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INTRODUCTORY MATERIALS

SURVIAC -A Capabilities Overview

Sponsor: JTTCG/AS and JTTCG/ME

Developer: SURVIAC, 1988

Cost: No Charge - 30 Day Loan

This 12-minute video on SURVIAC's capabilities focuses on the resources, services, and products provided by the Center and illustrates how SURVIAC's analysts work with the survivability and lethality community to meet critical needs. The video describes SURVIAC's libraries, databases, and models and illustrates how to take advantage of these resources. Viewing SURVIAC -A Capabilities Overview is an excellent way to promote awareness of the importance of survivability and lethality programs. Available in one-half inch and three-quarter inch VHS media.

SURVIAC Model Guide

Sponsor: JTTCG/AS and JTTCG/ME

Developer: SURVIAC, 1995

Cost: No Charge

The SURVIAC Model Guide describes the capabilities, assumptions, and limitations of selected survivability and lethality models. SURVIAC, a single source for these models and their methodologies, supports the model user community by distributing models and documentation, answering questions, alerting users to limitations or inconsistencies, hosting workshops, and providing a link to the Government technical focal point for each model.

The current model inventory includes models addressing engagement functions such as exposure, detection, track, launch and guidance, damage assessment, and failure analysis. The models can be applied to analyses involving:

- Aircraft Flight Path Generation
- Air-to-Air and Surface-to-Air Missiles
- Guns
- Advanced Threat Encounters
- Warhead-Target Fragment Interactions
- Penetration Mechanics
- Failure Mode Analysis

This guide assesses the general character of a model's required input data and resulting output data to help engineers and analysts decide if the model can solve a particular problem. The guide also describes the procedure for review and entry of candidate models into SURVIAC and discusses the procedures for acquiring these models.

SURVIVABILITY DESIGN

RADGUNS 1.8 Parametric Study

SURVIAC TR-94-017

Sponsor: Wright Laboratory

Developer: SURVIAC, August 1994

Cost: \$100, Free to Government

This report documents an extensive parametric study performed by Booz · Allen & Hamilton personnel with RADGUNS 1.8, and provides a companion set of information to the RADGUNS 1.9 Antiaircraft Artillery (AAA) Simulation.

The study evaluated the impact on RADGUNS 1.8 results of varying input data over wide ranges. A "representative" tactical aircraft was developed as the baseline to use for the study. This aircraft had an average presented area of 387.6 square feet with a 10 square meter "fuzzball" RCS. Conditions used for the baseline evaluation were a straight and level flight path at 304.8 meters (1000 feet) AGL with a speed of 500 knots and a multipath/clutter background of Hummocky/Rangeland terrain. Four typical AAA systems were selected for use in this parametric study with sizes and capabilities ranging from a small mobile system to a large fixed system. The projectile lethalties, rates of fire, detection and track capabilities, and effective ranges spanned those of the 25 AAA systems available in RADGUNS 1.8.

The impact of variations in many of the aircraft and gun system parameters over representative ranges on engagement probabilities of acquisition, hit, and survival was evaluated. Parameters evaluated included aircraft vulnerability representations, speed, altitude, flight path types, and radar cross section size and shape. Gun system parameters evaluated included firing rate, aircraft flight path offset, clutter/multipath, target track types, and electronic countermeasures. Table 1 summarizes the parameters evaluated, their location in the report and the range of variations evaluated.

The report shows the impacts of variations in most of the commonly used RADGUNS inputs on the probabilities of hit and kill. It is intended to be used as a companion to the RADGUNS manuals by analysts in defining needed runs and scoping new studies. It also contains suggested "workarounds" for inclusion of features such as velocity dependent or distributed vulnerable areas if they are needed for the study until they are incorporated into future RADGUNS versions. The modifications made to various gun systems in RADGUNS 1.9 do not affect the results presented in this report. Figure 1 shows a typical set of parametrics for the impact of aircraft velocity on probabilities of hit (Ph) and kill (Pk) averaged over offsets from the gun.

Countermeasures Handbook for Aircraft Survivability

JTCG/AS 93-SR-001

Sponsor: JTCG/AS

Developer: JTCG/AS, Susceptibility Reduction Subgroup, August 1993

Cost: \$200/3 Volumes, Free to Government

This handbook is a complete revision to the 1977 version and presents an historical, present, and projected perspective of Electronic Warfare as of 1991. The Countermeasures Handbook for Aircraft Survivability was sponsored and prepared by the Joint Technical Coordinating Group on Aircraft Survivability (JTCG/AS).

The purpose of this three-volume handbook is to provide a comprehensive, timely, and accurate publication on those aspects of EW that related to aircraft survivability. For purposes of this handbook,

EW includes radar and electro-optical warning, countermeasures equipment and techniques, expendable decoys such as chaff, flares, and electro-optical decoys, and electronic jammers and aircraft observable signature control techniques. The technical information is largely confined to EW, however there are some areas (i.e., medicine, space) that are included for completeness.

Survivability Systems Master Plan

Sponsor: U.S. Army, Armored Systems Modernization

Developer: Project Manager Survivability Systems (PM-SS), May 1993

Cost: \$50, Free to Government

This Survivability Systems Master Plan is the Army's strategic plan for selection, demonstration, and incorporation of survivability technology into current and future ground combat vehicles. In addition to describing the individual survivability technology programs, the SSMP provides an overview of the modernization and acquisition strategies at DOD, DA, PEO, ASM, and AMC in which the survivability technology programs are executed. The Master Plan is intended to provide a road map for logical and orderly incorporation of emerging survivability technologies and newly developed survivability systems into Army ground combat vehicles. This first publication of the SSMP will be restricted to discussion of the Army's Armored Systems Modernization (ASM) program.

The SSMP is intended for use by combat vehicle program

Testing of Aircraft Surrogates with On-Board Munitions

Sponsor: Office of the Under Secretary of Defense DDRE(T&E)/LFT

Developer: SURVICE Engineering Co., August 1991

Cost: \$100.00

This study addresses the need for live fire ballistic testing of aircraft with munitions on-board. The objectives of this study were to assess the potential benefits of live fire tests of aircraft or aircraft surrogates with live weapons on-board and to develop suggested notional testing schemes. Principal measures of effectiveness (MOE) for assessing aircraft vulnerability were identified. Available data on munitions contribution to aircraft vulnerability, including vulnerability/lethality testing, Southeast Asia combat data, and munitions sensitivity tests were examined to determine the quantity of the data and identify gaps or inconsistencies. Vulnerability assessments were then made on three notional aircraft: an air-to-air fighter, air-to-ground aircraft, and a rotary-wing aircraft. The changes in MOEs when munitions are added were quantified, as well as MOE sensitivity to munitions location, type of threat, and variations in postulated munitions probabilities of kill given a hit. Finally, suggestions were made on the conduct of live fire tests for aircraft with on-board munitions.

Penetration Characteristics of Advanced Engine Materials

JTCG/AS 91-VR-001

SURVIAC TR-89-001

Sponsor: JTCG/AS and U.S. Army BRL

Developer: SURVIAC, August 1990

Cost: \$100

This report presents the final results of a JTCG/AS program to evaluate the ballistic impact response of materials being used in past, present, and future military aircraft turbine engines, with emphasis on their vulnerability to small caliber (7.62 or Cal. 0.30 and 12.7-mm or Cal. 0.50) armor piercing projectiles.

The initial program efforts involved reviewing engine component vulnerability, engine material requirements and trends, and existing engine test data. A detailed ballistic test program was then planned and conducted by the U.S. Army Ballistic Research Laboratory, Aberdeen Proving Ground, Maryland in March 1989. This testing consisted of Cal. 0.50 impacts against metal and composite materials being used or considered for use in fan and intake assemblies, compressor and turbine disks, and combustor casing applications. Although ballistic test data are available for many older engines, they provide limited information for evaluating the damage characteristics of materials used in newer engine systems. An important objective of the program was to address this shortfall by developing ballistic data for later technology engine materials and design applications. The application of evolving engine material technology, design technology, and performance requirements has resulted in use of lighter materials with higher strength and higher temperature tolerance.

This product provides the designer with information to properly address vulnerability considerations in the design of future aircraft engines, and supplies the vulnerability analyst data with which to better evaluate engines containing high strength metal alloys and advanced composites.

Aircraft Fuel System Fire and Explosion Suppression Guide

JTCG/AS 89-T-005

USAAVSCOM TR-89-D-19

Sponsor: JTCG/AS

Developer: SURVICE Engineering Co., February 1990

Cost: \$150/3 volumes

Historically, fuel system damage --particularly that caused by fire--has been the main cause of aircraft combat losses. The materials and techniques of aircraft design have evolved and the survivability design discipline has improved, but fire remains the principal killer of aircraft. This practical, up-to-date reference condenses all identified documented vulnerability reduction technology pertinent to the design of modern aircraft fuel systems. Sponsored by the Fuel Committee of the JTCG/AS, this study addresses fuel system survivability in its broadest context, i.e., all damage effects by all pertinent threats to all fuel systems, components, and fuels for all types of military aircraft. The study includes vulnerability reduction by any and all passive and active means (e.g., inherent design, material selection, component location, self-sealing, leakage control, ignition suppression, fire extinguishing, insulation, fire walls, and other barriers) ranging from lighter than air inert gases to lightweight armor. A methodology to compare effectiveness and/or penalties among types of protection and among various combinations of protection(s) or alternative design options is also presented. This three-volume design guide identifies over 1,500 relevant reference documents which are listed in a bibliography in the appendix.

Compendium of References for Nonnuclear Survivability

SURVIAC TR-89-016

Sponsor: JTCG/AS and JTCG/ME

Developer: SURVIAC, April 1989

Cost: \$150

New and comprehensive, this compendium was prepared and organized as a resource for aerospace and defense organizations designers, analysts, and test personnel. It allows the user to quickly locate the most pertinent design, analysis, and test information for a particular system or subsystem. The compendium's scope includes nonnuclear survivability excluding directed energy weapons (to be covered in a future document).

Developed as a supplement to MIL-HDBK-336, this single-bound volume contains 490 references, a useful cross-reference section, abstracts, utility indicators, and an updated listing of applicable military specifications and standards. The 490 references were analyzed and selected from an initial search list of over 3,700 titles presenting information from 1975 to the present time. The major sources of reference material were: SURVIAC; DTIC; the Naval Weapons Center, China Lake; the Scientific and Technical Information Center of NASA; The SURVICE Engineering Company's libraries; DOD Military Standards; and Military Specifications listings. The documents chosen were reviewed for applicability and currency in the survivability subject area. Appendix A provides reference abstracts and additional detailed information on each reference. Appendix B lists military standards and specifications applicable to the subject area and Appendix C lists reference titles by technical subject areas.

Army Survivability Information Resource Database**Sponsor:** U.S. Army Survivability Management Office**Developer:** SURVIAC, February 1989**Cost:** \$200

Survivability is the ability to avoid or withstand the effects of enemy action and continue mission requirements. To achieve the highest survivability, combat systems must be:

- Difficult to Detect and Acquire --*Detectability*
- Difficult to Hit if Acquired --*Hitability*
- Difficult to Damage if Hit --*Vulnerability*
- Easily and Rapidly Repaired if Damaged --*Repairability*

The value of survivability is its contribution to improved force effectiveness. This is critical in the face of limited defense budgets, increasing equipment/system costs and complexity, and growing enemy threat capabilities. The increasing attention given to survivability for developmental and existing Army systems has resulted in the need for a centralized survivability information system able to more efficiently address survivability issues.

This document and its databases identify personnel, principal analytical programs, and major sources of experimental data for U.S. Army resources. The sections of this report, designed to stand alone, each include an interactive database designed for easy use. Army survivability resources are described as follows:

- U.S. Army Survivability Expertise Directory and Database --is a compilation of key Army organizations and personnel with their survivability-related expertise, addresses, and telephone numbers.
- U.S. Army Survivability Models Directory and Database --is a compilation of models and combat simulations on which the Army relies for survivability analyses. The database includes model descriptions, computer capacity and language requirements, required computer support, model residence, and points of contact.
- U.S. Army Survivability Data Source Directory and Database --is a compilation of Army survivability data sources. Such data are necessary for survivability modeling, simulations, and analyses. The database includes brief descriptions and formats of the data, survivability aspects the data sources address, and points of contact for obtaining the data.

Designing for Survivability**Sponsor:** Boeing Advanced Systems**Developer:** Boeing Advanced Systems, 1989**Cost:** 30-Day Loan

Available on videotape, this resource was produced to introduce aircraft designers to vulnerability reduction techniques and to promote the awareness of potential design solutions for reduced vulnerability. This tutorial will help start personnel on the road to reducing aircraft vulnerability. The videotape is made available by permission of the developer, Survivability/Vulnerability Group, Boeing Advanced Systems (MS 33-04, P.O. Box 3707, Seattle, WA 98124-2207), as a service to the survivability community. The 18-minute videotape, available in one-half inch VHS, can also be acquired by contacting Mr. Childress or Mr. Bristow at Boeing (206) 241-4953.

Advanced Material for Enhanced Survivability**SOAR-88-01****Sponsor:** JTCG/AS and JTCG/ME**Developer:** SURVIAC, June 1988**Cost:** \$100

This State-of-the-Art Report (SOAR), a top-level summary of advanced materials technology, identifies several advanced materials critical to enhancing survivability in present and future combat systems. The materials identified include thermoplastics, intermetallic aluminides, titanium alloys, aluminum lithium alloys, broadband absorbing coatings, and metal matrix composites. Intended to increase awareness of and sensitivity to material trade-offs and considerations, this document was developed to reach materials researchers and system designers integrating advanced materials into present and emerging programs, new materials researchers, research and development planners, and program managers requiring an overview of recent materials advances.

Chapter One includes background and introduction. Chapter Two discusses signature reduction and, while system specific materials are not identified because of security restrictions, candidate materials to perform signature reduction in radar, visible, and infrared wavelengths are discussed. Chapter Three describes materials used for performance enhancement via lighter weight and higher temperature operation. Methods of hardening against laser and ballistic effects are discussed in Chapter Four and Chapter Five presents the document summary.

Aircraft Survivability**Sponsor:** JTCG/AS**Developer:** SURVIAC, 1987**Cost:** \$50 or 30-Day Loan

This commercial broadcast quality videotape provides a high impact overview of aircraft survivability. The theme is force multiplication through survivability. The videotape emphasizes the realities of the hostile environment in which military aircraft must operate, the catastrophic results of inadequate survivability measures, and the high payoffs achievable by incorporating survivability measures. Because of this theme's complex nature, the importance of survivability is vividly illustrated. Detailed technical information is not presented. Although this videotape is suitable for a variety of research and development audiences, it was designed principally for middle to high level DOD, other Government, and civilian personnel. Available in one-half inch or three-quarter inch VHS media.

VULNERABILITY STUDIES

A Summary of Aerospace Vehicle Computerized Geometric Descriptions for Vulnerability Analyses

ASD-TR-91-5032

Sponsor: Advanced Systems Analysis Directorate, (ASD/XRM)

Developer: DCS Development Planning (ASD/XRM) SURVIAC, May 1992

Cost: \$100, Free To Government

This report presents the results of an update to a 1987 survey and summary of computerized geometric models of aeronautical systems being developed using the tri-service documented MAGIC, SHOTGEN, FASTGEN 3, GIFT, or SCAN computer programs. In addition, this edition also contains listings of aircraft analyzed using the HTCG/ME developed QRV computer program. A brief summary of each geometric model is presented and a DOD contract point for more information is identified. Models that have been placed in the Survivability/Vulnerability Information Analysis Center (SURVIAC) for distribution are also identified

Component Vulnerability Pd/h Workshop-Component Pd/h Handbook

JTCG/AS 92-SN-032

SD TR-91-5030

Sponsor: JTCG/AS, NAVAIR

Developer: ASD/XRM, Frontier Technology, October 1991

Cost: \$100, Free to Government

This report contains component vulnerability estimates developed by DOD and contractor experts during the 1991 Pd/h Workshop sponsored by the Joint Technical Coordinating Group on Aircraft Survivability (JTCG/AS) and hosted at Wright-Patterson Air Force Base, Ohio. The report contains sections on ammunition, flares, and stores; engines and accessories; helicopter-unique components; flight controls and hydraulics; fuel systems; structures, landing gear and armor; crew station; and avionics and electrical components. The data are presented in a form intended for use in developing inputs for vulnerability analyses to projectiles and missile warheads.

Collection of Vulnerability Test Results for Typical Aircraft Systems and Components

SURVIAC TR-90-20

Sponsor: U.S. Army Ballistic Research Laboratory

Developer: SURVIAC, April 1990

Cost: \$150

This document consolidates and presents over 1,100 vulnerability tests which were conducted and reported during the Utility Tactical Transport Aircraft System (UTTAS) and Advanced Attack Helicopter (AAH) development programs. This volume presents a summary distribution of all tests by developer, threat, functional system, and component. It also presents a total of 227 tables of individual test summary data in Appendices A through H for eight selected functional systems and their components. They are: flight control systems, rotor systems, drive train systems, fuel systems, crew systems, structure, and materials.

Vulnerability Reduction Design Guide For Ground Systems in a Conventional Combat Environment

Sponsor: U.S. LABCOM, Survivability Management Office

Developer: SURVIAC, October 1989

Cost: \$200

This Design Guide addresses the fundamentals for achieving "high survivability" characteristics for ground combat systems in a conventional environment. A conventional combat environment, as it applies to this guide, refers to those threats which include fragmenting munitions, armor piercing projectiles, shaped charge warheads, etc. The emphasis of this guide is on vulnerability reduction with a brief overview of repairability enhancement. The content of this guide is specifically oriented for use by Project Managers and other technical and non-technical personnel who may require a general knowledge of survivability issues. However, this guide can also be a valuable resource and reference document for those responsible for detailed survivability design and analysis

Comparative Close Air Support Vulnerability Assessment Study

SURVIAC TR-89-012

Sponsor: JTCG/AS

Developer: SURVIAC, 1989

Cost: No Charge - Government Only

Close Air Support (CAS) aircraft provide vital support to ground combat forces at or near the forward line of troops. These aircraft operate in an intensive hostile environment that consists of small arms/automatic weapons, anti-aircraft artillery, and mobile tactical surface-to-air missile threats. Because of the high density threat environment, the CAS aircraft historically have been a very robust aircraft, known to sustain extensive damage without loss. This CAS study was conducted to establish a baseline for CAS aircraft vulnerability comparisons and a database of vulnerability information relative to small arms and automatic weapons as well as shoulder-fired missiles likely to be encountered during the CAS mission.

Threat Effects in Aircraft Combat Survivability

Sponsor: JTCG/AS

Developer: SURVIAC/CID Productions, January 1987

Cost: \$150 or 60-Day Loan

This videotape vividly illustrates the cause/effect relationships between damage mechanisms in both fixed- and rotary-wing aircraft. A combination of vulnerability test footage and documentary films of actual combat environments, this film visually demonstrates how aircraft structures, components, and systems react to projectile, laser, and warhead fragmentation impact and penetration. Film clips taken from tests conducted at the Naval Weapons Center, Ballistic Research Laboratory, Applied Technology Laboratory, Air Force Wright Research and Development Center, and in industry are intercut with combat documentary films showing operating aircraft either under direct attack or after sustaining damage from conventional threats. Graphics are used to illustrate the many test layouts.

Damage processes (e.g., hydraulic ram, ignition, and fire) and kill modes (e.g., fuel ingestion) are explained in the narration as the vulnerability tests are shown. Sequences on the generation of damage mechanisms from the various threats and a section on laser weapons and their possible effects on aircraft are also included. The videotape concludes with a brief description of "before and after" tests on the use of foam for survivability enhancement. The direct cause/effect relationships seen in the footage make this aspect of survivability study comprehensible and valuable to anyone concerned with aircraft analysis, design, or use. The videotape, designed to educate both DOD and industry personnel interested

in increasing their knowledge of aircraft survivability, is available in one-half and three-quarter inch VHS and 16mm media.

Joint Live Fire/Live Fire Testing**Sponsor:** JTCG/AS and JTCG/ME**Developer:** SURVIAC, January 1995**Cost:** \$95

Available in hardcopy and electronic media, the catalogue provides information on the Joint Live Fire/Live Fire (JLF/LF) test programs including completed, on-going, and future tests. The database contains information describing each test program identified, including general test information, test documentation, target and threat information, and test results. Historical and planned armor/anti-armor and aircraft JLF tests and Navy LF tests are included. Version 3.1 of the catalogue includes over 90 individual tests. The electronic media provides an automated system that accommodates searches for key words or specific terms in descriptor fields such as system, subsystem, threat type, or conditions. This capability provides the user with a tool to efficiently identify a test(s) of specific interest before conducting an extensive review of all test information.

AIRCRAFT BATTLE DAMAGE REPAIR (ABDR)

PURPOSE: ABDR is a program developed by the United States Air Force (USAF) to initiate and standardize effective rapid repairs and return the battle damaged aircraft to fully or partial mission capable (FMC/PMC) status in the shortest possible time with the resources currently available.

HISTORY: ABDR, or utilizing the available resources to conduct rapid repairs was an informal practice since World War II. Allied air forces were outnumbered against the Axis powers. Each operational aircraft was a valuable asset. Every effort was made to return the damage aircraft to some sort of operational status as rapidly as possible. The long logistics pipeline for obtaining parts and supplies oftentimes meant the maintenance personnel had to utilize unorthodox methods to repair their aircrafts. These informal practices were handed down through each succeeding conflicts, i.e., the Korean War and the Southeast Asia operation. Battle damage analyses of these conflicts (and of the Israeli mature ABDR program in their battles) convinced the USAF to create a central office to standardize the rapid repair concept for all combat aircraft. In 1981, the USAF established the ABDR Program Management Office (PMO) to convert the ABDR objectives into formal procedures. The Gulf War in 1990 was the first time the ABDR concept was tested and vindicated by the US.

Doctrine: The USAF ABDR PMO is tasked to initiate and standardize repaired repair for all combat aircraft. Instructional courses were developed to train maintenance personnel to assess and repair battle damage. The organizations charged with this task are the Air Force Material Command (AFMC) Combat Logistics Support Squadrons (CLSS). The ABDR PMO published Technical Order (TO) 1-1H-39 as the official ABDR guide to general aircraft repair. Specific weapon systems TOs were developed and published under the -39 series.

**Aircraft Battle Damage Repair, A Survey of Actual Combat Experience, Volume I
AFWAL-TR-86-3064****Sponsor:** WRDC/FIVST**Developer:** SURVIAC, August 1986**Cost:** No Charge

The combat damage for which Aircraft Battle Damage Repair (ABDR) techniques will be used is difficult to predict. While advanced techniques to inflict realistic damage to static aircraft provide maintenance personnel with an opportunity to practice ABDR techniques, the value of actual combat damage information should not be overlooked. This study concentrates on Vietnam incidents for which relevant ABDR data exist. Estimated or actual manhours required for the repair were documented. From these combat damage incidents, the maximum available information was extracted, analyzed, and presented.

Volume I describes the results of a comprehensive review and analysis of selected individual combat damage incidents. It provides a pictorial representation of actual combat damage and battle damage repair and a description of the hours, skills, and parts required for repair.

**Aircraft Battle Damage Repair, A Summary of ABDR Activity in Southeast Asia, Volume II
AFWAL-TR-86-3064****Sponsor:** WRDC/FIVST**Developer:** SURVIAC, June 1989**Cost:** No Charge

The combat damage for which Aircraft Battle Damage Repair (ABDR) techniques will be used is difficult to predict. While advanced techniques to inflict realistic damage to static aircraft provide maintenance personnel with an opportunity to practice ABDR techniques, the value of actual combat damage information should not be overlooked. This study concentrates on Vietnam incidents for which relevant ABDR data exist. Estimated or actual manhours required for the repair were documented. From these combat damage incidents, the maximum available information was extracted, analyzed, and presented.

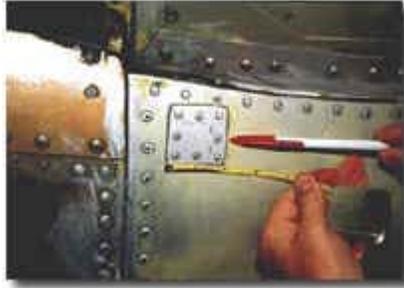
Volume II describes the results of a comprehensive review and analysis of selected individual combat damage incident folders from the SURVIAC collection. This volume summarizes all pertinent damage and repair data and cites several combat damage incidents as examples. The review and analysis described in this volume concentrated on incidents where data existed that are particularly relevant to ABDR. The principal criterion selected was that either estimated or actual man-hours required for the repair were documented. From these combat damage incidents, the maximum available information was extracted, analyzed, and presented in formats useful to ABDR program participants ranging from program managers to repair technicians.

Battle Damage Repair of Composite Structures**Sponsor:** WRDC/FIBCA**Developer:** McDonnell Douglas Corporation, August 1987**Cost:** \$75

This videotape illustrates repair designs and procedures developed and validated for the repair of battle damaged composite structures. Available Aircraft Battle Damage Repair (ABDR) materials, equipment, and skills were employed. The videotape highlights damaged test specimens (representative of wing skins and empennage) that were successfully repaired by Air Force battle damage repair maintenance/training specialists. The repaired specimens were tested to verify restored strength goals for unrestricted flight. The repairs proved that the repair technology is transferable to users. The one-half

inch and three-quarter inch VHS videotapes are also available to Government organizations through the Defense Audiovisual Agency.

Threat Warheads and Effects/Battle Damage Assessment and Repair (TWE/BDAR) Archival and Retrieval System (A&R) System



Sponsor: OSD/OT&E/LFT&E
Developer: SURVIAC, January 2001
Cost: No Charge - Government

The TWE/BDAR A&R System is populated with Joint Live Fire (JLF), Live Fire Test and Evaluation (LFT&E), combat, Battle Damage Assessment and Repair (BDAR) and Threat Warheads and Effects (TWE) incidents on air and ground systems. Users can access the system for specific damage and repair incidents to support their training development needs. The system features an Image Library in which all the images captured in the system can be quickly reviewed.

Classification: For Official Use Only (FOUO)

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DIRECTED ENERGY WEAPON TECHNOLOGY

Proceedings of the Eighth DOD Conference on DEW Vulnerability, Survivability, and Effects

Sponsor: ODDR&E

Developer: SURVIAC, October 1992

Cost: \$125 (2 volumes)

This conference, held in June 1992, provided a forum for discussion, interchange, and debate of accomplishments, discoveries, and issues in the areas of vulnerability, survivability, and effects of Directed Energy Weapons (DEW) such as lasers, standards, laser illumination tests, hazards and medical implications, capabilities, requirements, and myths. The conference was particularly significant because of the progress made in laser technologies and in the critical military use of new materials and substances affected by these new technologies.

Volume I of the proceedings details the general session and numerous presentations given on structures (tactical and space), eye and personnel protection, space platforms, and sensors. Volume II presents poster papers from the conference.

Proceedings of the fifth through seventh DEW conferences are also available.

An Overview of Laser Technology and Applications

SURVIAC SR-90-006

Sponsor: JTCG/AS, JTCG/ME

Developer: SURVIAC, October 1989

Cost: \$50

This comprehensive report compiles and summarizes the underlying principles of laser operation and explains some of the common applications of lasers in industry, communications, medicine, and the military. This excellent tutorial for understanding the physics of laser operations and the varied uses of this technology draws upon an extensive set of source material and presents the information in a useful format. The scope includes the physics of lasing and modification of laser output. The variety of laser mediums and their respective advantages and disadvantages are reviewed and various applications for lasers based on performance, cost, efficiency, and convenience are addressed.

Overview of Laser-Induced Eye Effects

Sponsor: JCG-CE and JP-BL

Developer: SURVIAC, October 1986

Cost: \$150

Throughout the Services, personnel protection warrants the highest priority. Protection against laser illumination has received attention because intelligence estimates of laser performance and actual incidents suggest lasers have the ability to significantly degrade combat performance under certain battlefield conditions. This State-of-the-Art Report (SOAR) compiles work performed by the Services on laser-induced eye effects and provides a basis for understanding the combat implications of battlefield lasers on the eye. This stand alone reference is a valuable tool for systems analysts who model laser effects, new laser effects researchers, research and development planners, and program managers who require an overview of laser-induced eye effects. The report discusses eye-laser interaction definitions including structure of the eye, optical wavelength bands, and laser-induced eye effects definitions. Permanent retinal damage effects are described including laser-induced retinal damage dependencies and higher order retinal damage effects. Permanent non-retinal damage is outlined for ultraviolet laser

effects and mid- and far-infrared laser effects, laser-induced transient effects are defined, intrabeam and non-intrabeam effects are described, and battlefield implications for future directions are discussed.

A Critical Review of Graphite Epoxy Laser Damage Studies

Sponsor: JTCG/AS and JTCG/ME

Developer: SURVIAC, November 1985

Cost: \$50

Fiber-reinforced epoxy composites have been used in military applications due to their high strength-to-weight ratio at low temperatures. For example, the structural surface area of the F-16A is partly composed of graphite epoxy composites, while the F-18 aircraft surface area is partly composed of carbon fiber composites. Much interest exists in projected enemy tactical laser threats and the ability of our epoxy-constructed aircraft to meet these threats. Two main issues are involved with these laser threats -- susceptibility of existing aircraft and methods of providing hardening through retrofit and design of future aircraft.

This document provides a critical review of the state-of-the-art in laser-induced damage to graphite epoxy composite structures. The susceptibility of these structures to laser illumination is described along with the vulnerability implications of tactical aircraft where applicable. The study reviews residual strength and fatigue results which identify the possible need for retrofitting, however, a number of gaps in the literature prohibit resolution of these issues. A conservative mean, determined for all graphite epoxy composites under non-loaded, compression-loaded, and tension-loaded conditions, represents the critical data review and interviews with key members of the community. The resulting mean is a conservative value of radiance under which most composite structures would fail. An appendix includes reviews of pertinent articles and reference to personnel interviewed.

ADDITIONAL REFERENCES

Survivability Analysis Workshop Notebook 1995

Sponsor: SURVIAC

Developer: SURVIAC, April 1995

Cost: \$100

This notebook is comprised of presentations given at the Survivability Analysis Workshop, held in April 1995. Government agencies and their contractors are required to conduct survivability analyses. Often, the analysts who perform these analyses have taken survey courses on what should be done, but have little or no in-depth training on how to use the available methodologies, models, and data sources, and other tools to conduct the full up survivability analysis. This "how-to" workshop and training course described all aspects of conducting a survivability analysis including susceptibility and vulnerability and how they contribute to mission effectiveness determination.

Alternatives for Halon 1301 in Army Ground Vehicle Firefighting Systems

Sponsor: U.S. Army TACOM (AMSTA-RSS)

Developer: SURVICE Engineering Co., July 1993

Cost: \$250

This report presents technical and scientific merits and feasibility of environmentally acceptable alternative firefighting agents to replace Halon 1301 in the crew and engine compartment fire extinguishing systems of U.S. Army tactical and combat vehicles. The data for this document were obtained through searches of the relevant literature; analysis of ground vehicle fire incident data; investigation of current industry, government, and academic research and development efforts; and laboratory research. The functional parameters that define the requirements for a replacement agent are presented and discussed. The data on combat vehicle fire incidents are also reviewed and analyzed to help refine those requirements. Based on this analysis and the functional parameters, a measure of merit system for assessing potential replacements is established and the various agents identified as potentially useful are evaluated and rated under that system. Finally, several agents are identified as the best candidates and recommendations are made for further testing to determine the best choice to replace Halon 1301 in Army ground vehicles. Summaries of all relevant literature located during the search and synopses of technical data and information on all agents considered are included.

This report should be of particular interest to anyone faced with the problem of selecting a firefighting agent for any new fire extinguishing system or replacing Halon in an older one. The process of developing a quantitative measure of merit system customized for the particular case is explained in detail, and the methodology can be applied to any system. Also, the study and analysis of past fire incidents provides an excellent example of how to factor such data into the agent selection process. The technical synopses of the agents provide a concise summary of the parameters, characteristics, and test data for all the agents considered, including all of the Halon replacement/alternative agents available at the time the report was written. These synopses provide a quick means of direct comparison of the properties and capabilities of the various agents.

**DOD Directive 5000.1 and DOD Instruction 5000.2/5000.2M Survivability Excerpts
SURVIAC TR-92-004**

Sponsor: Department of Defense

Developer: SURVIAC, August 1992

Cost: \$50, free to Government

The Department of Defense (DOD) Directive governing defense acquisition, previously dated September 1, 1987, was updated and replaced on February 23, 1991. The Directive, its instruction (DODI 5000.2), and manual (DODI 5000.2M), provide a guide of fundamental policies from DOD executive levels down through field operating agencies. The Directive establishes a disciplined management approach for acquiring systems and materials to satisfy the operational user. It provides guidance for requirements generations, acquisition management and planning, programming, and budgeting. The DOD instruction 5000.2 contains 16 parts and defines responsibilities and tasks for all aspects of an acquisition program. The DOD instruction 5000.2M contains procedures and formats for preparation of milestone documentation, periodic in-phase status reports, and statutory certification.

The purpose of this document is to assist those who are particularly concerned with survivability of new material. This document consolidates those parts of the new DOD publication which focus on survivability and would be of most interest to the survivability community. The DOD Directive 5000.1 is provided in its entirety, and selected portions of the instruction (5000.2) and the manual (5000.2M) are also provided. The selected portions of the instruction and manual deal with aspects such as threat development, test and evaluation, susceptibility/vulnerability assessment, live fire testing, and guidance on preparing required documents.

Unmanned Aerial Vehicles Survivability Compendium**SURVIAC TR-90-004****Sponsor:** DOD UAV Joint Program Office**Developer:** SURVIAC, April 1990**Cost:** \$200

This library and accompanying database serve as a compilation of survivability information and data on Unmanned Aerial Vehicles (UAVs), remotely piloted vehicles, and drones of all ranges and missions. This information and data are helpful for survivability review, analyses, and decision-making. This database was developed because of the large number of UAVs developed during the past few decades, the extensive nature of the detailed survivability information, and the need to readily access the information. The Compendium includes references for over 900 documents with each reference including title, DTIC and SURVIAC library numbers, author(s), sponsoring agency, classification, date, release restrictions and authority, key words, an abstract, and 19 additional descriptors. The interactive database executes on IBM PC-compatible machines and communicates with the user through a series of prompts. The system allows the user to retrieve information on a particular report, perform queries on key words or fields, and run comparative searches on multiple key words or fields. The user can also obtain hardcopy printouts of document descriptive information.

Gas Explosion Suppression Agent Investigation**SURVIAC TR-89-021****Sponsor:** Naval Weapons Center**Developer:** SURVIAC, July 1989**Cost:** \$200

Combat aircraft are exposed to a wide variety of threats, many of which are capable of penetrating fuel tanks and igniting the fuel/air vapors in the ullage space. Such threats include high velocity fragments from exploding warheads, armor-piercing incendiary projectiles, and high explosive incendiary projectiles from air-to-air or surface-to-air systems. When the ullage space is entered, the resulting fire/explosion can produce overpressure sufficient to critically damage the aircraft structure. Vulnerability to this damage mechanism can be reduced by incorporating systems that react to the incipient explosion by discharging a suppression agent before critical overpressures are reached.

This report recommends agents for follow-on testing in the live fire, gas explosion suppression test series and explains why. Agents identified are those that appear most likely to be successful explosion suppressants, are not subject to the Montreal Protocols (the so-called Halon Ban Treaty), and have not been tested previously at China Lake by the Naval Weapons Center. The nature, advantages, and disadvantages of the recommended agents and their explosion suppression mechanisms are discussed. Summaries of an agent's physical properties and other information is included.

Aircraft Engine Analyst Reference Manuals**Sponsor:** JTCG/AS, JTCG/ME**Developer:** SURVIAC, October 1986**Cost:** \$400 Per Set or Separately:

1-0 - \$75
1-1 - \$75
1-2 - \$50
1-3 - \$75
1-4 - \$100
1-5 - \$100
1-6 - \$75
1-7 - \$50

This document series was established to fulfill an increasing need for organized retrievable information on target vulnerability and survivability against various threats. The six database categories established for assembling the survivability/vulnerability data are contained in Volumes 1-1 through 1-6. Two additional volumes provide a general summary and describe vulnerability reduction features and design criteria. The volumes, which are bound separately in a loose-leaf format to simplify additions of new information, are organized as follows:

- **1-0. General Summary and Reference** --presents a general summary and overview of SURVIAC and explains the ARM concept. Each ARM is summarized and cross-reference listings of ARM 1-2 through ARM 1-7 are provided in three tables organized by ARM manual, aircraft engine type, or aircraft system/component.
- **1-1. Resource Database** --includes a key personnel and organizations listing, vulnerability database inventory, and bibliography.
- **1-2. System Description Database** --contains relevant physical and functional characteristics normally desired for aircraft engine survivability/vulnerability studies. Data for each engine are divided into 16 system/assembly categories and include pertinent component identifying numbers. Detailed information, such as nomenclature, dimensions, and performance characteristics, is listed and defined in a thesaurus of 126 relevant generic components. Data are organized by turbojet, turbofan, and turboshaft types; an index of the included engines begins each section.
- **1-3. Operational Database** --summarizes combat damage data from SURVIAC and analysis reports on aircraft engine combat records. Data are presented on 15 different engines: J34, J52, J57, J65, J75, J79, and J85 turbojet; TF30 and TF41 turbofan; and T53, T33, T56, T58, T73, and T76 turboshaft. Additional data were included for the J60, T63, and T64 engines.
- **1-4. Experimental Databases** --Part One, Controlled Damage Data, includes controlled damage tests that simulate ballistic impact damage on engine subsystems/components and/or simulate the secondary damage effects from impacts/damage on nearby aircraft subsystems/components. The database includes over 1,000 controlled damage tests conducted on 21 engine models. Part Two, Ballistic Firing Tests Against Non-Operating Engines, summarizes data from ballistic test firings conducted against non-operating, static engines or subsystems and their components. Part Three, Ballistic Firing Tests Against Operating Engines, summarizes ballistic firing tests conducted against operating aircraft turbine engines. Tabulated results are presented for 261 tests against eight (mostly obsolete) turbojet engines, 44 tests against four turboshaft engines, and four tests against one turbofan engine. Part Four, Directed Energy Weapons Tests, summarizes the results of directed energy weapons tests conducted against operating engines and non-operating engines, subsystems, or components. The database summarizes high energy laser damage tests including tests conducted against operating J57, J69, T53, and T58 engines

and against non-operating components from T53/TF-30/Soviet D25V engines, miscellaneous fuel lines, and other related components from the Soviet MI-8 helicopter.

- **1-5. Probability of a Kill given a Hit (Pk/h) Database** --Part One, Generic Engine/Subsystem/Component Kill Criteria and Probability Functions, presents empirically developed kill criteria and evaluation methodology, the heart of a vulnerability assessment. The database includes a complete system of detailed kill or lethality criteria with supporting definitions and rationale for standard usage. Part Two, Specific Engine System Kill Probabilities, presents uninstalled engine system average Pk/h. Tabulated data are presented for K-, A-, and B-kills for 7.62mm, 12.7mm, 14.5mm, and 23mm API projectiles striking at velocities ranging from 500-3,500 ft/sec in 500 ft/sec increments. Part Three, Specific Engine Subsystem/Component Kill Probabilities, presents uninstalled engine critical subsystem and component Pk/h's extracted from published and unpublished engine type assessments. The initial database was prepared for critical subsystems and components from the J57, J60, J79, and F19 turbojets; TF34 turbofan; and T73, T700, and F17 turboshaft engines.
- **1-6. Vulnerable Area Database** --provides estimates of engine vulnerable areas derived, directly or indirectly, from the estimates for "bare" (uninstalled) engines and their components. Included are data on striking velocities for a variety of armor-piercing projectiles on various engine components. Data are available for J57, J60, J79, and R13 turbojet engines and T53, T73, PT6B-9, PT6T-4, and GE12/ST9 turboshaft engines.
- **1-7. Vulnerability Reduction Features and Design Criteria** --includes information on reduction of vulnerability in aircraft engine design. Documentation presents specific vulnerability reduction design guidelines organized by major engine section or subassembly and includes a bibliography listing 76 source references relevant to vulnerability reduction of engines and their subsystems.

To order any SURVIAC product in this document, contact us at 937-255-3828 x284 or DSN 785-3828 x284