of Alternatives (AoA)
- Modeling and Simulation Test and Evaluation Reform (MASTER)
- Simulation Test and Evaluation Process (STEP)
- Simulation-Based Acquisition (SBA)

Handbook Structure and Users

This handbook series is designed to document survivability and its elements and delineate how survivability relates to the other acquisition activities and how the associated survivability activities are accomplished. The series addresses survivability during pre-acquisition and acquisition from a program management perspective.

A work breakdown structure (WBS), an integral part of systems engineering, is applied to structure each volume where a WBS is pertinent. The series uses the process delineated in MIL-HDBK-881 to structure the technical volumes (primarily vulnerability, susceptibility, lethality, etc.). The Program WBS provides a framework for specifying the objectives of the program and its elements. It defines the program in terms of hierarchically related product-oriented elements. Each element provides logical summary points for assessing technical accomplishments and for measuring cost and schedule performance. In our case, survivability is the program and the survivability process delineates the elements.

This handbook series may be used by management, engineers and analysts including conceptual designers, system developers, vulnerability assessment analysts, susceptibility assessment analysts, survivability assessment analysts, and test and evaluation personnel conducting activities in support of survivability in the acquisition process. At the same time, design trade studies are conducted to evaluate the benefits and penalties associated with candidate system and subsystem elements.

The results of vulnerability, susceptibility, lethality and survivability analyses, and design trade studies are used as input data for system and cost-effectiveness analyses. These evaluations, inherent elements of the survivability process, provide system design managers and survivability engineers with overall system benefits and penalties for the various design concepts. The

survivability process permits selection of the most effective combinations of survivability-enhancement features for the specific system applications and identifies areas of deficiency or overdesign. The process is iterative, and is continued until the most cost-effective design concept is developed during the Concept and Technology Phase. This concept then becomes the baseline design for the system acquisition. The same process is repeated throughout the acquisition cycle.

The user can enter and exit the process at any point depending on the need. For example, when the user performs an AoA, the process for survivability assessment might suffice, whereas a system upgrade requires a different entry and exit point.

Handbook Series Topics

Because of the large amount of existing information and the complexity of the subject matter, a series of documents (volumes) has been produced, thus allowing each volume to address thoroughly a specific stand-alone topic.

The handbook series is structured as follows:

- Volume 1. Handbook Overview
- Volume 2. Survivability and Acquisition
- Volume 3. The Survivability Program Plan
- Volume 4. Survivability Engineering
- Volume 5. Survivability Models and Simulations
- Volume 6. Survivability Test and Evaluation
- Volume 7. Vulnerability Analysis
- Volume 8. Susceptibility Analysis
- Volume 9. Lethality Evaluation
- Volume 10. Survivability Assessment
- Volume 11. Electronic Warfare/Electronic Combat Evaluation
- Volume 12. Threat and Targets

Comments and recommendations for subsequent issues in this handbook series are solicited. Inputs may be submitted to the JTCG/AS Central Office, 1213 Jefferson Davis Highway, Suite 1103, Arlington, VA 22202, phone (703) 607-3509.

2.0 BACKGROUND

Responsibility

This Aerospace Systems Survivability Handbook Series was developed by the JTCG/AS to provide guidance to government and industry survivability managers, engineers and analysts involved in systems acquisition. The contents have been reviewed and approved by the cognizant technical agencies, specifically the JTCG/AS.

The organization of the JTCG/AS is depicted in Figure 1.

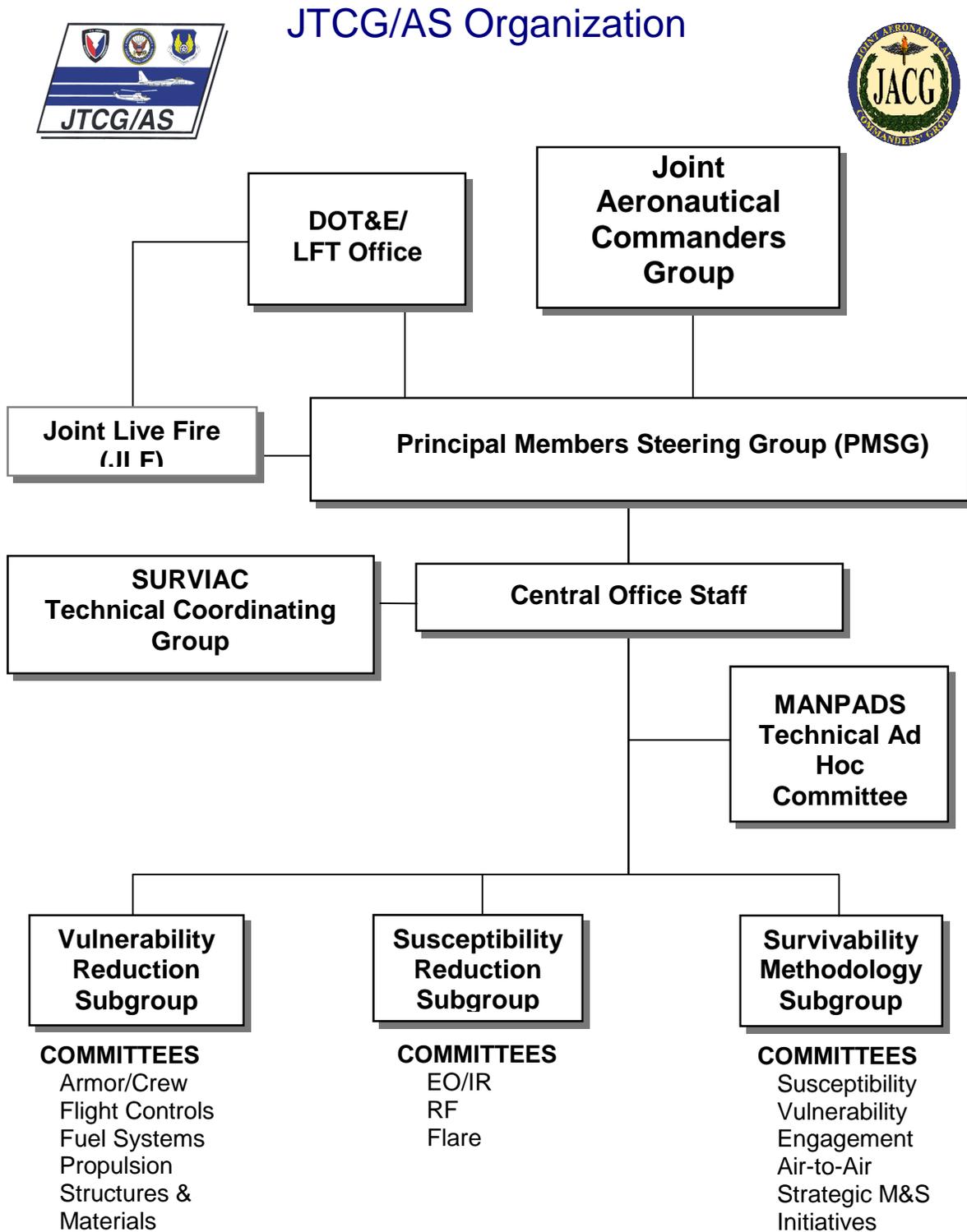


Figure 1. Organization of Joint Technical Coordinating Group on Aircraft Survivability.

Purpose of Series

This handbook series has been prepared to provide military planners and industry with the information and guidance needed for the management, engineering, test and evaluation, and systems analysis of new or redesigned aerospace systems where survivability is a design and warfare requirement. The series also provides data and guidance for the incorporation of survivability enhancement features into existing aircraft systems as retrofit modifications and gives the warfighter the tools necessary to determine the survivability of existing aerospace systems against new or modified threats. The handbooks contain information for fixed-wing, rotary-wing, and space systems.

The aerospace systems survivability functional discipline covers the full acquisition spectrum from requirement definition and concept development through systems acquisition. Survivability activities performed in pre-acquisition include the following:

- Science and technology technological developments to fulfill identified mission needs, deficiencies, or opportunities
- Pre-Milestone-A requirements generation to define the need
- Acquisition support
- Concept design
- Preliminary and detailed design and development
- Production
- Utilization and support

To meet the foregoing responsibilities many diverse management, engineering, test and evaluation, and analysis capabilities and commitments are required. These include the following:

- Project Management
 - IPPD
 - IPT
 - SE
- Engineering
 - Systems
 - Concept
 - Detailed design
 - Development
 - Enhancement
- Test and Evaluation
 - M&S
 - Developmental T&E
 - Operational T&E
 - Live-Fire T&E

- Ranges
- Analysis
 - CONOPS
 - Systems
 - Engineering
 - Concept
 - Trade Studies
 - Threat
 - Vulnerability
 - Susceptibility
 - Lethality
 - System Effectiveness
 - Survivability
 - AoA
 - Data
- M&S
 - Development
 - Enhancement
 - VV&A
 - Application
- Training
 - Ranges
 - Tactics Development
 - Evaluation
 - Proficiency

The diverse activities and functions associated with the survivability discipline range from analyses of the inherent capability of enemy threats to the effectiveness of those threats in particular environments; from the engineering of survivability design features or enhancements to susceptibility of the system; from T&E and analysis of inherent aircraft vulnerability to damage response of materials to threat impact; from development of analytical assessment procedures to analysis of combat data; and from the development of vulnerability/susceptibility-reduction techniques to aircraft trade studies that include and interface with other functional disciplines (maintainability, reliability, etc.). This diversity makes the survivability functional discipline multidimensional and inter-dependent. Close technical working relationships, with interchanges of data and methodology among these activities and functions, require a precise understanding of the processes and terminology used and the full support of program management, systems engineering, and Integrated Product Teams.

All of the military standards listed in the References section have features in common. Though different descriptors may have been used, all cover the following basic elements: Program Objectives, Organization, Plans and Requirements, and Verification Procedures. This handbook

series integrates pertinent parts of the foregoing standards into a single JTCG/AS Survivability Handbook Series correlated with systems acquisition policies and procedures.

3.0 APPROACH

Survivability plays a role in all aspects of the systems acquisition process, with survivability-related items needing to be managed and engineered using the best processes and practices that are known to reduce cost, schedule, and technical risks. Survivability policy requires survivability systems design to be based on systems engineering principles followed in concert with the PM and the associated IPTs.

Another way of looking at the field of survivability relative to systems acquisition management is to examine some individual elements encompassed by each of these terms. DoD policy calls for the systems acquisition process to be directed by a responsible manager under the concept of program management. Milestone B, the beginning of the acquisition process, marks the initial formal interface between the generation of requirements and the acquisition management systems.

From a DoD standpoint, survivability is accomplished as an integral part of acquisition where:

- **Acquisition** includes research, development, test and evaluation (RDT&E), production, procurement, and operations and support.
- **Procurement**, “the act of buying goods and services for the Government,” is often (and mistakenly) considered synonymous with acquisition.
- **Defense acquisition** generally applies only to weapons and management information systems processes, procedures, and end products. However, nonweapon and non-Automated Information System (AIS) items and services required by DoD, such as studies, passenger vehicles, supplies, construction, and waste removal, are also “acquired” and thus considered part of the acquisition process.
- **Management** includes a set of tasks required to accomplish a specified project.

This handbook series, produced by the JTCG/AS, is based on a thorough understanding of:

- **What** the survivability requirements are and how acquisition reform and changes in the DoD structure affects them.
- **Where** each survivability requirement fits in the acquisition structure.
- **When** survivability requirements are applied in support of the acquisition cycle, the PM’s integral system engineering process, and Integrated Product and Process Development (IPPD)/Integrated Product Teams (IPT) structure.
- **How** management, engineering, analysis, test and evaluation, and associated models and simulation resources are used to fulfill the survivability requirements.

Some of the primary topics the series considers are discussed in the following subsections.

Acquisition Process

For the acquisition process, DoD establishes requirements, prepares plans, and develops policy and guidance providing direction to the individual services, associated agencies (centers and laboratories), and contractors in the performance of defense-related activities required to meet the acquisition strategy. Contractors involved in the acquisition process include the prime contractor, his or her subcontractors, and those involved in independent validation and verification (V&V) and assessments. Prior to Milestone A, DoD, in concert with the military departments and defense agencies, orchestrates the S&T program to develop options for future decisive military capabilities based on superior technology. Survivability must be capable and responsive to acquisition needs throughout the acquisition life cycle.

Test and Evaluation

In defense acquisition, survivability is a major subject of T&E (including Congressionally mandated LFT&E) and of systems analysis as a primary element of AoA. T&E programs must be structured to integrate all developmental T&E, operational T&E, live-fire T&E, and M&S activities conducted by the agencies involved. All such activities are a part of a strategy to do the following:

- Provide information on risk and risk mitigation.
- Provide empirical data for validation of models and simulations.
- Permit an assessment of the attainment of technical performance specifications and system maturity.
- Determine whether systems are operationally effective, suitable, and *survivable* for the intended use.

The LFT&E strategy for a covered system, major munitions program, or missile program, as well as for a covered product improvement program, includes full-up, system-level tests, that is to say tests that fully satisfy the statutory requirement for “*realistic survivability testing*” or “*realistic lethality testing*” as defined in Section 2366, Title 10, USC.

Analysis of Alternatives

The AoA prepared for Milestone A and/or Milestone B provides a major portion of the documentation required for program initiation. Survivability is a major topic of that analysis. The AoA, along with other documentation, supports a decision on whether to continue with and fund the planning activities associated with the prospective investment.

S&T Planning

In 1993 the Director of Defense Research and Engineering initiated a corporate S&T planning process designed to more effectively link the products of the Defense S&T Program with the needs of the warfighter. The foundation of this process is the *Defense Science and Technology*

Strategy supported by the Joint Warfighting Science and Technology Plan, the Defense Technology Area Plan, and the second edition of the Basic Research Plan, which present the DoD S&T. These documents are revised annually and are collaborative products of the Office of the Secretary of Defense, the Joint Staff, the military services, and the defense agencies.

Modeling and Simulation

Modeling and simulation (M&S) are used as tools in all DoD technology areas to support conceptual analysis, technology development, acquisition, testing, fielding, sustainment, operational effectiveness, training, and planned product improvement. Therefore, M&S are demonstrated in concert with most current DoD technology developments.

M&S can substantially contribute to improving the pillars of military capability — readiness, modernization, force structure, and sustainability. M&S enable cost-effective joint and combined training, mission planning, and mission rehearsals involving active and reserve forces, multiple echelons, and computer-generated simulations of large-scale forces (friendly, neutral, and hostile) on a synthetic battlefield. The distributed, interactive, synthetic environments created with M&S can bridge large geographic regions and involve entire joint forces from senior commanders to individual warriors. The use of M&S reduces time, resource requirements, and risks associated with the acquisition process. Representations of proposed systems (virtual prototypes) are used to support acquisition activities, significantly reducing the time and expense of concept exploration, engineering, manufacturing, and follow-on support activities (e.g., training, maintenance). Decision-makers can effectively and quickly simulate and then evaluate the consequences of alternative force structures with known or projected capabilities placed in various mission scenarios. High-fidelity models of logistics, personnel management, medical support, etc., can be integrated with combat models to allow a comprehensive analysis of sustainability.

M&S core technologies must provide a cost-effective and timely capability to authoritatively represent systems, processes, and operational environments. M&S must provide readily available and operationally valid environments for DoD components to train jointly; develop doctrine and tactics; formulate operational plans; assess warfighting situations; support technology assessments, system upgrades, and system developments; and conduct force structure analyses and assessments. Research is needed to allow M&S to be broadly and authoritatively applied across all of DoD. Supporting technologies are being developed in other sub-areas of the Information Systems Technology (IST) area, as well as in other DoD technology areas (e.g., Human Systems; Sensors, Electronics, and Battlespace Environments; and Materials/Processes) and in the commercial sector. Major M&S efforts are in the areas of (1) simulation interconnection, (2) simulation information technologies, (3) simulation representation, and (4) simulation interfaces. The efforts of interest concentrate on technologies that bring about M&S that are distributed, seamless, interactive, and adaptable.

4.0 SCOPE

Systems and Elements Covered

This multi-volume survivability handbook series addresses management, test and evaluation engineering and analysis of survivability of military aerospace systems. The aerospace area covers five of the seven major systems listed below: aircraft, electronic/automated software, missile, and ordnance and space systems. The following terms apply to the following activities and systems:

- ***Aircraft system*** — a fixed- or movable-wing, rotary-wing, or compound-wing manned/unmanned air vehicle designed for powered or unpowered (glider) guided flight
- ***Electronic/automated software system*** —electronic, automated, or software system capability
- ***Missile system*** —a weapon producing a destructive effect on selected targets in an operational environment
- ***Ordnance system*** — any munition (nuclear, biological, chemical, psychological, or pyrotechnic) and the means of launching or firing it
- ***Ship system*** —a naval weapon or the performance of another naval task at sea
- ***Space system*** —a mission payload developed, delivered, and maintained in a specific orbital placement; the operation and recovery of a manned or unmanned space system
- ***Surface vehicle system*** — a system that navigates over the surface

The list below identifies the elements that all seven major systems have in common. Those elements are:

- Integration, Assembly, Test, and Checkout Efforts
- Systems Engineering and Program Management
- Training
- Data
- System Test and Evaluation
- Support Equipment Peculiar to the System
- Common Support Equipment
- Operational and Site Activation
- Industrial Facilities
- Initial Spares and Repair Parts

In addition to these common elements, each defense system has a unique complex of equipment (hardware and software) that defines the capability or end product of that system.

Need To Address Space Systems

Initially, the handbook series concentrates on conventional threats, but it will also contribute to the development of additional volumes covering all major systems and threats. The JTCG/AS requirement to integrate space systems survivability is based on the realization that space systems are of joint interest. They are essential assets for the warfighter, but have not been designed and developed with survivability as a major requirement.

The space systems community contributed to the Defense Acquisition Deskbook by preparing the Critical Process Assessment Tool (CPAT) for Survivability, listed under discretionary references in Deskbook Subtopic 2.6.6.