SURVIAC Bulletin

Volume XVII Issue 2 - 2001

Cleared for Public Release - Distribution Unlimited

Survivability/Vulnerability Information Analysis Center

SURVIAC is a U.S. Department of Defense Information Analysis Center (IAC) sponsored by the Defense Information Systems Agency (DISA), Defense Technical Information Center (DTIC).

Fire Suppression Technology Applied To Chemical/Biological Warfare Protection

In 1999, the Naval Surface Warfare Center, Dahlgren (NSWCDD) entered into a Cooperative Research and Development Agreement (CRADA) with Cummins Industries, Inc. of Joshua, Texas. The objective of the CRADA was to assess the compatibility of the NSWCDD-developed Quaternary Ammonium Complex (QAC) decontaminant with Cummins Industries' fire fighting compressed air foam system (CAFS). (See SURVIAC Current Awareness Bulletins Vol XIV, No. 1 and Vol XV, Issue 3, Fall 1999.) Development of the QAC decontaminant was also sponsored in part by the Office of Naval Research and by the Joint Science and Technology Panel for Chemical and Biological Defense, under the Decontamination Commodity Area of the Joint Service Materiel Group. Cummins Industries owns the original US Patents for the invention of CAFS.

USMC Photo by Cpl. Jason Ingersoll

The Pentagon in flames just minutes after a hijacked jetliner crashed into the building on September 11, 2001

QAC/CAFS Technology

The QAC decontaminant has the ability to neutralize chemical and biological agents without the severe disadvantages of the currently used decontaminants, namely DS2 and the hypochlorites. The technology is based on an amino-alcohol solvent system. The decontaminant has been shown to be noncorrosive and compatible with materials damaged by the currently used decontaminants (for example, butyl rubber gloves and painted surfaces) while still neutralizing the chemical agents. Toxicity tests have shown the product to be approximately 30 times less toxic than the US Army standard, DS2. The new product is environmentally friendly and the product itself is nonflammable. It is easily removed from surfaces with water.

The QAC decontaminant agent potentially may be used with a compressed air foam system (CAFS) for suppression of Class A and B of fires. CAFS foam requires less water to control comparable fires, thus there is less runoff and a greater coverage for a given on-board capacity. The CAFS foam generating method works with any environmentally friendly foaming agent and makes a smaller celled, more effective fire extinguishing foam blanket than the most commonly used military foaming agent aqueous fine film foam (AFFF) which is more expensive and contains an environmentally haz-

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Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2001		**00-00-2001 to 00-00-2001**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
SURVIAC Bulletin: Fire Suppression Technology Applied to Chemical/Biological Warfare Protection, Volume 17, Issue 2 - 2001	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **JAS Program Office,200 12th Street South,Crystal Gateway #4, Suite 1103,Arlington,VA,22202**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**24**	

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SURVIAC Bulletin Vol XVII Issue 2

SURVIAC, a DoD Information Analysis Center (IAC), is administratively managed by the Defense Information Systems Agency (DISA), Defense Technical Information Center (DTIC), under the DoD IAC Program. SURVIAC is sponsored by the Joint Technical Coordinating Groups on Aircraft Survivability (JTCG/AS) and for Munitions Effectiveness (JTCG/ME). SURVIAC is operated by Booz·Allen & Hamilton Inc. The Contracting Officers Technical Representative (COTR) for the Center is Mr. Martin L. Lentz, 46 OG/OGM/OL-AC, 2700 D Street, Bldg. 1661, Wright-Patterson AFB, Ohio 45433-7605. He may be reached at DSN 785-6302 or (937) 255-6302.

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Space Survivability

The third annual Space & Air Protection Workshop was held in Albuquerque, New Mexico at Kirkland AFB on 29-30 August 2001. The workshop provided an excellent forum for information exchange between the space and aircraft communities. Presentations were shared on respective problems, threats, methodologies, technologies and approaches that each community uses to enhance their respective survivability of their systems. One of the air vehicle survivability assets that was presented to the space community was the support that an Information Analysis Center, IAC, organization can do.

What Is An IAC?

Kevin Crosthwaite, the director of the Survivability/Vulnerability Information Analysis Center, SURVIAC, started out by giving an overview of what an IAC is and does. There are currently 13 IACs that serve various technical specialties. Each of these IACs is charged with gathering scientific technical Information, STI, which is relevant to their respective technical field. Upon data collection, the IAC then processes, analyzes and disseminates the data. These 13 IACs are all directed and funded through the Defense Technical Information Center, DTIC. The IACs are staffed and operated by contractors under a DTIC contract. They are individually sponsored by their respective technical communities. Each IAC can readily add on to their contract related Technical Area Tasks, TATs, to support specific work for other agencies.

Kevin then discussed SURVIAC as an example of what an IAC can do to support a technical community. SURVIAC's technical area encompasses survivability and weapon lethality. Aircraft, tanks, and ships are included within the SURVIAC scope.

Kevin also mentioned that survivability of spacecraft also falls under the SURVIAC charter, however he did acknowledge that only a little work had been done in this area.

SURVIAC responds to thousands of inquiries related to survivability each year. They distribute hundreds of standardized products that they have prepared. SURVIAC also distributes a set of government approved models and provides user support and training. They also assist the model manager to track changes and maintain configuration control. SURVIAC has an active outreach program with a newsletter, frequent conferences, workshop displays, and presentations. SURVIAC has a large and successful TAT program. The TAT funding actually dwarfs the "core" DTIC funding. The TATs enable SURVIAC staff to stay on the cutting edge of analysis, testing, and technology developments in their area.

SURVIAC maintains a large reference library for automated searches. There is also the repository for data on combat incidents as well as test results. This information resource is readily available to any requestor in the DoD or a supporting contractor. Kevin gave examples of some key TATs that spanned live fire testing, analysis, and quick reaction technical support.

SURVIAC is sponsored by the Joint Technical Coordinating Group for Aircraft Survivability, JTCG/AS and the Joint Technical Coordinating Group for Munitions Effectiveness, JTCG/ME. The main SURVIAC office is located on Wright-Patterson AFB, near Dayton, Ohio. With the active support of the sponsoring communities, SURVIAC has grown into a central integral role within the survivability and lethality communities.

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Component Vulnerability Analysis Archive (CVAA)

A critical input to a non-nuclear vulnerability analysis involves making estimates of the response of critical components to threat damage mechanisms. The response of a component to a particular damage mechanism is generally expressed in terms of a Probability of Damage or Dysfunction given a Hit (Pd/h or Pcd/h). This factor represents the level of damage required so that the component can no longer perform its design function. The Pcd/h is strictly a function of the component design, and therefore can be determined independently of how it is installed or integrated into a particular weapon system. To determine if a component is no longer functional, i.e. "killed", the level of damage must be correlated with required capability. This correlation is accomplished through the Probability of Kill given Damage (Pk/d). Thus the component Probability of Kill given a Hit (Pk/h) is the product of Pcd/h and Pk/d. For example, a Pcd/h function might describe the probability of achieving a certain leak rate given a puncture of an actuator. The corresponding Pk/d would vary from system to system depending on size of hydraulic reservoirs, reservoir sensing/shutoff valves, kill level being assessed, etc.

The JTCG/ME and the JTCG/AS jointly initiated the Joint Component Vulnerability Program (JCVP). Both organizations recognized that probably the most critical inputs to a vulnerability assessment for a ground or aerial target were estimates of the Probabilities of Component Damage or Dysfunction (Pd/h or Pcd/h) given a Hit. Experienced analysts using a mix of ballistic test data, accident data, component failure modes and effects analysis, and engineering judgment typically make these estimates. Since they form the core of every vulnerability analysis it was felt to be a high priority effort to collect, evaluate, document, and archive the currently available data sets and methodologies.

CVAA

The primary missions of the JCVP are (1) to coordinate development/documentation of the methodologies for making consistent engineering level estimates of component Pcd/h, (2) to standardize Pcd/h analysis generation and documentation practices, and (3) to archive supporting data and methodologies. The major functions of the JCVP were broken out and assigned to working groups. These working groups are the Archive and Structure Team, the Data Review and Acceptance Team, the Pcd/h Code Team, and the Data and Methodology Team. The Data and Methodology Team has been assigned the task of gathering existing methodologies and data and planning a long-term methodology improvement program. As part of this effort the Component Vulnerability Analysis Archive (CVAA) has been developed as the repository for methodologies and component vulnerability and test data. The CVAA has been developed, documented, and is being populated with component vulnerability analysis methodologies and the supporting vulnerability, ballistic test, and combat data.

The CVAA is contained on a CD ROM. It is structured so that the existing database may be accessed, searched and used or a local version can be created and data added. This requires a personal web browser. After the CVAA is opened a screen appears.

The "Members" header accesses a listing of the current JCVP DoD and contractor members. The "Documentation" header accesses the CVAA program documentation while the "Status" header accesses JCVP Working Group minutes. The "Tools" header accesses some component vulnerability analysis tools and the "Related Data" lists some relevant databases such as Joint Live Fire. The heart of the program, the CVAA database is accessed through the "Archive" header.

The database is divided into two branches or "Systems" which contain descriptions and vulnerability analysis references for aircraft (in-flight and parked), ground vehicles, ground structures and ships and "Components" which contains vulnerability data, analysis techniques, supporting references and test data.

The CVAA Version 5.0 is now ready for release and a Workshop is planned. Future plans for CVAA include insertion into SURVIAC after the Workshop, yearly users group meetings and continued addition of component vulnerability data, analysis techniques and supporting test and combat data. Other specific systems information will also be added and the documentation upgraded. Inputs from users will also be considered for inclusion in CVAA.

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THE CVAA WORKSHOP HAS BEEN RESCHEDULED FOR DECEMBER 11, 2001

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What a Space IAC Could Do

Kevin then continued by projecting what the IAC can do for space. An IAC would be a common data collection point. Examples of data that could be held include satellite orbital data, launch schedules and payloads, space debris distribution and size, and information on spacecraft threats from manmade threats to the environment. Once the common data collection point is established, the IAC becomes a natural distribution point. Users from throughout the space community could come to the IAC to answer their data needs as a one-stop shop. Data that is distributed could be standardized for ease in communication throughout the community. As the IAC develops a list of key users, the IAC could also serve as a central notification point to get the word out quickly to the community. The IAC could also distribute models that the community selects to standardize around.

The IAC would build a subject matter expert database for quick referrals of thorny technical questions. The IAC could also help to promote space community events - symposia, new technology discoveries, and report findings. They could also establish and host training courses for workshops on particular topics of hot interest.

Regarding the status of a space related IAC, Kevin mentioned that there has been an effort to lay the groundwork for a SPACIAC. In the meantime SURVIAC does have a charter for spacecraft survivability. Whatever evolves as a space IAC a key issue will be the sponsorship. The sponsor needs to provide infrastructure, financial support and direction. That direction will dictate how broad or narrow a charter the IAC will work towards. Another key issue will be how to structure the IAC to allow commercial access to the data. This is essential since a majority of satellites are now operated by commercial entities. Once these issues are resolved, then the IAC can make strides to build its data collection, model suite, and subject matter expert contacts. A space related IAC would surely then grow into an integral productive part of the space community just as other IACs have done.

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ardous product. The system offers an emergency response vehicle the dual capability to extinguish fires more effectively and to neutralize toxic products such as stored chemicals and terrorist chemical/biological agents, and possibly even reduce the toxic by-products produced by fire and spread by smoke and water run-off. It is an integrated CAFS/QAC decontaminant system that provides emergency responders with effective, efficient, and environment-friendly capabilities.

Advantages and benefits of the QAC/CAFS technology include the following:

- Neutralizes chemical/biological accidental discharges or terrorist-type releases,
- Can be used before exposure to toxic products to prevent contamination,
- Highly effective against biological agents including spores,
- Non-corrosive and environmentally friendly,
- Fills voids and hard to reach areas that are inaccessible to spray or brush applications,
- Covers large areas of contamination with long hose lines and minimum manpower,
- Provides a method to apply the decontamination products from a safe stand-off position,
- Adheres to non-horizontal surfaces,
- Visual confirmation of treated areas,
- Reduces collateral contamination from runoff,
- High coverage/volume ratio with foam,
- More uniform application of decontamination products,
- Remediates a broad class of pesticides for environmental cleanup,
- Contains no volatile organic, halogenated, or fluorinated compounds,
- Potentially effective fire fighting foam for Class A (ordinary combustibles) and Class B (burning liquids) fires which can be used to replace the harmful AFFF products,
- Limits collateral damage from fluid runoff, particulate matter, and vapor escape from fire fighting activity.

DoD Needs

The QAC/CAFS technology addresses a number of DoD needs. First among these is the need for a chemical/biological agent decontaminant that is noncorrosive, nontoxic, nonflammable and environmentally friendly. Current decontaminants can damage a variety of materials and pose serious environmental and health hazards. The QAC/CAFS technology is effective against all agents, stable in storage, usable on all surfaces and materials, and reduces transport, storage and use issues associated with current decontaminants. In addition, the QAC/CAFS foam is well suited for aerial application. This feature will allow for rapid intervention in the event of an aerosol release (i.e., from a crop duster aircraft). In the event that the QAC/CAFS foam is used in this manner, a secondary benefit of the air drop is that the "hot zone" will be visually marked with the foam. This will be useful information for any ground personnel.

Another need addressed by the QAC/CAFS technology includes the growth of mildew, fungus, and bacteria on

interior surfaces of operational helicopters. This is an extensive Navy problem, particularly with aging aircraft. Interior aircraft surfaces are often inaccessible for cleaning and removal of these organic contaminants results in significant aircraft down-time. Standard cleaning methods are not effective. Mildew, fungus, and bacteria are suspected of deteriorating protective paint films, promoting corrosion, and causing an unhealthy atmosphere for flight crews. CAFS decontaminate foam can be forced into small openings to fill voids from top to bottom with the solution.

The QAC/CAFS technology provides the capability for large area decontamination and can be used before exposure to toxic products in order to prevent contamination. QAC/CAFS can also be adapted to help meet other defense requirements, such as thermal protection from radiation and camouflage from heat seeking weapons.

QAC/CAFS Technology Can Reduce Decontamination Costs

The technology has the potential for cost savings in a variety of areas, including Nuclear, Biological and Chemical (NBC) decontamination techniques available for weapons systems and equipment, pollution prevention, and environmental restoration. Existing procedures for the decontamination of chemical protective masks, protective clothing and other items of equipment are inefficient and fail to remove all traces of deadly chemical agents. These agents permeate into the materials they contact and, unless completely removed, continue to off-gas into the environment even after decontamination. In addition, the Army uses wet chemistry (bubbler) technologies to detect and monitor the presence of chemical agents. These technologies result in costly processing and disposal of the chemistry components (annual costs for handling, processing and disposal are estimated at $2M). Further, the Army uses many carbon filtration systems in its chemical storage activities. The decontamination process for spent carbon is highly regulated and requires incineration and land disposal at considerable cost. Current technologies for decontamination, such as DS2 (caustic) and Super Tropical Bleach (corrosive), have been shown to cause damage, including rendering completely unusable, some weapon system parts and equipment (e.g., generators) not coated in a chemical agent resistive coating (CARC). The QAC/CAFS technology provides an alternative, more environmentally-friendly, operationally-acceptable replacement for current decontamination technologies, which will help reduce equipment repair and replacement costs.

From the pollution prevention perspective, the technology offers a more environmentally suitable process for decontamination of materials and equipment. Residuals from cleaning with this technology would be less toxic and require less treatment. The technology is also less corrosive than existing technologies and would cause less damage to equipment, thereby reducing replacement and maintenance costs.

The technology has similar benefits for environmental restoration of soils and debris contaminated with chemical and biological agents. One recent application of the CAFS system was as a bioremediation system to apply oil eating microbes to a gasoline pipeline release in Texas. The CAFS 230 Unit was used to apply 4,000 gallons of microbe foam concentrate to remediate 82,000 gallons of gasoline released from the ruptured pipeline. The gasoline spill covered 15 acres. Any forest animal within 3 feet of the ground died from the vapors.

To address this leakage problem, the entire spill area was covered with approximately 4 inches of hydrocarbon eating microbe foam using a thousand-foot long hose lay. The foam blanket sealed the vapors and

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CAFS Bioremediation Application

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stopped the problem. Before the CAFS decontamination, the bodies of the dead animals were decaying and emitting a foul oder. Their skin was polluted with the benzene from the fuel. This made the scavengers eat contaminated food. After the CAFS decontamination, there was no odor except the light perfume in the foam. In addition, all the dead animals were washed clean. This was a great improvement. In addition, there was no run-off of the CAFS foam which is one of the advantages of its utilization.

The alternative to using the CAFS bioremediation process for this incident was to have the 15 acres of forested land dug up and transported to a licensed landfill that could accept the polluted soil. This would have been cost prohibitive and would only have move the contaminated soil from one location to another.

Other cost saving features include:

- The QAC/CAFS method of generating foam requires half as much foaming agent to produce twice as much dense vapor sealing foam and has been proven to extinguish more fire in less time than present military foam systems.

- The QAC/CAFS technology uses less expensive and more environmentally friendly foaming agents.

- The QAC/CAFS equipment can be added onto existing fire fighting vehicles to upgrade their capability and requires minimum training.

- QAC/CAFS permits sub-surface injection of decontamination products to efficiently cleanup difficult environmental projects.

Potential Commercial Uses

Potential commercial uses of the QAC/CAFS technology include the following:

- Cleaning material/equipment contaminated with chemical or biological agents,

- Remediation of contaminated soil/water,

- Response by local/municipal hazardous waste response teams,

- Response by SWAT teams to chemical/biological threats,

- Fighting fires that involve chemical and biological materials, and

- A cleaning product for home use.

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State-of-the-Art Report on Munition Response

The SURVIAC has recently completed a State-of-the-Art Report (SOAR) on the reaction of missile warheads, bombs, and propellants to energetic stimuli. The goal of this work was to consolidate and summarize relevant information from past and current studies, gain a better understanding of munition response phenomena, and provide recommendations for future efforts to reduce the vulnerability of U.S. systems and improve the lethality of our weapons against opposing munitions-carrying platforms.

Historically, munitions have been a two-edged sword in that they contribute to the means by which combat vehicles accomplish their mission, but at the great risk of reacting to hostile threat stimuli and damaging/destroying the air, land, or sea systems that carry the munitions. From a survivability standpoint, then, the challenge is to understand the physical nature of the reaction, identify the probabilities of reaction for given threats, and determine possible means to prevent or mitigate the effect on the host platform.

The 1967 incident on the USS Forrestal, in which U.S. senator and presidential candidate John McCain was injured, illustrates the importance of understanding munition response.

The SOAR addresses these issues in four sections: (1) theoretical understanding of the hazard, (2) predictive methodology and modeling, (3) design and protective measures, and (4) testing and combat data.

Included in the theoretical discussion is an identification of the different types of reactions, as defined in MIL-STD-2105B (i.e., detonation, partial detonation, deflagration, and burning); the physics of explosive behavior; and the fundamentals of the initiation and propagation of detonation. The basic theory of explosive behavior was found to be well understood, but more work is needed in subdetonation-level initiation/propagation and in the response of operational and developmental munitions to ballistic impact.

The section on predictive methodology and modeling discusses (by Service and by system type) practices and models currently in use as well those in development. Empirically based efforts to predict and model munition response were found to be the most successful. Some limitations were found in the reliability of selected methodologies beyond the specific test cases used to develop them, in the modeling of ballistic impact on munitions (especially in the area of less complete and immediate reactions), and in the methods used to project response predictions into vehicle vulnerability estimates.

In the area of design and protective measures, two principal avenues for reducing vehicle vulnerability to munition response are addressed: (1) munitions desensitization and (2) damage mitigation. The Department of Defense's Insensitive Munitions (IM) Program was found to have made significant progress in desensi-

Munition Response SOAR continued on page 22

ESAMS ECAT

The Enhanced Surface-to-Air Missile Simulation (ESAMS) Cooperative Assessment Team (ECAT) is a joint effort sponsored by the Office of the Secretary of Defense (OSD), Deputy Director, Operational Testing and Evaluation/Live Fire Test and Evaluation (DDOT&E/LFT&E) and the Joint Technical Coordinating Group for Aircraft Survivability (JTCG). ECAT was formed in response to a memorandum from the Deputy DOT&E/LFT&E that expressed concerns over the verification and validity of the most popular model utilized by the Services for their evaluation of aircraft survivability:

"I recommend that the JTCG/AS charter a small group of operational analysts and range and ESAMS experts. Such a group would compare relevant measures from many open-air range tracking runs under a variety of conditions to those measures as simulated by ESAMS, and seek out root causes of any significant differences that may exist."

Thus, the JTCG/AS assembled a team of ESAMS experts and analysts to assist in the formation of a plan and charter for ECAT. The members decided to have three tiers within the ECAT structure. At the top is the Executive Steering Group comprised of Mr. James F. O'Bryon (DDOT&E/LFT&E) and Dr. Steven L. Messervy (JTCG/AS PMSG Chairman). The Operations and Management Group is the middle level and consists of co-chairman Mr. Michael Weisenbach (JTCG/AS Central Office), co-chairman Dr. Gary Comfort (Institute for Defense Analysis), Mr. Dave Hall (Chairman, JTCG/AS Survivability Assessment Subgroup) and Capt. Barry Behnken (ESAMS Model Manager, AFIWC/453 EWS). The Working Group includes the Principal Investigators of ESAMS, Dr. Greg Born (SURVICE Engineering), Dr. Rex Rivolo (IDA), Mr. Mike Miles (SURVIAC), Dr. Brad Thayer (IDA), Dr. Byron Burel (TRW) and Mr. Ralph Mattis (NAWC).

The ECAT Working Group has met three times to discuss the analytical progress. Dr. Born presented his comparison of White Sands Missile Range (WSMR) LFT data with ESAMS runs. Ralph Mattis and Roger Madonna (NAWC) discussed their effort on the comparison of target tracking errors for 19 runs of range radars tracking F/A-18 with ESAMS runs of those tracking errors. Mike Miles and Alfred Yee (SURVIAC), briefed on their investigation of the effects of using a multi-scattering target model in ESAMS.

The stage of the investigation of each of the respective area varies, but for the most part, the early analysis has shown varying ESAMS agreement with the available test data. Dr. Born's simulation work with the QF-106 towing an ALE-50 approaching a radar site has shown excellent agreement. In contrast, the receding shots are not as quite robust. Ralph Mattis and Roger Madonna's work has shown partial agreement with more work to be completed. Mike Miles and Alfred Yee's work on n-point scatterers was identified as a possible "root cause of differences". More investigation will be performed, such as adding dynamic scatterer masking to the algorithm.

A related ESAMS issue is the delay in releasing ESAMS version 3.0. Mr. O'Bryon's approval of the release of ESAMS 3.0 was withheld until he felt the ESAMS community had adequately addressed the verification and validation issue and identified known shortcomings in the model that might impact its utility to support some types of analyses. A consensus was reached to insert caveats into the ESAMS simulation, warning the user of the known limitations of the data. In addition, the JTCG/AS and the ESAMS model manager briefed Mr. O'Bryon on the community's course of action. In the meantime, the latest approved Jun 01 Model Deficiency Reports (MDRs) have been incorporated and the model is in the midst of being re-tested to ensure the deficiencies have been corrected.

For more information on ESAMS/ECAT, please contact Mr. Alfred Yee, (937) 431-2716 E-mail: yee_alfred@bah.com.

2001 SURVIAC Liaison Workshop Held

The Survivability/Vulnerability Information Analysis Center (SURVIAC) hosted its sixth annual SURVIAC Liaison Workshop at its facility at Wright Patterson AFB, Ohio on 14-16 August 2001. The objectives of the workshop were to increase the knowledge about SURVIAC and what resources we have to support other agency's/company's mission and for SURVIAC to find out about your respective needs so that we can better support you in the future. The workshop was open to government and industry personnel.

2001 Attendees: Front Row - John Gallagher, NAVAIR, Donna Egner, SURVIAC Deputy Director, Dave Ferguson, Paradigm, Mike Wall, Paradigm. Back Row - Harold George, Pax River, Bill Krause, Pratt & Whitney, Maj. Kevin Young, Hurlbert Field, Florida, Kevin Crosthwaite, SURVIAC Director.

Three days were spent investigating databases and libraries, performing searches, reviewing products and models, reviewing Technical Area Tasks, becoming familiar with key survivability and lethality agencies, as well as simply becoming familiar with the day-to-day operation of the SURVIAC office.

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Survivability of a Different Kind

The SURVIAC team participated in a different type of survivability test this summer. Eager SURVIAC employees and their families "dunked the directors" to raise money for Special Olympics. As you can see from the photos, they didn't survive long!

Above: SURVIAC Director Kevin Crosthwaite takes the plunge for Special Olympics.

Right: SURVIAC Deputy Director Donna Egner awaits her fate.

SURVIAC Fire Suppression Efforts

Aircraft have special problems with regard to fires. Aircraft contain large quantities of fuel distributed in fuel tanks throughout the aircraft, with fuel lines running between these tanks and the engine(s). In addition, aircraft carry munitions, which can be activated by a fire.

In most cases, fire is either the primary cause or a contributing factor to loss of aircraft assets. In many instances, injuries to personnel and loss of mission capability accompany a fire event. Aircraft fires are a significant cost to the Department of Defense. Methods and technologies to mitigate them or "design them out" are imperative, not only to save aircraft, but also to save lives and prevent property damage.

Fire-extinguishing systems are used on military and commercial aircraft to protect engine nacelles (the region surrounding the exterior of the jet engine case and shrouded by an outer cover, and typically ventilated), and dry bays (which can include wing leading/trailing edges, landing gear, avionics, and weapons bays). These systems are fixed in configuration and activated remotely to totally flood the compartment in question with fire extinguishant. Auxiliary power units (APUs), which provide ground, supplementary or emergency power, are also frequently protected using such systems, either as stand-alone units or in conjunction with the engine nacelle fire-extinguishing system.

In a previous issue of the Current Awareness Bulletin, SURVIAC introduced its methodology for applying business solutions with technical expertise in evaluating halon replacement systems. This article describes how the cost of the fire suppression system is vastly overshadowed by the cost resulting from either a peacetime- or wartime-induced fire. Therefore the more effective the fire extinguishing system is, the greater the reduction in the loss of aircraft assets (costs).

Fire Extinguishing System Characteristics

There are a large number of platforms that have Halon 1301 fire-suppression systems. Obtaining information on all of these would be difficult, costly, and unnecessary. Therefore, the Military Services identified a small subset of these platforms whose halon systems are representative of the range of fire suppression needs:

- Ground vehicles: M992 (FAASV), M1 tank, and M2/M3 (BFVS)
- Aircraft: C-130, F/A-18 C/D, C-17, H-60, CH-47, F-16
- Ships: DDG 51, LHD 1/LHA 1

SURVIAC researched the fires experienced and Halon 1301 fire suppression systems in current weapon systems. To accomplish this, the following objectives were met:

- Characterized and tabulated the nature, frequency, consequences (including personnel injuries), and severity of fires previously and currently attacked using Halon 1301.
- Derived a small set of representative (model) fires (using the analyses described above) for other elements in the Program.
- Compiled characteristics and limitations of the systems that new fire suppression technologies will replace or into which they will be retrofitted. The descriptions of the environments of the current systems compiled during this program will serve as boundary conditions for the new technologies to be developed in subsequent Elements of the Next Generation Fire Suppression Technology Program (NGP).

In order to characterize and tabulate the nature, frequency, consequences (including personnel injuries), and severity of fires previously and currently attacked using Halon 1301, the Safety Centers of the Services and SURVIAC were contacted for both noncombat and combat data, respectively. Items such as fire zone, fire incidence rate, hazards to be protected against by the Halon 1301 system, flame suppression time requirements, and the current system tests were investigated.

Previous research, development, testing and evaluation have led to the identification of ways to provide halon-equivalent fire protection for some platforms. However, some of the most important platforms (and the types of fires most commonly experienced) remain to be examined. They are:

- Crew compartments of ground vehicles. In the case of ground combat vehicles, the justification for the cost of automatic halon fire-extinguishing systems rests on the ability of these systems to extinguish the mist fireball explosion. This is a rapid growth fire caused by the release and ignition of large quantities of fuel or hydraulic fluid, mist, vapor, spray, etc. in an occupied compartment.

- Dry bays in aircraft. An in-flight fire in a dry bay typically occurs when a ballistic projectile impacts the dry bay, rupturing fuel system components and generating tremendous ignition energy.

- Engine nacelles in aircraft. Engine nacelle fire protection systems are designed to protect against fire events such as those caused by ruptured or leaking fuel, hydraulic fluid, or oil lines within the nacelle. In these circumstances, flammable fluid can leak onto the hot engine case or accessory components and ignite.

- Storage compartments in ships. (Fires in shipboard flammable liquid storerooms (FLSRs) and paint issue rooms result from burning fuel cascading over highly obstructed and fuel loaded shelves and into flaming pools.

- Machinery spaces in ships. Fires in shipboard main machinery rooms (MMRs), auxiliary machinery rooms (AMRs), engine enclosures, and generator rooms result from the ignition of a pressurized fuel (diesel/hydraulic or lubricating oil) leak or ignition of fuel soaked insulating material. Leaks onto hot surfaces result in three-dimensional spray fires with cascading liquid flow on complex surfaces and into flaming pools.

- Fuel tanks in aircraft. Ullage (the void space above the fuel level in a fuel tank) in aircraft fuel tanks can have a potentially explosive fuel-air mixture. If initiated by a combat threat, an explosion can result.

During the course of the NGP, a large number of experiments will be conducted and considerable effort will be devoted to computer modeling of fire phenomena in order to ensure the applicability of the new fire suppression technologies. A small set of model fires has been constructed to enhance the effectiveness of these studies. These model fires capture the essence of the fires actually experienced by the weapon systems. The mist fireball explosion captures the essence of both the ground vehicle crew compartment and the dry bay fires. An appropriate laboratory apparatus for studying this model is an opposed flow diffusion flame (OFDF). The obstructed pool fire simulates fires that might occur behind clutter in engine nacelles, storage compartments and shipboard machinery spaces. The inert atmosphere simulates conditions that are desirable in fuel tank ullage, where an ignition source should not generate a sustained ignition of a fuel/air mixture.

Characteristics and limitations of the systems that new fire suppression technolo-

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gies will replace or into which they will be retrofitted were compiled. The descriptions of the environments of the current systems compiled during this program will serve as boundary conditions for the new technologies to be developed in subsequent elements of the NGP. The system configuration (number of fire zones, extinguisher requirements, distribution system requirements, modification potential, etc.), system schematic, and the current Halon 1301 system activation/sequence of events were examined.

The results of this effort are detailed in SURVIAC TR-00-007, "Fires Experienced and Halon 1301 Fire Suppression Systems In Current Weapon Systems", United States Air Force - Air Force Research Laboratory - Survivability and Safety Branch, Booz Allen Hamilton, United States Army - Army Research Laboratory, United States Navy - Naval Research Laboratory, and National Institute Of Standards and Technology - Fire Science Division, September 2001.

Fire Extinguishing System Costs

SURVIAC developed an historical estimate of the cost of fire to the U.S. Air Force for the period 1966 to 1995 and also projected a cost to the Air Force for the period 1996 to 2025. Three broad cost categories were considered: cost of peace time aircraft losses to fire; cost of combat aircraft losses to fire; and the cost of aircraft fire protection. Each of these categories is in turn composed of very many components. Resource constraints precluded investigating all of them. However, data were obtained on many and these have formed the basis of the analysis. Unfortunately, much of the data are of a highly sensitive nature, allowing only summary results to be presented.

Data sources used in the compilation of the costs of peacetime aircraft losses due to fire included: in-flight and ground fire incidents aboard aircraft (mishap classifications), aircraft replacement costs, annual flight hours, ground related costs - military and civilian payroll, and training and fire fighting vehicle operating and maintenance costs. By combining these components, a resulting historical peacetime cost of approximately $9.271 billion was obtained, measured in 1995 dollars. Projected peacetime fire-related costs totaled $12.558 billion (in 1996 dollars) for 1996 to 2025. The projected costs are higher due to the expectation of future higher value assets (e.g., B-2).

Data sources used in the compilation of the costs of combat aircraft losses due to fire, included: SURVIAC's Southeast Asia Fixed Wing Aircraft Database (ACFTDAB) and the Desert Storm aircraft database, provided combat losses, aircraft replacement cost data (Technical Order (TO) 00-25-30), cost of human life and medical care (obtained primarily from Air Force Instructions, training costs for replacement personnel, aircraft battle damage repair (ABDR) cost (man-hours necessary to repair the aircraft and the necessary replacement parts, if given) and projected wartime attrition and repair costs (based on assumed sortie rates and attrition factors). By combining these components, a resulting historical combat cost of approximately $5.878 billion was obtained, based primarily on SEA experience. Projected combat costs were $2.868 billion in 1996 dollars, based on the scenario and the assumptions defined above.

The costs of aircraft fire protection, included: research costs, maintenance costs, additional fuel required to fly the additional weight of the fire protection systems, live fire tests of aircraft with fire suppression, detection, research costs, fire suppression systems maintenance costs, cost of additional fuel, halon banking, and disposal/demilitarization. By combining these various components, an historical fire protection cost of approximately $315 mil-

lion was determined, measured in 1995 dollars. Projected fire protection costs are estimated to be $563 million, measured in 1996 dollars, for the time period 1996 to 2025.

These data above show that the costs to the U.S. Air Force of losses due to fire have been significant. The total historical cost of fire to the U.S. Air Force over the 1966 to 1995 time period is estimated to be $15.465 billion (in 1995 dollars). The total projected cost of fire to the U.S. Air Force over the 1996 to 2025 time period is estimated to be $15.990 billion (in 1996 dollars).

The results of this effort are detailed in SURVIAC-97-033, "Annual Fire Protection Cost Model [1966-1995;1996-2025]", M.L. Kolleck, G.M. Brightsen, M.V. Bennett, and J.A. Wheeler, Technical Report, Booz Allen Hamilton, Dayton, Ohio, February 1997.

SURVIAC performed a comparative cost analysis for a Halon 1301 and HFC-125 fire protection system as integrated into applications similar to several typical military aircraft platforms. This effort developed a methodology to determine the total system costs of an aviation on-board fire protection system, the cost savings resulting from having a fire protection system, and the net cost of the fire suppression system. This methodology was developed for systems with equivalent performance of Halon 1301 and for systems with varied performance, to optimize benefit per system weight and cost. Aircraft dry bay and engine nacelle applications were examined. The methodology has been (or will be) developed for representative cargo, fighter, and rotary wing aircraft.

A methodology was developed to determine the net cost of the fire suppression system. This methodology incorporates the cost of the system, which is a function of system size/weight, and the cost savings provided by the system, which are a function of extinguishant effectiveness and the resultant aircraft saved. The net cost is the cost of the system minus the cost savings.

System characterization was necessary to fully understand and appreciate the system cost information. This was accomplished for both a Halon 1301 and HFC-125 system. Information which assisted in characterizing these systems included technical manuals, HFC-125 Design Guide, and assistance from the program managers. Additional system characterization data included the number of bottles, bottles size, activation, number of shots, and information on the distribution system. Space limitation, bottle/plumbing accessibility, and modification potential data were compiled.

System cost information was developed utilizing the data contained in logistics databases that contains part numbers, suppliers, and other logistical information specifically for the Service of interest, and various traditional costing factors that are used by government and industry. Additional data came from the program managers. Fire suppression system and chemical manufacturers were contacted for cost information. Maintenance costs were based on the maintenance manhour per flight hour. Military personnel costs were based on authorizations.

The following figure shows a standard process used to determine fire suppression system costs.

Standard Life Cycle Cost Estimating Process

The cost savings for the life cycle period of interest in this study were estimated by using the traditional success rate for existing engine halon systems, the estimated fire costs per flight hour, and the number of flight hours for the aircraft of interest.

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Field experience of existing engine halon systems on current aircraft, depending on the platform, shows that the systems have a 60 to 80 percent success rate. The Annual Fire Protection Cost Model (described previously in this paper) postulated that future aircraft losses due to fire incidents were a function of the total number of flight hours (FH) for this period. An historical relationship between fire costs and flight hours was established. The resulting average fire costs per flight hour (in FY 2000 dollars) was $62.85 per flight hour.

The negative net cost values determined for the platforms evaluated to date are in effect the benefit of having the fire suppression system on board. Therefore, the benefit of having a fire suppression system substantially outweighs its cost. The methodology developed during this effort can be used to assist decision-makers to obtain the optimum solution for their particular platform.

The results of this effort are detailed in SURVIAC TR-01-005, "Cost Analysis of Fire Suppression Systems For Fighter Aircraft", M.L. Kolleck, M.V. Bennett, and K.L. Mercer, Technical Report, Booz Allen Hamilton, Dayton, Ohio, August 2001 and SURVIAC TR-00-006, "Cost Analysis of Fire Suppression Systems For Cargo Aircraft", M.L. Kolleck, M.V. Bennett, and K.L. Mercer, Technical Report, Booz Allen Hamilton, Dayton, Ohio, May 2001.

Summary

As seen by the results of these studies, the cost of fire protection is only a small factor of the total fire related costs. This greatly leverages the potential payoff for greater investment in fire protection technologies. The next issue of the Current Awareness Bulletin will discuss various fire suppression technologies under examination.

SURVIAC has proven to be a valuable resource to the fire suppression community and has in return benefited from its involvement in addressing this very pressing operational requirement. SURVIAC's technical area task (TAT) program has

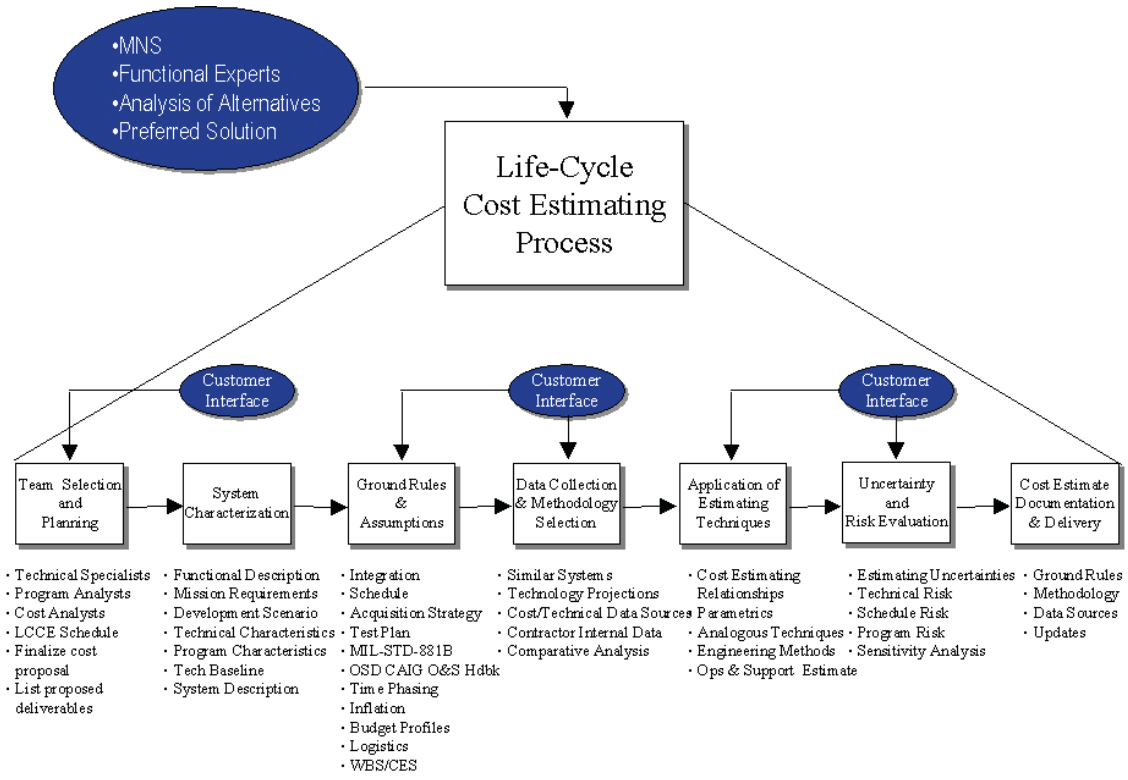


Figure 1. Standard Life Cycle Cost Estimating Process

facilitated numerous aircraft fire protection efforts. These include multi-year client engagements such as support for the Halon Replacement Program for Aviation (HRPA) and the NGP. The HRPA was a Tri-Service and Federal Aviation Administration venture to develop and demonstrate the best available substitutes for halons for new aircraft dry bay and engine nacelle applications. The NGP goal is to develop and demonstrate retrofitable, economically feasible, environmentally-acceptable, and user-safe processes, techniques, and fluids that meet the operational requirements currently satisfied by Halon 1301 systems in aircraft, ships, and land combat vehicles. The NGP addresses halon replacement issues for fielded (legacy) weapon systems. SURVIAC's detailed expert assistance and technical support services will continue to support fire researchers and their future efforts.

SURVIAC has a storied history in its support of fire research. However, the final fire suppression chapter has not been written. There are still numerous areas which need to be addressed. These include, but are not limited to, fire suppression in non-traditional platforms (such as unmanned aerial vehicles, Airborne Laser, space, etc.), fire modeling, effect of utilization of non-traditional materials (such as composites), aging aircraft issues (aircraft wiring), potential for replacement of some halon alternatives as a result of political (such as the continued use of the Halon 1301 bank) or environmental (such as the acceptance of the Kyoto Protocol) restrictions, and examining the physical and chemical properties of advanced agents. No matter the problem, SURVIAC will continue to provide relevant and continued support to the fire suppression community.

For more information please contact Mr. Matt Kolleck, (937) 431-2702 or by email at kolleck_matt@bah.com or Ms. Ginger Bennett,(937) 431-2706 or by e-mail bennett_ginger@bah.com.

SURVIAC Employee Receives Award

Cpl. Clint Black, Cpl. Jim Davis, Cpl. Brad Johnson

On August 17, 2001 James Davis, an employee of SURVIAC and a United States Marine Reservist, was in Washington D.C. to receive an award from the Commandant of the Marine Corps and to be recognized at the Friday Night Parade at Marine Barracks 8th and I in Washington. James was part of the winning squad in the annual Marine Rifle squad competition that was held at Camp Pendleton in San Diego, California. The competition is held every year to determine the top infantry squad in each Division of the Marine Corps. James' squad won nearly every section of the competition, which included physical fitness, land navigation, defensive tactics, offensive tactics, ambush tactics, and marksmanship. Congratulations to James and his squad.

Model Spotlight

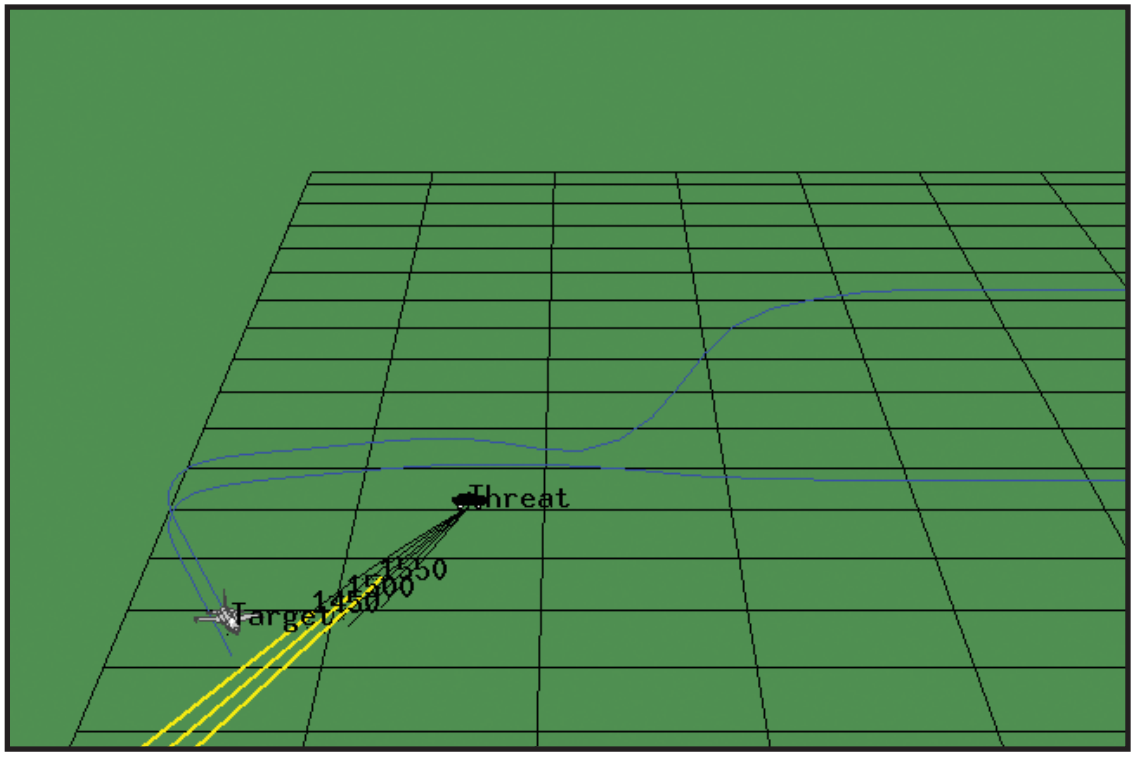
Radar-Directed Gun System Simulation (RADGUNS) 2.3 Released

Starting in September of 2001, SURVIAC began distributing the newest version of RADGUNS (Version 2.3) which was provided by the National Ground Intelligence Center (NGIC). RADGUNS is used to evaluate the effectiveness of Air Defense Artillery (ADA) gun systems against a penetrating aerial target. It can also evaluate the effectiveness of different airborne platform characteristics (RCS, maneuvers, use of electronic countermeasures, etc.) against a specific ADA system. RADGUNS is a complete one-on-one simulation including weapons system, operators, platform mode (RCS and presented/vulnerable areas), flight profiles, environment (clutter/multipath), electronic attack, and endgame. RADGUNS can assess many aspects of a weapon system's performance including platform detection, tracking performance, probability of hit and probability of kill, expected number of hits, and the effects of jamming.

NGIC has placed RADGUNS in a maintenance mode. Aside from integrating standardized models and code agreed to by the BLUEMAX-ALARM-ESAMS-RADGUNS-DIME (BEARD) Alliance, no new features are planned. However, this new version does offer improvements and additions over its Version 2.2 predecessor. The following list outlines the key new features and changes in RADGUNS Version 2.3:

- RADGUNS Fortran source files are now identical for the Unix and Windows operating systems. New run scripts are provided for both platforms and customization of the RADGUNS execution environment is now accomplished via environment variables for defining input and output file locations. For Windows users, a new C++ executable provides the same functionality as the Unix runrg shell script when running the model.

- RADGUNS run screen output can now be saved to a log file.



RADGUNS Results Viewed with IVIEW 2000

• Version 2.3 has a new customizable directory structure. Users are not limited to fixed directory names - the run scripts and RADGUNS executable can be accessed from any directory and the RADGUNS environment variables allow the user to determine input and output directories.

• The local inertial coordinate system has been changed to x North, y East, and z Down (NED coordinate system). A C++ file conversion utility is included to uplift Version 2.2 input parameter and jammer files to Version 2.3 format.

• RADGUNS 2.3 includes a new capability for simulating air-burst munitions such as the AHEAD round. This capability is not fully integrated into RADGUNS, but is included in this release so users may experiment with it.

• A number of bug fixes from Version 2.2 have been made. These bug fixes may cause RADGUNS Version 2.3 simulations to generate different results from those produced by Version 2.2, however these differences are not expected to be large for most simulations.

• The RADGUNS manuals have been updated and improved. There is also an updated and expanded bibliography for RADGUNS which is classified and available upon request from NGIC.

This new version is available directly from SURVIAC on CD-ROM which includes complete versions ready to run on both PC and Unix machines, as well as the full manual set in Adobe Acrobat (PDF) format.

Order requests can be directed to
Mrs. Geri Bowling, SURVIAC,
Com: (937) 255-3828 x285 or
E-mail: bowling_geri@bah.com
Technical questions should be directed to
Michael Bennett at Com: (937) 431-2707 or
E-mail: bennett_michael@bah.com

JMUM 2001 Held

The Joint Technical Coordinating Group on Aircraft Survivability (JTCG/AS) Model User Meeting (JMUM) was held on 19-22 June 2001 at the United States Air Force Academy in Colorado Springs, Colorado. JMUM 2001 was the sixth combined users meeting that has been funded by the JTCG/AS and executed by SURVIAC. The models in the JMUM are: ALARM, AJEM, BLUEMAX, BRAWLER, COVART, DIME, ESAMS, FASTGEN, MIL AASPEM II, and RADGUNS. 100 attendees participated in this the meeting.

JMUM began with a general session. The session contained overviews of JTCG/AS, SURVIAC, and DOT&E and how each organization contributes to the modeling and simulation community. Briefs on each model were presented giving either a status of the model or another related issue. Updates on the Joint Modeling and Simulation System (JMASS) and the Joint Synthetic Battlespace (JSB) Simulation Based Acquisition (SBA) were presented to the community.

Model breakout sessions for each model were held following the general session. Model specific topics were discussed during each of these sessions. Status of the models was presented and future schedules were discussed. The break out sessions included formal presentations and working forums for the users. The working groups also include Configuration Control Board meetings.

JMUM 2002 is scheduled for the 25-28 June 2002 at the United States Air Force Academy. Mark your calendars and plan on attending.

SURVIAC Product Availability

SURVIAC is a U.S. Department of Defense Information Analysis Center (IAC) sponsored by the Defense Technical Information Center (DTIC)

Products

Product	Classification	Reproduction & Handling Fee
A Critical Review of Graphite Epoxy Laser Damage Studies	SECRET	$ 50.00
A Summary of Aerospace Vehicle Computerized Geometric Descriptions for Vulnerability Analyses	Unclassified	$100.00 (Free to Gov't)
Advanced Materials for Enhanced Survivability	SECRET	$100.00
Aircraft Fuel System Fire and Explosion Suppression Design Guide	Unclassified	$150.00/3 Volumes
'Aircraft Survivability' Video	Unclassified	$ 50.00 or 30-Day Loan
Alternatives For Halon 1301 In Army Ground Vehicle Firefighting Systems	Unclassified	$250.00
An Overview of Laser-Induced Eye Effects	SECRET	$150.00
An Overview of Laser Technology and Applications	Unclassified	$ 50.00
'Battle Damage Repair of Composite Structures' Video	Unclassified	$ 75.00
Collection of Vulnerability Test Results for Typical Aircraft Systems and Components	CONFIDENTIAL	$150.00
Comparative Close Air Support Vulnerability Assessment Study - Executive Summary	SECRET	None (Gov't. Only)
Compendium of References for Nonnuclear Aircraft Survivability (A Supplement to MIL-HDBK-336)	Unclassified	$150.00
Component Vulnerability (Pd/h) Workshop Component Pd/h Handbook w/addendum	SECRET	$200.00 (Free to Gov't)
Component Vulnerability Database Development - CD	SECRET	$100.00 (Free to Gov't)
Countermeasures Handbook for Aircraft Survivability (3 Volumes)	SECRET	$200.00 (Free to Gov't)
Critical Review and Technology Assessment (CRTA) for Soldier Survivability (SSv)	Unclassified	$ 50.00
'Designing for Survivability' Video	Unclassified	30-Day Loan
Gas Explosion Suppression Agent Investigation	Unclassified	$200.00
Gun and Missile Pedigree Threat Reports - CD	SECRET	$150.00
Joint Live Fire/Live Fire Test Program Catalogue, Version 3.1	Unclassified	$ 95.00
MANPADS Threat to Aircraft: A Vulnerability Perspective - Final Report	SECRET	$200.00
Model User Group Meeting Minutes - CD	Unclassified	$ 50.00
Munition Response State-of-the-Art Report (SOAR)	Unclassified	$ 50.00
National MANPADS Workshop: A Vulnerability Perspective Proceedings 2 Volumes	SECRET	$200.00
Penetration Characteristics of Advanced Engine Materials	Unclassified	$100.00
Proceedings of the Eighth DOD Conference on DEW Vulnerability, Survivability and Effects - 2 Volumes	SECRET	$125.00/Per Set
RADGUNS 1.8 Parametric Study	SECRET	$100.00 (Free to Gov't)
Ship Survivability Overview	Unclassified	$ 50.00
'SURVIAC - A Capabilities Overview' Video	Unclassified	30-Day Loan
Survivability Analysis Workshop Notebook - 2000	Unclassified	$100.00 (Free to Gov't)
Survivability Systems Master Plan	Unclassified	$ 50.00 (Free to Gov't)
Testing of Aircraft or Aircraft Surrogates with On-Board Munitions	Unclassified	$100.00
"Threat Effects in Aircraft Combat Survivability" Video	Unclassified	$150.00 or 60-Day Loan
Ullage Explosion Hazard State-of-the-Art Report (SOAR)	Unclassified	$ 50.00
Unmanned Aerial Vehicles Survivability Compendium—Interim Report Database	Unclassified	$200.00
U.S. Air Force Surface-To-Air Engagements During Operation Desert Storm	SECRET	$100.00 (Free to Gov't)
Vulnerability Reduction Design Guide for Ground Systems in a Conventional Combat Environment	Unclassified	$200.00

For further information on how to obtain these products and how to establish need-to-know certification, please contact SURVIAC at (937) 255-4840 or DSN 785-4840. Requests from non-U.S. agencies must be forwarded to their country's Embassy in Washington DC, Attn: Air Attache's Office.

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Model	Classification	Reproduction & Handling Fee	
		Model	Documentation
AIRADE 7.4—Airborne Radar Detection Model	Unclassified	$500.00	$ 36.00
ALARM 4.1—Advanced Low Altitude Radar Model	Unclassified	$500.00	$ 50.50+
BLUEMAX IV—Variable Airspeed Flight Path Generator	Unclassified	$500.00	$ 15.00+
BRAWLER 6.4—Air-To-Air Combat Simulation	SECRET	$500.00	$231.50+
BRL-CAD—Ballistic Research Laboratory Computer-Aided Design Package*	Unclassified	$500.00	N/A
COVART 4.1—Computation of Vulnerable Area and Repair Time	Unclassified	$500.00	$ 37.00
DIME—Digital Integrated Modeling Environment	Unclassified	$500.00	$ 63.00
ESAMS 2.8.3—Enhanced Surface-To-Air Missile Simulation	SECRET	$500.00	$295.50+
FASTGEN 3.2—Fast Shotline Generator	Unclassified	$500.00	$ 52.00
FATEPEN—Fast Air Target Encounter Penetration Program	Unclassified	$500.00	TBA
IVIEW 2000—Graphical User Interface for Output Simulation	Unclassified	$100.00	+
JSEM - Joint Service Endgame Model	Unclassified	$500.00	TBA*
LELAWS 3.0—Low Energy Laser Weapons Simulation	Unclassified	$500.00	$ 31.50
MIL-AASPEM — Man-in-the-Loop Air-To-Air System Performance Evaluation Model	Unclassified	$500.00	$ 80.00+
RADGUNS 2.2—Radar-Directed Gun System Simulation	SECRET	$500.00	$ 59.50+
TRAP 3.1a—Trajectory Analysis Program	Unclassified	$500.00	$256.00
TRACES 1.0—Terrain/Rotorcraft Air Combat Evaluation Simulation	Unclassified	$500.00	$127.00

* For more information regarding BRL-CAD or JSEM documentation contact Mr. Bob Strausser at the SURVIAC Aberdeen Satellite, Office, (410) 273-7722.

+ Documentation included with code on CD version of Model at no charge

For further information on how to obtain these models and how to establish need-to-know certification, please contact SURVIAC at (937) 255-4840 or DSN 785-4840. Requests from non-U.S. agencies must be forwarded to their country's Embassy in Washington DC, Attn: Air Attache's Office.

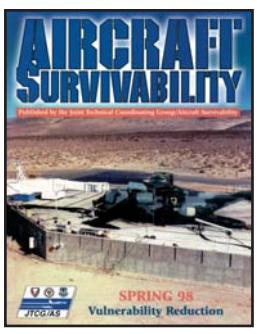
Munituon Response SOAR continued from page 9

tizing munitions to prevent propagation to nearby munitions, especially on ships and in ammunition storage facilities. More work is needed in the area of ground and air vehicle desensitization as well as in the general ability to address changing threats and the different hazards they present.

The testing and combat data section provides a synopsis of the tests performed on the reaction of munitions to ballistic impact, identifies the areas in which emphasis is currently being placed throughout the community, and discusses specific Service programs that are using actual weapons to develop weapons-specific empirical data.

The SOAR concludes with an overview of current and planned activities in this area, requirements for future activities, a list of recommendations, and a comprehensive reference list.

For more information on the SOAR please contact Mr. Art LaGrange, Director, SURVIAC Aberdeen Satellite Office, at (410) 273-7722 or art@survice.com. For a copy of the Munition Response SOAR, please contact Ms. Geri Bowling, DSN: 785-4840, Com: 255-4840 x285 E-mail: gbowling@bah.com



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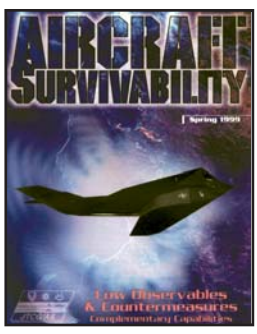


January 2002

2002 Tactical Wheeled Vehicles (event #253)
27-29 January 2002
Monterey, California
POC: NDIA, Angie DeKleine, (703) 247-2599, E-mail: adekleine@ndia.org,
http://www.ndia.org

February 2002

Testing and Evaluation Conference - *Test And Evaluation In The Midst Of Conflict: Confronting the New War*(event #2910)
25-28 February 2002
Savannah, Georgia
POC: NDIA, Phyllis Edmonson, (703) 247-2588, E-mail: pedmonson@ndia.org,
http://www.ndia.org

5th Space Policy & Architecture Symposium (event #234)
26-27 February 2002
Falls Church, Virginia
POC: NDIA, Rhonda Mohrmann, (703) 247-2586, E-mail: rmohrmann@ndia.org,
http://www.ndia.org

Annual Technical Symposium and Exhibition
"Test and Evaluation in the Electronic and Information Domains"
12-14 February 2002
Eglin AFB, Florida
POC: AOC Conference Dept., (703) 549-1600 or (888) OLD-CROW, http://www.aochq.org

March 2002

M&S Follow-on Workshop
4-8 March 2002
Reno, Nevada
POC: Kathy Russell,(760) 939-4908, E-mail: russellka2@navair.navy.mil.

Navy Ballistic Missile Defense Conference (event #2160)
19-20 March 2002
Arlington, Virginia
POC: NDIA, Rhonda Mohrmann, (703) 247-2586, E-mail: rmohrmann@ndia.org,
http://www.ndia.org

April 2002

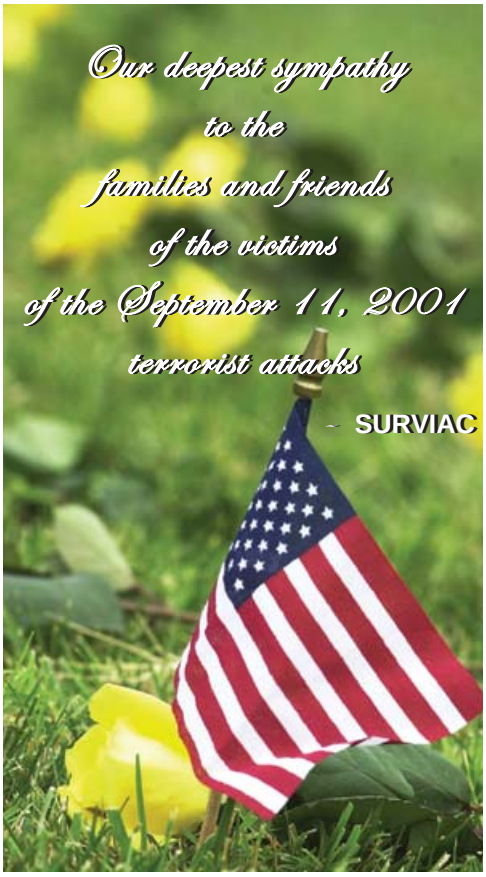
Ground Vehicle Survivability Symposium
8-11 April 2002
Navel Postgraduate School, Monterey, California
POC: Joe Moravec, (810) 978-3106, E-mail: moravec_joseph@bah.com

Advanced Technology Electronic Defense Systems (ATEDS) Program Review
8-11 April 2002
San Diego, California
POC: Jack Kress, (812) 330-1800, E-mail: ATEDS@teklaresearch.com,
http://ateds.crane.navy.mil

Global Air & Space International Business Forum and Exhibition
22-24 April 2002
Arlington, Virginia
POC: AIAA, (703) 264-7500 or (800) 639-AIAA, E-mail: custserv@aiaa.org

For additional conferences visit our website at http://iac.dtic.mil/surviac

Calendar of Events



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