WEAPON SYSTEM POLLUTION PREVENTION

MONITOR

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CONTENTS

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F-22

THE F-22 RAPTOR NEXT-GENERATION FIGHTER UNVEILED

"We see the F-22 as a revolutionary step for the future that will result in an aircraft that we'll be operating well beyond the year 2030."
Air Force Chief of Staff Gen. Ronald R. Fogelman,
Rollout Ceremony for the F-22, 9 April 97

On 9 April, 1997, the first production F-22 air dominance fighter for the U.S. Air Force was unveiled. General Richard Hawley, commander of the Air Force's Air Combat Command - the ultimate user of the F-22 - announced the popular name for the next-generation fighter – *Raptor.* The F-22, which will replace the F-15 Eagle air-superiority fighter in the 21st century, is being developed under the guidance of BGen Mike Mushala at Aeronautical Systems Center (ASC). The goal of the F-22 Single Program Office (SPO) is to develop, field, and support the next-generation air-dominance fighter weapon system, and to establish the standard for acquisition excellence.

To set the standard for acquisition excellence, the F-22 SPO set a goal at the onset of the EMD contract (1989) to become the most "green" aircraft in the world. Subsequently, Boeing/Lockheed-Martin in conjunction with the Air Force, began to establish a comprehensive Pollution Prevention Program to aggressively eliminate and substitute hazardous material throughout all levels of the weapon system design. This issue of the MONITOR summarizes the efforts of the F-22 SPO and the prime contractor team to institutionalize Environment, Safety and Health (ESH) in all phases of the weapon system. ■

DIVISION OF WORK

Boeing (Seattle, Washington): is responsible for the wings, aft fuselage (including the structures necessary for engine and nozzle installation), radar system development and testing, avionics integration, the training systems, and flight-test development and management.

Lockheed Martin Aeronautical Systems (Marietta, GA): is responsible for program management, the integrated forebody (nose section) and forward fuselage (including the cockpit and inlets), leading edges of the wings, the fins and stabilators, flaps, ailerons, landing gear and final assembly of the aircraft.

Lockheed Martin Tactical Aircraft Systems (formerly General Dynamics, Fort Worth Division): is responsible for the mid-fuselage, stores management, integrated navigation and electron warfare systems (INEWS), the communications, navigations, and identification (CNI) system, and the weapon system support.

> *"Air superiority is not a God-given right of Americans Somebody's got to pay attention to this. It's not a business you want to be second best in. You have to dominate. We must overcome an adversary's fighters and surface-to-air missile systems to ensure air superiority for friendly forces."*
>
> Air Force Chief of Staff Gen. Ronald. R. Fogleman
> Rollout Ceremony for the F-22, 9 April 97

FEATURES OF THE F-22 RAPTOR NEXT-GENERATION AIR FIGHTER

Reduced observable: The F-22's stealth is acquired through a combination of shape and materials that deflect or absorb radar energy. This reduces the range at which enemy radar can detect it.

Integrated avionics: The F-22 possesses a sophisticated sensor suite that allows the pilot to track, identify and shoot the threat before it detects the F-22.

Supercruise: This technology is a combination of a new engine and aerodynamic advances that allow it to cruise at supersonic speeds without using fuel-gulping afterburners.

Maneuverability: The F-22 is the first maneuverable stealth aircraft. The B-2 and the F-117 have stealth but cannot maneuver well if engaged by enemy aircraft.

Payload: The F-22 is capable of carrying existing and planned medium- and short-range air-to-air missiles in internal bays. The F-22 will also have an internal 20-mm cannon and provisions for carrying precision ground attack weapons.

> *"Parity is not acceptable with the stakes so high. We owe it to the kids of today who will be soldiers, sailors, airmen and Marines tomorrow."*
>
> Honorable Secretary of the Air Force Sheila E. Windnall
> Rollout Ceremony for the F-22, 9 April 97

Powerplant:
Two Pratt & Whitney F119-PW-100 engines.

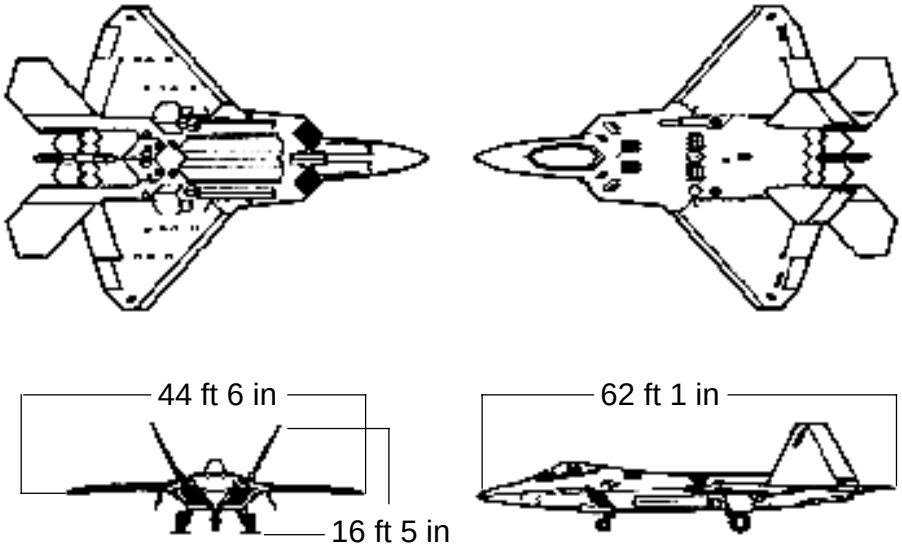
Speed:
The F-22's speed class is Mach 2.

Armament:
Air-to-air and air-to-ground missiles.

Crew:
Model F-22A will carry one crewperson; model F-22B will carry two.

Milestones:
Sept. 29, 1990
First flight of Lockheed Martin-Boeing YF-22 prototype.
April 23, 1991
Air Force awards F-22 Engineering & Manufacturing Development Contract to Lockheed Martin-Boeing team.
Feb. 24, 1995
Air Force approves final design of the F-22.
May 1997
First flight of the F-22 is scheduled.

F-22 Air Dominance Fighter



F-22 PROGRAM INTEGRATES ENVIRONMENT, SAFETY, AND HEALTH CONSIDERATIONS INTO THE ENGINEERING & MANUFACTURING DEVELOPMENT (EMD) CONTRACT LANGUAGE

The F-22 program's efforts to establish a pollution prevention program in the early phases of the acquisition cycle demonstrates that pollution prevention pays. In 1991, after the first YF-22 prototype was developed, the Air Force awarded Lockheed-Martin/Boeing the F-22 Engineering & Manufacturing Development (EMD) contract. Involving occupational, safety, and health personnel in the contract language development has greatly contributed to the program's success in minimizing hazardous materials (HAZMATs) requirements during the design phase of the weapon system.

Traditionally, the responsibility of screening HAZMATs during the design phase has been limited to activities at the contractor facilities and the System Safety Program Office (through MIL-STD-882). For post design activities, this responsibility has been performed by bioenvironmental and civil engineering functions at the base. The F-22 contract language specifically states that all related organizations become involved early in the system design and address HAZMAT *concerns* for the entire system life cycle. The Aerospace Industry Association embraced the F-22 philosophy as a template for developing NAS-411.

Overview: ESH Integration into the F-22 EMD Contract Language

Key elements from the F-22 EMD contract language that facilitate ESH integration into weapon system design are summarized below.

*Approach To Identifying HAZMATs***:** The F-22 contract language stresses the use of a life cycle approach to HAZMAT concerns to assure the system is supportable in the field, and that these concerns are balanced against other weapon system requirements. Specific contract language that makes this weapon system unique for the early 1990s includes the following:

- The contractor is required to identify HAZMAT concerns including health hazards, environmental emissions, and disposal waste products from manufacturing (for processes specific to the Air Force), maintenance, and repair.
- Associate and subcontractors are required to identify HAZMATs used in support of their equipment.
- All appropriate members (e.g., Hazardous Material Management Program (HMMP) Manager, system engineers, etc.) are required to participate in the design of the system and in identifying, where appropriate, potential HAZMAT concerns.
- The HMMP Manager is required to be listed as the point of contact for resolution (including tooling materials, shop consumable, and processing chemicals) of HAZMAT concerns raised during manufacturing, inspection, and flight testing.

*Approach to Controlling/Mitigating HAZMAT Use***:** The F-22 program's contract language specifies the following approaches for controlling HAZMAT use:

- Residual risk from material is documented and reviewed at Environmental Working Group (EWG) meetings and presented to the SPO for review and acceptance.
- Integrated Product Teams (IPTs) review alternative materials and decide whether to eliminate the HAZMAT, substitute a less hazardous material, or accept the risk.
- Materials hazard and control measures are summarized by the contractor and reviewed at EWG meetings which are scheduled and chaired by the SPO.

Methodology for Integration of the Hazardous Materials Management Program (HMMP): Highlights from the contract language supporting this methodology includes the following:

- The contractor provides the EWG a status of the HMMP, identifies HAZMATs selected for use in the system, and provides the results of the HAZMAT risk assessments and material selection trade studies. The

EWG provides a forum for HAZMAT information exchange and guidance to assist in balancing HAZMAT concerns against other program requirements.

- A HAZMAT database (HMDB) be developed from multiple inputs, including inputs from HAZMATs, M&P, Maintainability, and Environmental Protection Safety and Health (EPSO) organizations, as part of the Logistics Support Analysis (LSA) data bases. Currently, the HMDB is available on line to all F-22 team members.
- A joint contractor/government team is developing a bioenvironmental plan for flight testing conducted at Edwards AFB. This plan includes the development of the HAZMAT Pharmacy.

Results

In February 1995, at the critical design review (CDR), the F-22 had a clean record for eliminating all uses of Ozone Depleting Substances (ODS) with the exception of the use of Halon 1301 for fire suppression. Additionally, substantial progress has been achieved in reduction of design related uses of HAZMATs. Some of the successful accomplishments that can be attributed to pollution prevention initiatives have been summarized in Figure 1.

Figure 1. P2 Successes for the F-22 Program

- Incorporated Bioenvironmental engineers early (see related article)
- One ODS requirement at CDR (Feb 95)
- ODC Free Technical Order
- Integrated HAZMAT database with LSA Database (see related article)
- Automated license form for HAZMAT Pharmacy
- Replacement of Cadmium on Landing Gear (per OO-ALC's request)
- Cadmium Free F-119 Engine (see related story)
- No hydraulics on engine cart - all mechanical
- VOC Compliant topcoats and primers

For further information regarding the F-22 program's efforts to integrate ESH considerations into the EMD contract language, please contact Mr. Brian Townsend at DSN 785-7611 ext. 2360. ■

F-22 ESTABLISHES AN INFORMATION MANAGEMENT TOOL FOR INTEGRATING ESH CONSIDERATIONS INTO WEAPON SYSTEM DESIGN

One of the challenges facing the F-22 Environmental Working Group (EWG) has been developing a data system to manage the growing amount of information concerning HAZMAT use. Since many of the same materials used in design and manufacturing are subsequently used in maintenance and support tasks (e.g. primers and paints), the goal was to create a data management system that could provide information relative to all HAZMATs required to support the F-22 for the life cycle of the program.

The vision for such a tool was to share common data regarding HAZMAT use during manufacturing and design across multiple platforms. The relational structure of the Logistics Support Analysis (LSA) data system provides such a capability. The LSA system is an on-line system that provides real-time capability to review weapon system supportability data (see Figure 2 on page 5) for the linkages of this data system in the F-22 Program). To make the required links, the contractor chose ATLAS as the governing software to emulate the LSA data system. Additionally, Lockheed-Marietta used MIL-STD-1388-2B as the source document, to structure the data and to standardize reports.

The relationship between the LSA/HAZMAT database is summarized in Figure 3. The boxed area represent the LSA database in place at the prime contractor's facility, Lockheed-Marietta. ATLAS, which is the software system used for the LSA database, acts as a storage site for "design" HAZMAT information and material analysis reports (HMAR). ATLAS also provides the relations connection of the data elements to the LSA database as discussed above. User interface at the contractor locations is performed through the local server using Access database. The SPO and other government customers access the data through a similar process

In summary, the F-22 program has established a means to link design information in the stand alone HAZMAT database to the maintenance and support tasks information in the LSA database. Current efforts are underway to

Figure 2. LSA Data System

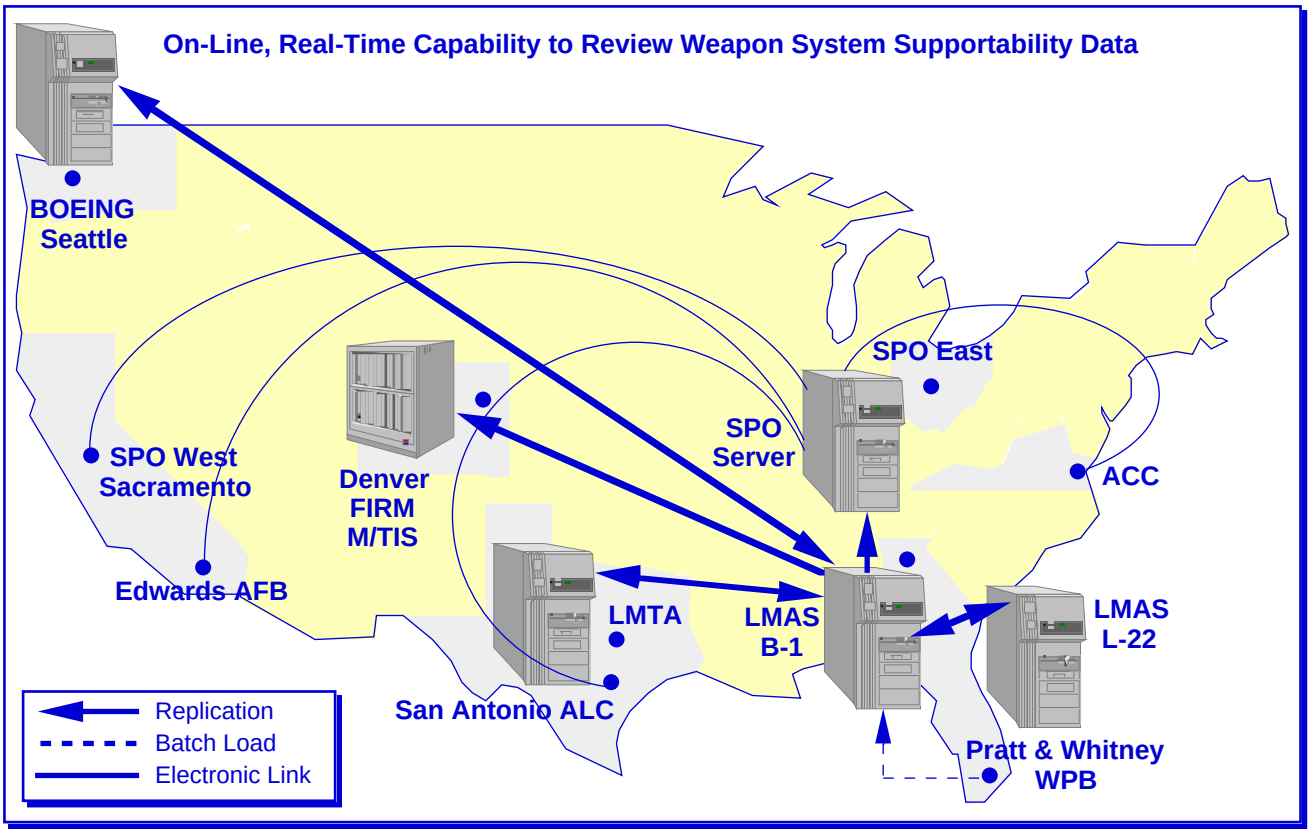
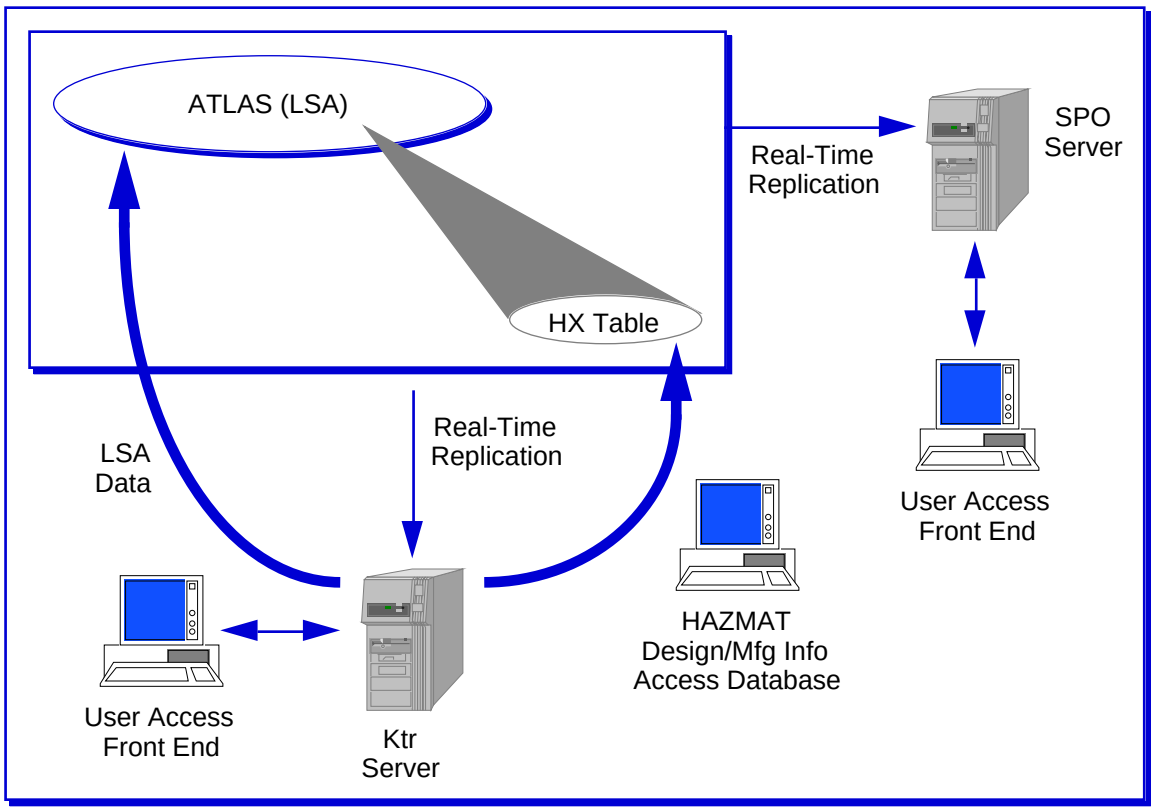


Figure 3. LSA/HAZMAT Data System



complete the HAZMAT license forms for Edwards AFB. Follow on work is planned for electronically loading this information in the pharmacy database. Additional queries are being developed to review various technical order data real time to allow the base bioenvironmental personnel to perform in-process reviews.

For further information regarding how the F-22 Program is using the LSA/HAZMAT database as a tool to integrate Environment, Safety, and Health (ESH) concerns in the F-22 weapon system design, please contact Mr. Brian Townsend at DSN 785-7611 ext. 2360. ■

EDWARDS AFB INTEGRATES THE BIOENVIRONMENTAL ENGINEER (BEE) INTO F-22 FLIGHT TEST OPERATIONS

Edwards AFB, in collaboration with the F-22 SPO, has spearheaded the way for integrating the Bioenvironmental Engineer's (BEE's) traditional roles and responsibilities into flight test operations (see Figure 4). The flight test center has re-allocated its resources and taken a pro-active approach to include the BEE into pre-flight test and beddown activities. The results of this effort clearly demonstrate that the upfront involvement of the BEE can have a positive impact on mitigating risk and ensuring worker health and safety from flight testing to operational beddown activities.

Figure 4. Linking the Bioenvironmental Engineers Traditional Roles and Responsibilities Into the Vision & Strategy for the F-22 Flight Test Operations

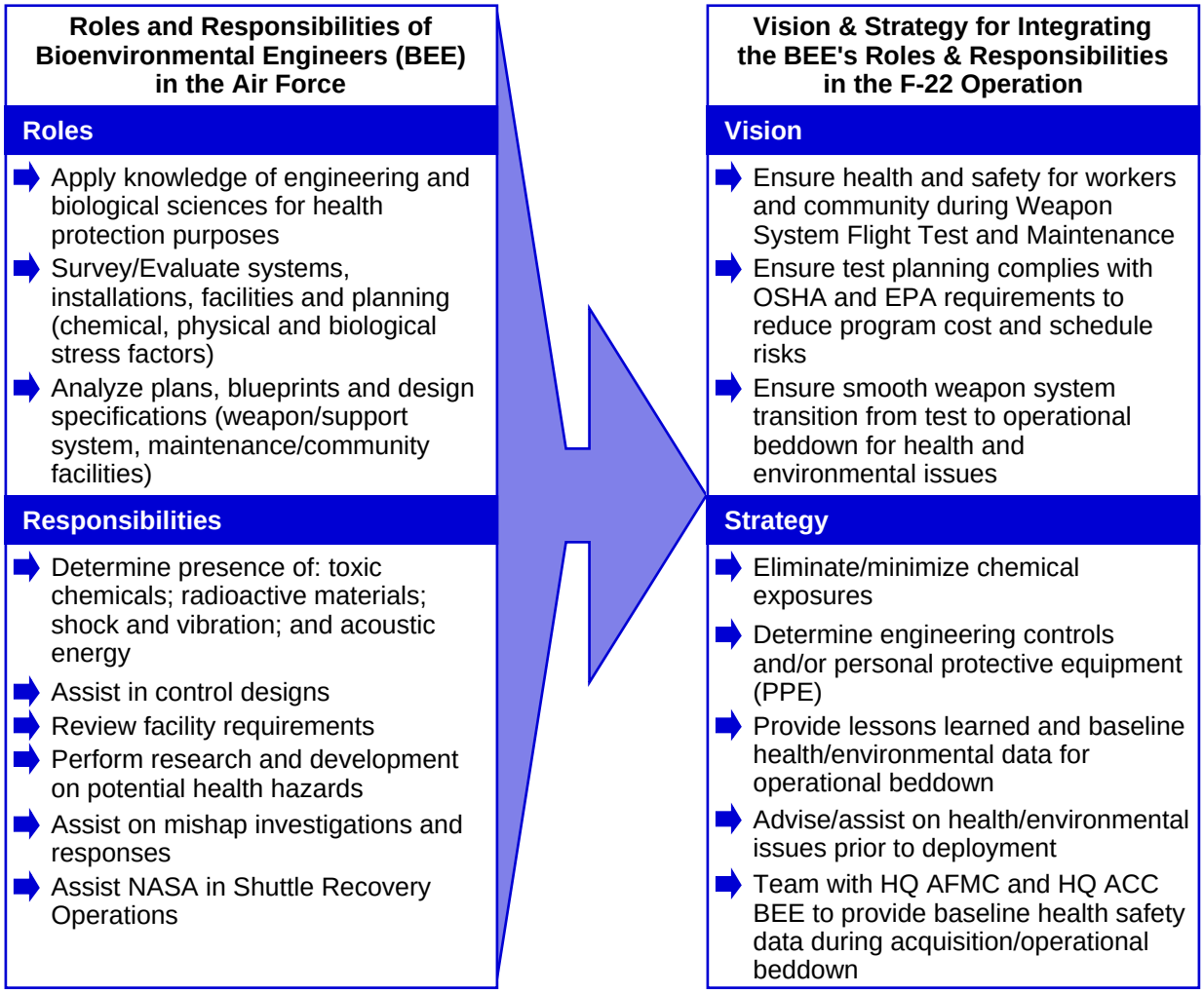
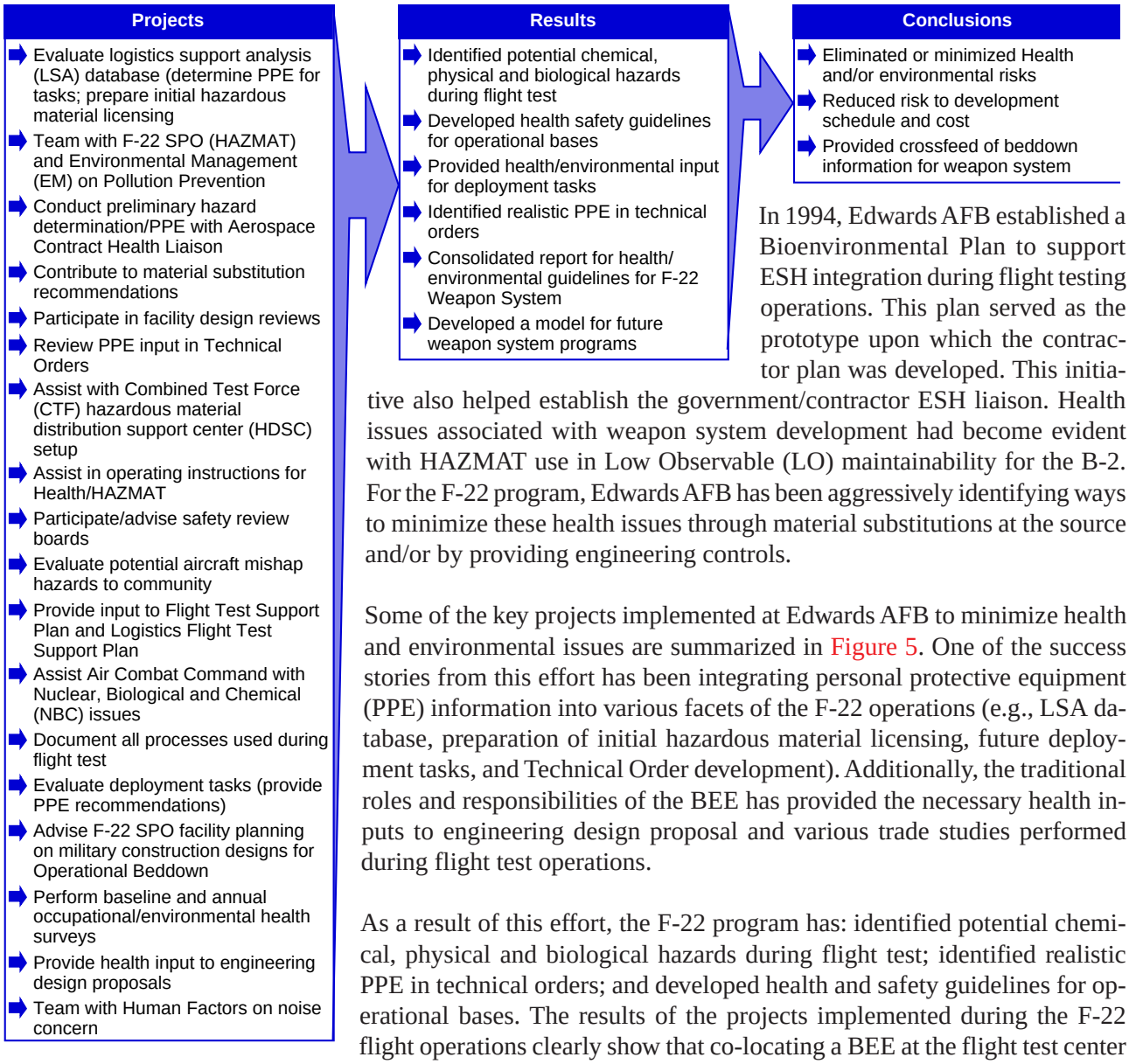


Figure 5. Accomplishments of Integrating Bioenvironmental Engineering into the F-22 Flight Test Operations



In 1994, Edwards AFB established a Bioenvironmental Plan to support ESH integration during flight testing operations. This plan served as the prototype upon which the contractor plan was developed. This initiative also helped establish the government/contractor ESH liaison. Health issues associated with weapon system development had become evident with HAZMAT use in Low Observable (LO) maintainability for the B-2. For the F-22 program, Edwards AFB has been aggressively identifying ways to minimize these health issues through material substitutions at the source and/or by providing engineering controls.

Some of the key projects implemented at Edwards AFB to minimize health and environmental issues are summarized in Figure 5. One of the success stories from this effort has been integrating personal protective equipment (PPE) information into various facets of the F-22 operations (e.g., LSA database, preparation of initial hazardous material licensing, future deployment tasks, and Technical Order development). Additionally, the traditional roles and responsibilities of the BEE has provided the necessary health inputs to engineering design proposal and various trade studies performed during flight test operations.

As a result of this effort, the F-22 program has: identified potential chemical, physical and biological hazards during flight test; identified realistic PPE in technical orders; and developed health and safety guidelines for operational bases. The results of the projects implemented during the F-22 flight operations clearly show that co-locating a BEE at the flight test center has eliminated and/or minimized health and environmental risks, and provided cross-feed for beddown information for the weapon system.

For further information regarding the BEE's efforts in the F-22 program at Edwards AFB, please contact Capt Shelia Scott at DSN 525-4535. ■

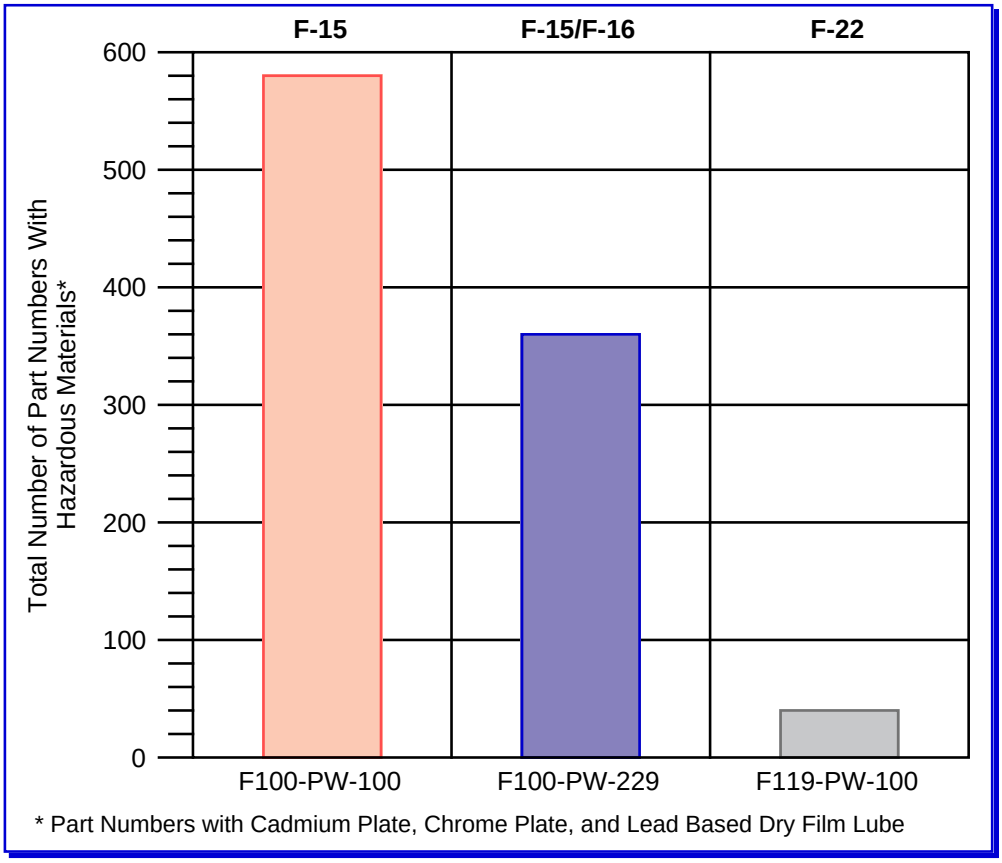
"THE GREEN ENGINE CONCEPT": A NEW WAY OF DOING BUSINESS

This article provides a brief overview of how Pratt & Whitney has changed its business practices in order to produce a greener engine. The success that can be achieved when an effort is made to systematically change processes and modify designs to eliminate and/or minimize the use of hazardous materials (HAZMATs) is shown in Figure 6 (see page 8).

In 1989, under an Air Force F100 engine repair development program, Pratt & Whitney established the design and management structure to ensure that no new HAZMATs were introduced into the Air Force inventory. This initiative was further developed under the requirements of the Hazardous Materials Management Program (HMMP)

for the F-22 Program. Today, the F119 is the "greenest engine" in the Air Force inventory. The engine is cadmium free with minimal application of chromium based materials (excluding alloys) and lead based dry film lubricants.

Figure 6. Moving Towards a Greener Engine



The significant reduction in HAZMAT use in the F-22 engine, as compared to the F-15/F-16, can be attributed to the up front efforts of various integrated product teams (IPTs) and a design review process. Changes were often driven as much by performance requirements as HAZMAT minimization efforts. For example, a large number of designs containing cadmium were eliminated due to a low-melt alloy concern on newly developed alloys in other parts of the engine. This represents a performance driven requirement. There also exists a perception that HAZMAT substitutions will always result in a cost increase and/or a loss in performance. However, Pratt & Whitney has experienced the opposite, especially with regard to manufacturing processes

The "Green Engine Concept" represents a new way of doing business. Pratt & Whitney works up front with various IPTs to assess the expected design, performs trade-off studies, and makes the appropriate recommendation to the Product Manager. The decision on how far to go to make a greener product depends on HMMP costs, the technical feasibility of developing an alternative as well as the impact to product cost, schedule, and performance.

The lessons learned from producing the F119 will be applied and further enhanced for the Joint Strike Fighter (JSF). Although the engine for the JSF is very similar to the F119, an opportunity still exists to make the engine even greener while maintaining current performance, cost, and schedule requirements.

For further information regarding this success story, please contact Dr. Mike Gehron (Pratt & Whitney) at 561-796-6435 or Mr. Brian Townsend (F-22 SPO) at DSN 785-7611 ext. 2360.

This article was prepared in collaboration with Dr. Mike Gehron, Pratt & Whitney, West Palm Beach, FL. ■

If you would like your weapon system to be featured in the MONITOR, please contact Mr. John Biggs at:
JOHN.BIGGS@GUARDIAN.BROOKS.AF.MIL

COMMUNITY CROSS-FEED

FROM THE DESK OF MR. TAD McCALL

It is a pleasure to relate to you the significant progress the AF continues to make to support readiness, be a good neighbor, and leverage resources in areas related to Environment, Safety, and Health (ESH). Your actions are improving productivity, avoiding cost, and supporting the Air Force mission.

We have learned that an earnest dialog with the public is essential to support readiness. Three years ago the public was challenging our use of air space needed for training our pilots in Alaska, Idaho and Colorado. On April 22, 1997, after three years of discussion, over 100 community meetings, the AF and the public have reached agreement that will allow us continued access to 60,000 square miles of Alaskan air space for training. We made over 30 significant modifications and mitigations to our major flying exercise and routing readiness training programs based on a positive interaction with the people of Alaska.

We are learning that Being a Good Neighbor can save time and money. We have established 95 Restoration Advisory Boards at active installations that have opened the door to putting cleanup remedies in place at all but two of our active installations by the year 2007. As an example, a joint venture between the AF's 611th CE Squadron and two Alaskan-native owned businesses avoided spending $500K, sped the cleanup at King Salmon and benefited the local economy.

I am convinced that the most important lesson to be learned is that Leveraging our Resources in the industrial and maintenance workplaces in the AF is a crucial key to productivity and cost reduction. I applaud the C-17 Single Program Office and their leader Brig Gen Charles L. Johnson on their success at systematically reducing present and future costs while minimizing operational problems related to Hazardous Materials and Class 1 Ozone Depleting Substances. The pre-coated rivet success story (MONITOR Vol 4, Number 3, Mar 1997 - Mr. Vickers ASC/YCEF) is an excellent example of avoiding cost and increasing throughput. I am very pleased with the evolution of AFI 32-7086, Hazardous Material Management and the hard work by the MAJCOMs and the AF Tiger Team. Efficient management of hazardous materials is crucial to minimizing operations and maintenance costs through the system's life cycle, eliminating cleanup costs, and maintaining trust with the public.

The Honorable Rodney Coleman, Assistant Secretary of the Air Force (Manpower, Reserve Affairs Installations and Environment) summarized these beliefs in his testimony to the U.S. Senate Defense Subcommittee of the Appropriations Committee. His concluding remarks during this testimony, set the future direction for us collectively. I continue to look forward to hearing about your successes toward this endeavor.

> *"Mr. Chairman, and members of the Committee, three years ago I pledged to build on the Air Force's record for environmental protection and performance. Today, I pledge to revolutionize every aspect of Air Force operations. I am leading the Air Force in new directions. Through Environment, Safety, and Occupational Health, I am building a stronger, more flexible Air Force. With your support, we can meet the challenges of the next century."*
>
> *The Honorable Rodney Coleman*
> *Assistant Secretary to the Air Force* ■

NEXT ISSUE'S SUCCESS STORY

The Air Transport Galley Laboratory (ATGL) is a common use system in multiple weapon systems. The ATGL was designed for Commercial-Off-The-Shelf (COTS) use. All major LRUs such as the oven, refrigerator, brewer, and waste system are COTS items. The ATGL replaces both the C-5 and C-141 comfort pallets and is the only comfort pallet being used for the C-17. The July 97 issue of the MONITOR will provide an overview of the efforts made by the Air Force Single Manager and his staff to make the system "green".

If you have a success story that you would like to feature in the MONITOR or if you would like to be a regular contributor to the "Community Cross-Feed" Section, please contact Mr. John Biggs at e-mail JOHN.BIGGS@GUARDIAN.BROOKS.AF.MIL.

FEEDBACK FROM THE READERS

I find the MONITOR to be a very good source of information about what is going on in weapon system P2. I put this document in my CWG Handbook along with P2IPT and CWG information. It is an excellent publication and maybe the only cross-feed mechanism we have on what is going on with weapon system problems and solutions.
Mr. Dave Bury, WR-ALC/EMP, Robins AFB, GA.

I think your readers at bases and using commands get the most value from articles that summarize what the various ALCs and SPOs are doing in the areas of ODS and HM substitutions, HM minimization, and P2 initiatives. General articles like the B-2 EWG overview are great. I would like to see one from each SPO. Also, more detailed articles on specific imminent changes to Technical Orders (TOs) are of great interest to the field units. They want to know what they can implement in 3 or 4 months from now, not 5 years from now. Keep up the great work.
Mr. Charles Nault, Parsons Engineering Science, Hampton, VA.

Kudos on the March issue. One of the best I have seen to date. Packed with a lot of good information. Keep up the good work!
Capt Allen Naugle, SM-ALC/EMPM, McClellan AFB, CA.

The MONITOR is a great newsletter that covers high interest issues. I rate it an outstanding publication.
Maj Nick Muszynski, HQ AETC/CEVP, Randolph AFB, TX.

The MONITOR keeps me informed about what is happening in weapon system P2. I find it very helpful and it meets my expectations.
Mr. Mike Sneed, OC-ALC/LACRA, Tinker AFB, OK.

The MONITOR provides me with helpful information in the area of P2. I specifically liked the C-17 articles.
SSgt Donald Sedericks, 2nd MUNS/LGWR, Barksdale AFB, LA.

The MONITOR is a good source of information about changes being made in P2.
TSgt Oscar Johnson, 4 AMDS/SGPB, Seymour Johnson AFB, NC.

Based on the feedback received to date, the MONITOR will continue to feature different AF weapon systems and for future issues determine the most effective way to communicate imminent changes to Technical Orders. Please continue to provide your feedback to Mr. John Biggs at (JOHN.BIGGS@GUARDIAN.BROOKS.AF.MIL). ■

THE MONITOR ON INTERNET

The Weapon System Pollution Prevention MONITOR is now available on the Internet. Issues will be placed on the net about one week after publication. The newsletter can be accessed via the HSC/EMP Home Page at http://www.brooks.af.mil/HSC/EMP/emp-home.htm. Any World Wide Web browser (e.g., MOSAIC) can be used to view or download newsletter issues. All internet sites listed in this publication can be accessed through the MONITOR directly.

PERSPECTIVES IN PROFILE FEEDBACK

I read the "Perspectives in Profile: The Challenges Associated with Conducting Life Cycle Cost Analysis" in the March 97 issue of the MONITOR with great interest and concern. Life Cycle Analyses (LCAs) have been difficult and expensive to conduct in the past, and thus have been utilized primarily by large companies for very specific purposes. In the past few years, USEPA's National Risk Management Research Laboratory has been diligently working with the "masters" of LCAs to establish and document consistent methods and procedures, and to expand the realm of applicability of conducting at least parts of the LCA process (i.e., scoping, inventory, impact and/or improvement analysis.)

Concurrently, the Air Force has focused on using the costs associated with environmental management, workplace exposure and long-term liability as the single basis for making decisions within industrial processes. Indeed, for some time now the Air Force has coined and used the term Life Cycle Costing. This aspect of decision making is critical: what is lacking is an appreciation for blending the two analytical tools of LCA and LCC. When "masters" of cost estimating and modeling are tasked to create a system for quantifying environmental costs, their natural tendency is to first identify the elements that establish the cost drivers, and to build an algorithm to integrate those drivers into a specific output format. Just as LCAs must be tailored and literally designed to be specific to the application that they are to be used for, LCCs that attempt to capture the environmental impacts associated with all weapon systems and all aspects of operation and maintenance will ultimately fail.

The M2PCAT model appears to be fundamentally sound and well conceived. The items presented in the figures in the March 97 article capture the cost-related elements of manufacturing and maintenance processes. What is not stated is that the data to input these cost models DOES exist, just not in an off-the-shelf, convenient form. It takes the expertise and experience of those familiar with environmental management to estimate and quantify the time, equipment, production impacts, extent and severity of the hazard, and to establish the long term liability associated with conducting certain activities and/or using certain chemicals in the workplace. The tools to assess these factors exist within the LCA framework.

There is an analogy between LCC and another Air Force program that can now be made in hindsight. When the IRP was developed and documented, it was patterned after already existing Superfund and CERCLA guidance. The only quintessential difference between the two was IRP Phase III, which allowed for R&D/ treatability studies to be done prior to selection of the final remedy (incidentally, IRP Phase III was a direct parallel to the Superfund Innovative Technology Evaluation program). During the first few years of the IRP, more time was spent arguing and defending the Air Force's autonomy and reasons for establishing its own version than in getting sites evaluated. I believe a similar conflict may be occurring with LCC and LCA.

Finally, there is no more critical or optimum time for the DoD to assimilate and make use of the combined LCA and LCC mindset for decision-making than now. With the dramatic and constant downsizing and privatization that is occurring in the DoD today, making sound decisions on what processes and activities must stay within the government, and on what basis, is paramount. It is quite possible that the infrastructure developed, the training and experience of the production staff, and the attention paid to implementing pollution prevention practices into the workplace could make government facilities the right decision. That decision must be based not only on the cost of operation labor, but on factoring and detailing the competitive basis for managing environmental risk.

Gary E. Baker, Pacific Environmental Solutions, Cincinnati, Ohio. ■

SMC INPUT: ENVIRONMENTAL, SAFETY, AND HEALTH MANAGEMENT AND COST HANDBOOK TO BE EXPANDED

The necessity to identify total environmental, safety, and health (ESH) life cycle costs during the acquisition phase is rapidly emerging as one of the most significant challenges program managers face today. Recently, the ESH cost risk of several major programs has been underestimated, resulting in budget and schedule overruns. In many cases, the cause can be traced to poor initial cost estimating. The majority of existing, well-tested environmental cost tools are limited in scope, or have not been appropriate to DoD weapon systems.

DoD Regulation 5000.2-R requires that:

- Safety and health hazards are to be managed and cost-effective.
- Hazardous materials are to be evaluated and managed so that the DoD incurs the lowest cost over the system's life cycle.
- Pollution prevention programs are to be established to help minimize life cycle costs.

The common thread in these requirements is the need for accurate cost information.

In response to this growing list of environmental regulations and requirements, and the increased need for visibility into system ESH life cycle costs, the Air Force Space and Missile Systems Center (SMC) developed and released an ESH Management and Cost Handbook in Sep 96, intended for the single/program managers, cost analysts and the financial community. This 66-page, single volume handbook provides an overview of ESH management and costing, addresses cost estimating methods and tools, core activities that are associated with cost estimating and analysis, and finally ESH cost management trends. The handbook is publicly available through DENIX at **http://128.174.5.51/denix/Public/Policy/ESHMC-Handbook/cost.html**.

Efforts are underway to further develop the SMC ESH Management and Cost Handbook into an Air Force Materiel Command guide to assist Single Managers in consistently evaluating ESH costs in their decision making process. The Acquisition Pollution Prevention Center Working Group endorsed this effort as a Weapon System Pollution Prevention tool under development. The following subjects are being considered for incorporation into the Handbook:

- ESH Work Breakdown Structures
- ESH Risk
- Activity-Based Costing (ABC)
- EPA-model Environmental Accounting
- ISO 14000 Implementation
- Alternative Track to ESH Command & Control

The most promising techniques will be tested, measured, and evaluated within an actual System Program Office.

To formally launch this effort to improve and expand the scope of the Handbook, a kick-off strategy meeting is scheduled to take place at the Space and Missile Systems Center, Los Angeles AFB, on 20-22 May 97. Financial community representatives from each AF product and logistics center, as well as our sister services, have been invited to present and discuss their organizational responsibilities, and the ESH products and services they currently employ. The collective input gathered from the meeting will be used to enhance initial efforts with the intention of making the Handbook applicable to a wide range of weapon systems. For further information about the Handbook, contact Mary Helen Alverio, DSN 833-2822.

This article was submitted by Maj Dan Kamieniecki, SMC/AXZ, DSN 833-6445. ■

HQ AFMC/LG-EV INPUT: CHANGES TO MILITARY WINTER AIRCRAFT DEICING PRACTICES AND AFMC CONCERNS

In the past decade, federal and state Environmental Protection Agency officials have become increasingly strict on waste water discharge. On the federal level, the Clean Water Act Amendments of 1992 started regulating airfield discharge through operational permits. About the same time, Pittsburgh International Airport, which has an AF Reserve unit, was fined by Pennsylvania officials for an Ohio River fish kill. Missouri, Pennsylvania and other states have since banned urea and glycol run-off into water ways. Urea and glycols have been the primary chemical used in public and military airfield deicing operations.

Unfortunately, urea breaks down into a fertilizer which when introduced into rivers or lakes accelerates plant life. Initially, this decreases the water's dissolved oxygen levels. If the concentration of urea discharge is sufficiently large it can result in suffocation of aquatic life. The degradation of glycols also cause similar demands on dissolved oxygen. As a result of federal and state restrictions and fines, Civil Engineering (CE) started looking for alternative deicing compounds. AF Civil Engineering Support Agency (AFCESA) performed field testing on sodium formate (at Minot AFB) and sodium acetate (at Elmandorf AFB) during the 1995-96 deicing season. Field tests showed that sodium formate and sodium acetate performed equivalent or superior to urea as airfield deicing chemicals. The test findings, along with complementary civilian aircraft experience, AFCESA forwarded and HQ USAF/CE signed a memo on 13 September 1996, recommending that all base CE functionals discontinue using urea and switch to sodium formate or sodium acetate as an approved airfield deicing agent. Potassium acetate was already an approved airfield deicing chemical in the governing AFI 32-1045 "Snow and Ice Control." In addition, AFCESA requested and was granted National Stock Numbers (NSNs) for alternate chemicals through the Defense Logistics Agency (DLA). HQ USAF/CE, now HQ USAF/ILEV, again endorsed this recommended substitution in a pamphlet titled "Interim Guidance of Best Management Practices for Aircraft and Airfield Deicing" dated 5 December 1996. The guidance requires CE functionals to get Single Manager and Maintenance coordination prior to converting to an alternative deicing compound.

During winter season of 1993-94, Eielson AFB used potassium acetate for airfield deicing. In February during an exercise involving the F-16s with problematic Electronic Counter Measure (ECM) pods attached, the planes taxied through large pools of slush on the runway. Unfortunately, at times the ECM pods were submerged into the potassium acetate laden slush. Shortly thereafter, severe external and internal corrosion and wiring problems were found on the exposed ECM pods. AFCESA investigated the incident and reported that the chemical application and runway's physical condition were significant contributing factors.

Ethylene glycol was historically the aircraft deicing fluid of choice until the early 1990s. At that time the toxicity of the chemical to animal life became a major concern. So USAF signed a letter which required all bases to substitute propylene glycol for ethylene glycol. Both of these chemicals are Chemical Oxygen Demand (COD) substances, which means they consume oxygen as they break down into simpler chemical compounds. When introduced into water, where dissolved oxygen can be limited, these chemicals can reduce available oxygen significantly resulting in suffocating other animal species. It is rather ironic that converting to the propylene glycol increased the COD problems. To-date, no known environmentally acceptable or humanly safe substitute is available for the glycol based chemicals. Therefore, all Society of Automotive Engineers (SAE) Aerospace Material Specifications (AMS) for aircraft are either ethylene or propylene glycol based. There is basic research and development being performed to find more environmentally friendly deicing chemicals.

Reserve, National Guard, PACAF, and USAFE bases may be the most vulnerable to asset damage due to these new deicing compounds. Operational tenant-host agreements, especially at commercial airports, and foreign regulators, may dictate exposure to these new chemicals. In addition, a significant number of base maintenance organizations do not know what field deicing chemicals are being used at their installation.

Following repeated calls from System Program Offices (SPOs) to HQ AFMC/LG and Wright Labs (WL/MLS) and WL's electrical-conductivity test report findings on these chemicals, HQ AFMC and WL determined that a need exists to investigate further corrosion problems on AF unique materials and systems. WL agreed to determine what test data is available and what additional corrosion compatible requirements are needed. A workshop with MAJCOM and SPO participation occurred in Dayton Ohio on 20 and 21 March. The purpose of the workshop was to determine additional material testing requirements and identify the office of primary responsibility (OPR). For more information or to obtain a copy of the meeting minutes, call 1Lt Ita Udo-Aka, WL/MLS at DSN 785-3953.

After completing the additional AF unique tests, the results will be forwarded to the MAJCOM and/or SPO weapon system owner. The owner will review the test results and if necessary, determine how to minimize the risks identified. Some systems may not require any deviations from current procedures; while others may require Technical Order or local Office Instructional changes, maintenance procedure changes, or possibly the discontinued use of specific systems which exhibit extreme sensitivity to the deicing materials during routine winter operations. For additional information on this subject, please call Mr. Warren Assink, HQ AFMC/LG-EV, at DSN 787-3487/3078.

This article was submitted by Mr. Warren Assink, HQ AFMC/LG-EV, DSN 787-3078. ■

INTERNATIONAL HALON REPLACEMENT WORKING GROUP ACTIVITIES

The International Halon Replacement Working Group (IHRWG) met on 14-16 April, 1997 in Long Beach, CA. The chairperson of the group is Mr. Richard Hill, FAA Program Manager for Aircraft Fire Safety. The IHRWG has representation from national and international airlines, airline manufacturers, and vendors for fire suppression and detection equipment, as well as participation from the FAA, the US Navy, Wright Laboratory and ESC. There were approximately 100 attendees. The purpose of the group is to address the replacement of Halon in aircraft nacelles, cargo compartments, lavatories, and handhelds. The IHRWG is a working group, not a conference, and is technically oriented versus regulatory. Anyone can be a member and there are task groups to work issues. The IHRWG meets 3 times per year.

A number of organizations discussed their halon replacement efforts, and the FAA discussed future rule releases. The FAA is preparing to release a Notice of Proposed Rule Making (NPRM) which identifies a replacement agent with certification criteria of concentration and time for cargo compartments. The leading contender for the replacement agent is HFC-125.

Mr. Frank Hughes from British Airways reported on their task group's briefing to the Montreal Protocol meeting in February 1997 in Melbourne, Australia. The purpose of the briefing was to describe the issues related to the use of Halon in the aviation industry and the need to segregate aviation requirements from facilities. The major issues are safety, minimal releases of Halon and retrofit costs. The task group is developing a 30 year plan for Halon redistribution, redeployment, recycle

and banking for the 30989 aircraft in the international civilian commercial fleet. An informal estimate of the quantity of Halon usage for the 30989 aircraft was also presented and is about 100,000 pounds per year. The estimate was generated by one organization and the data is very "soft". There is a need to get better data to develop an adequate strategy. The Montreal Protocol Group had a positive response to the briefing, did not see any Halon use restrictions, but wanted to see the aviation industry do the following:

- Proceed but not compromise safety.
- Change over ground systems to a Halon free system.
- Continue working to find alternative agents.
- Use simulants for certification.

Mr. Bill Leach from the Naval Air Warfare Center briefed on the results from testing of simulants for Halon 1301. The modification of aircraft that require a test to certify Halon 1301 concentration levels and time duration should use a gas simulating Halon 1301 rather than Halon 1301. They have found that HFC-125 is a candidate for use as a simulant in certifying a Halon 1301 system and have identified appropriate ratios and criteria. The criteria for engine compartments is different than in cargo compartments.

Mr. Konstantin Kallergis from DLR in Germany briefed on the results of performance of agents for handhelds. The results indicated that Halon 1211 and Triodide were close performers, followed by FM-200 and then by PF5014. The testing was for information and was not tied to the FAA hidden fire requirement. Mr. Hill from the FAA then discussed the criteria for replacement of the Halon 1211 in handheld fire extinguishers. The new agent should be:

- equivalent to Halon 1211 i.e., combat the seat fire;
- contained in an approved extinguisher;
- no more hazardous that Halon 1211 in a compartment for a large fire. Toxicity should include agent and burning material;
- able to combat hidden fire.

Mr. Hill from the FAA discussed the status of the engine nacelle task group. The minimum performance standards were defined at recent meeting in Atlantic City. The engine simulator is being assembled. There are no replacement agents approved, but CF_3I is the closest to being approved. The program is being delayed due to FAA personnel being temporarily assigned to the Trans World Airlines Flight 800 investigation.

Mr. Dave Blake from the FAA briefed on testing to date on cargo compartments. The configuration tested is a typical cargo compartment of 2357 cubic feet with class A containers. Agents tested included Halon 1211, HFC-125, FM-200 and CF_3I. Graphs showing oxygen concentration, agent concentration, and temperature versus time were presented with the purpose of identifying the time the fire breaks out. These tests will be used as a qualitative indicator for identifying agents and certification criteria for replacement of Halon systems. There was a toxicity issue resulting from the test. I_2 and HI, which are reaction products of CF_3I, were measured as a combined concentration due to the limitations of the sampling instrumentation. The combined measured concentrations of I_2 and HI were higher than OSHA's ceiling limits for I_2. This condition persisted for up to 48 hours after initial CF_3I application.

The residual concentration of I_2 and HI caused some concern for using CF_3I in cargo compartments due to leakage through the floors of the aircraft into the passenger compartment. The question put to the floor was should CF_3I continue to be an alternative for cargo compartments. Some participants indicated that it would be advantageous to have the same agent in the nacelles as in the cargo compartments. Others thought having different agents would not be a problem. The conclusion was to continue testing CF_3I as an alternative with the acknowledgment that CF_3I leaves a residue which continues to outgas.

Dr. Robert Tapscott for New Mexico Engineering Research Institute (NMERI) at the University of New Mexico discussed the status of his working group on reviewing all Halon options technology. He has a draft

report available on the web at http://nmeri.unm.edu/cget/cget.htm. He also reported that keeping up with new technology is difficult and he welcomes inputs from all interested parties.

Mr. Hill from the FAA led a discussion on strategy for usage of Halon in the aviation industry. He believes Halon will be used for a long time in aviation especially in terms of retrofit. New systems should take the initiative for new agents. The industry should look at improving the recycling and preserving of the Halon available. Other related areas include:

- Identify other simulants.
- Put more effort on reducing releases.
- Address maintenance procedures.
- Identify changes in training which could reduce releases.
- Reduce false alarm rates.
- Evaluate changes in hydrostatic testing.
- Replace Halon 1301 in all ground systems.
- Make a case for continued airborne use of Halon.
- Continue working to find replacement agents.

During this discussion ATA Airline indicated that they requested and were granted a waiver by the DOT of performing the hydrostatic testing of the Halon bottles until the rupture disk fails, which is expected at about 14 years. The Navy also indicated that they have reviewed data from 30 years of hydrostatic testing and never had a failure. They have suspended the requirement for hydrostatic testing of Halon bottles unless there is an indication of a problem on the bottle. The comment was made that material changes on bottles may have obviated the need for hydrostatic testing although the requirement for testing still exists. A new task group on hydrostatic testing of bottles was initiated.

For further information, please call Mr. Dick Lamontagne, ESC/AXEE, at DSN 478-5980 ask for MITRE ext. 6930/Comm 617-271-6930.

This article was submitted by Mr. Dick Lamontagne, MITRE. ■

SYSTEM SAFETY AND MIL-STD-882: THEIR IMPORTANCE TO WEAPON SYSTEM POLLUTION PREVENTION

The origins of modern system safety are generally recognized to have been in the ballistic missile development programs during and after World War II. The late-20th century has seen the advent and/or maturing of several programs and industries that involve increasingly complex systems controlling more acutely hazardous sources of energy and toxicity. These programs, including the nuclear power industry, aviation, human space flight programs, the chemical processing industry, and of course, DoD weapon system programs, have provided the necessary hosts for evolution and refinement of system safety as a formal technical discipline. Though system safety is a formal and distinct discipline, its fundamentals are fairly universal and overlap with the fundamentals of many other technical and assurance disciplines, such as human factors and reliability engineering.

The Military Standard for System Safety Program Requirements, MIL-STD-882, originally debuted over 25 years ago, and has been improved upon through various revisions. Its most recent approved version is Revision C, although a draft Revision D has been disseminated for review and comment. MIL-STD-882C is a very flexible standard, geared towards the setting up and running of a System Safety Program. It provides a "menu" of system safety tasks grouped into Program Management and Control, Design and Integration, Design Evaluation, and Compliance and Verification. The standard also gives detailed guidance on how to "tailor" the system safety program; that is, how to select tasks appropriate to the overall activity and apply them within the context of mission constraints.

One of the basic tenets of the standard (and of system safety in general) is that management emphasis on safety being designed in is applied early—during system acquisition—and throughout the system life cycle. Through adherence to this tenet and judicious tailoring of the system safety program, the system safety function is assured

of adding value, rather than an obstacle, to the program. Pollution prevention (P2) concepts have been a part of system safety for quite some time. Damage to the environment, which includes pollution, is part of the MIL-STD-882C definitions of "mishap" and "safety."

The direction provided by MIL-STD-882C indicates clearly that a system's life cycle, throughout which the system safety program is applied, includes the disposal/retirement phase. Analysis to identify all hazards associated with the retirement phase of a program should be performed as early in the program's life cycle as possible. Areas and activities involving potential retirement phase hazards may include the following:

- Transportation, handling, destruction, or permanent storage of hazardous wastes or hazardous materials generated during the program
- Cleanup of chemical, radioactive, or other contamination caused by the program.
- Dismantling/disposing of systems and equipment and/or deactivation of facilities no longer needed after completion of the program.
- Consideration for mothballing facilities and/or equipment for future reactivation.

It can be seen that proper consideration of these areas and activities will support P2 efforts.

This article was submitted by Mr. David B. West, SAIC, Dublin, Ohio. ■

UPCOMING EVENTS

Date	Meeting	Location	POC	Phone/Fax
04 Jun	Weapon System P2 Center Working Group VTC	1100-1200 Eastern Time	Mr. Peter Logan	DSN 478-8338
04 Jun	Center Environmental Protection Committee Meeting	WPAFB, OH, Area B, Bldg. 10	Capt Craig Smyser	DSN 785-3054, ext. 345
04-05 Jun	Weapon System P2 Applications Course	OO-ALC, Hill AFB, UT	Maj Norm LeClair	DSN 777-6655
09-11 Jun	SAE G-12 Aircraft Ground Deicing Committee Meeting	Pittsburgh Airport Marriott, Pittsburgh, PA	Ms. Gina Saxton	(412) 772-4841
11-13 Jun	SAE 97, Aircraft Ground Deicing Conference	Pittsburgh Airport Marriott, Pittsburgh, PA	SAE	(412) 772-7131
11 Jun	B-2 Environmental Working Group Meeting	Whiteman AFB, MO	Capt Jason Herman	DSN 785-9502
16-20 Jun	Weapon System P2 Applications Course, 2-2 day courses	ASC, WPAFB, OH	2Lt Saulo Cepeda	DSN 785-3054, ext. 314
17-18 Jun	Process Solutions Recovery & Recycle Information Exchange	Key Bridge Marriott Hotel, Arlington, VA	Ms. Kathy Noll	(814) 269-6859 FAX (814) 269-2798
Week of 23-27 Jun	Weapon System P2 Applications Course	ASC, Eglin AFB, FL	Dr. Odin Toness	DSN 872-3310, ext. 2161
25-26 Jun	Air Force Coating Technology Screening Committee Meeting	WR-ALC/TIE, Robins AFB, GA	Mr. Jim Kampe	DSN 785-3370 FAX DSN 986-2284
08-09 Jul	3rd Annual Cadmium Alternatives: Information Exchange	NDCEE, Johnstown, PA	Ms. Teresa Kishlock	(814) 269-2800
15-17 Jul	Weapon System P2 Center Working Group Conf. - 7th Joint Solutions to Common Problems	NDCEE, Johnstown, PA	Ms. Kathy Noll	(814) 269-6859 FAX (814) 269-2798
16-18 Jul	USAFSAM Advanced Environmental/Readiness Operations Course (AEROC)	Brooks AFB, TX, Bldg. 775	Maj Richard McCoy	DSN 240-3831
22-24 Jul	Halon Replacement Symposium	Hope Hotel & Conference Center, WPAFB, OH	Dr. Harvey Paige	(937) 255-9038 FAX (937) 255-9019
04-07 Aug	Annual Joint Service Pollution Prevention Conference and Exhibition	Henry B. Gonzalez Convention Center, San Antonio, TX	Mr. W. Bruce Holt, ADPA	(703) 522-1820 FAX (703) 522-1885
26-29 Aug	1997 Aerospace Industries Association's Hazardous Materials Management Conference	The Breakers, Palm Beach, FL	Aerospace Industry Association	(303) 690-4245, internet: www.summits.com/aia97