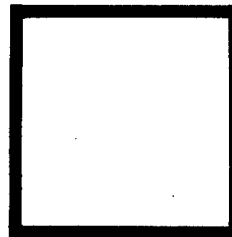


# AIR FORCE JOURNAL <sup>of</sup> LOGISTICS



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1980**

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## Aircraft Battle Damage Repair: A Force Multiplier

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### Abstract

*Past combat experience indicates that for every aircraft lost in combat a similar or often greater number will return with some form of combat damage. During an intense conflict, additional aircraft will be damaged on the ground due to enemy attacks and aircraft accidents. To meet the high sortie rates required by the various operational plans, these aircraft must be quickly repaired and returned to combat. Our peacetime repair of damage normally takes weeks rather than hours; consequently, our normal peacetime repair procedures cannot be expected to meet our wartime needs in a surge sortie environment.*

*This paper presents a program to enhance the capability of the Air Force to accomplish rapid repair of battle damaged aircraft as a means to increase wartime aircraft availability and sortie rates.*

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### Introduction

In recent years, there has been much concern about the threat imposed by potential adversaries who possess vast quantities of sophisticated weapons of war. It is almost certain that our aircraft casualties, either damaged or destroyed, will be very high in any future conflict. A significant number of aircraft will return from combat missions with battle damage that will preclude their use for further missions until a measure of repair has been made. It will be essential that repairs be made, and the aircraft returned to operational use in the shortest possible time.

There is no doubt that if our operational effectiveness is to be maintained, aircraft damaged in battle will have to be repaired quickly. This can be illustrated by a preliminary assessment of the effect of battle damage, and the resultant repairs, on the possible sorties of two A-10 squadrons of 48 aircraft operating in Central Europe. Although the A-10 is specifically designed to tolerate damage and be easily repaired, when an attrition rate of 3% and an associated damage rate of 13% are assumed, and unless a good repair capability exists, 177 sorties will be lost over a 10 day period from the 777 that would be theoretically available. Assuming that 50% of the damaged aircraft can be repaired in 6 hours, and the remaining aircraft repaired in 18 hours, 114 additional sorties would be available. If higher rates are assumed, such as attrition rate of 5% and a damage rate of 22%, even more dramatic numbers of mission denials occur (1:2). In both these cases, we are talking about the repair of about 12 aircraft a day. This is just for two squadrons, but indicates the size of the task facing us. It is very unlikely that today's peacetime resources or procedures could successfully operate on such a scale. Analysis of

historic combat data, including World War II, suggests that two to four aircraft will return damaged for every aircraft lost. This proportion has been reasonably constant for all conflicts since World War II and will probably hold true for future conflicts. In a recent study completed by HQ PACAF, aircraft battle damage repair had the greatest influence of all factors on sortie surge capabilities during the first five days of a conflict. The study further concluded that we have an overwhelming need to create, plan for, and identify procedures to expedite the repair of battle damaged aircraft (6:2).

### REQUIREMENT FOR RAPID REPAIRS

In previous conflicts, aircraft maintenance support requirements (both personnel and materiel) have been dominated by scheduled and unscheduled maintenance. Extensive preparations for repair of battle damage were not necessary due to the relative security of U.S. forces, no necessity to surge aircraft, the luxury of extra "attrition filler" aircraft, and the availability of depot teams to accomplish the necessary repairs. It is reasonable to assume that in the event of a future conflict, the requirement for sorties will be very high, especially in the initial phase of hostilities. Without an effective capability to rapidly repair battle damaged aircraft, the theater commander can expect to lose a significant number of sorties due to damaged aircraft awaiting repair actions.

In peacetime, maintenance standards and repair criteria are geared to maintaining a long operational life on the aircraft. Repairs are made to restore the structure to its original strength, and to last for the duration of the aircraft's life. In the event of war, carrying out repairs to these high standards would involve long periods of time and eventually would lead to a lack of aircraft. It is essential, therefore, that capabilities be developed to make speedy repairs and return battle damaged aircraft to operational use in the shortest possible time.

There are three types of preparations which have the potential for minimizing delays caused by the repair of battle damage, and which could significantly increase the number of damaged aircraft returned to operational service: allow the use of time saving temporary or partial repairs on certain types of damage; train maintenance personnel in the skills and techniques required to effect rapid repairs; and provision the necessary materiel required to accomplish rapid aircraft and battle damage repair.

The primary purpose of any rapid battle damage repair is to restore sufficient strength and serviceability to the

aircraft to permit the aircraft to fly additional operational sorties, of at least partial mission capability, in time to contribute to the outcome of the on-going battle. A secondary objective is to enable those aircraft damaged beyond unit repair capability to make a one time flight to its home station, rear area base, or major repair facility. Rapid aircraft battle damage repair involves simple repair techniques which eliminate most of the fatigue conscious methods used in peacetime. Rapid repairs can be performed on most types of damage, resulting in significant savings of time without compromising the safety or mission effectiveness of the aircraft.

### Effect of Battle Damage Repair Times

The savings in time using rapid repair techniques can best be illustrated by comparing the repair times from Southeast Asia and those from Israel's Yom Kippur War. In Southeast Asia, the Air Force was able to repair some 46% of the F-4 battle damage cases within 24 hours, and another 13% within 48 hours. In contrast, using rapid repair techniques, the Israelis repaired and returned to combat a majority of their battle damage aircraft within 24 hours (6:40:45). Within current USAF organizational capabilities, it would appear that the Air Force would indeed be hard pressed to approach Israeli repair times.

The markedly strong influence of battle damage repair times on sortie generation, while surging under moderately heavy attrition and battle damage rates, is shown in Figures 1 and 2 (6:28-29). Figure 2 indicates that if a strong emphasis is placed on preparation for rapid repair of battle damaged aircraft during surge operations by providing manning, supplies, and facilities as appropriate, a high payoff in terms of sortie generation is available.

### THE AIR FORCE PROGRAM

Headquarters Air Force has recognized the need for a viable aircraft battle damage repair program and has set out to establish a program in each of the major commands. This section outlines the program being implemented and

Status of Fleet during Surge  
(2.88% Attrition) (4 to 1 Damage/Loss Ratio)  
(USAF Damage Repair Times)

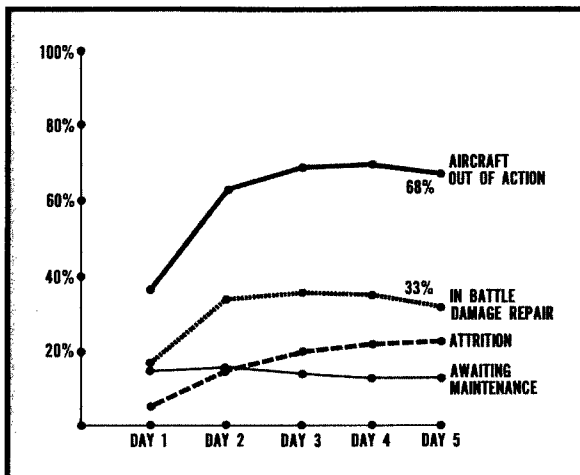


Figure 1.

addresses procedures, manpower and training, and required research and development necessary for such a program.

In order for the Air Force to attain a maximum capability to repair battle damaged aircraft, both an organic unit ABDR capability as well as specialized ABDR augmentation support provided by AFLC Combat Logistics Support Squadrons (CLSS) is required. Each unit will have ABDR technicians trained and prepared to repair the initial damaged aircraft until supplemental ABDR augmentation forces from AFLC become available through normal deployment. The Air Force concept requiring these ABDR teams has been completed. The AFLC ABDR Concept was effective 1 June 1979, and each CLSS has been transitioning to the new ABDR role; at the same time, six Air Force Reserve CLSS's have been restructuring their missions and manning to better meet wartime needs. As of the start of 1980, USAFE was in the process of establishing ABDR units at each of the wings in Europe.

The assessment of damage to each aircraft is the key to any battle damage repair capability, both in the unit and augmentation team levels. The assessors for each team will play a critical role in the speed with which damaged aircraft can be regenerated for wartime sortie requirements. Their primary tasks are to evaluate the extent of battle damage, determine the capability to effect repairs given the available resources of materials, tools, facilities and manpower; estimate the amount of time required to repair all or part of the damage; and specify the repairs to be accomplished and/or deferred so as to return the aircraft to wartime mission capable condition in minimum time. Complete knowledge of aircraft structures and systems operation is required; therefore, only the most qualified and experienced maintenance personnel available should be selected and trained as ABDR assessors.

As a minimum, both organic unit and Combat Logistics

Effect of Battle Damage Repair Times  
Air-to-Ground Sortie Surge  
(2.88% Attrition) (4 to 1 Damage/Loss Ratio)

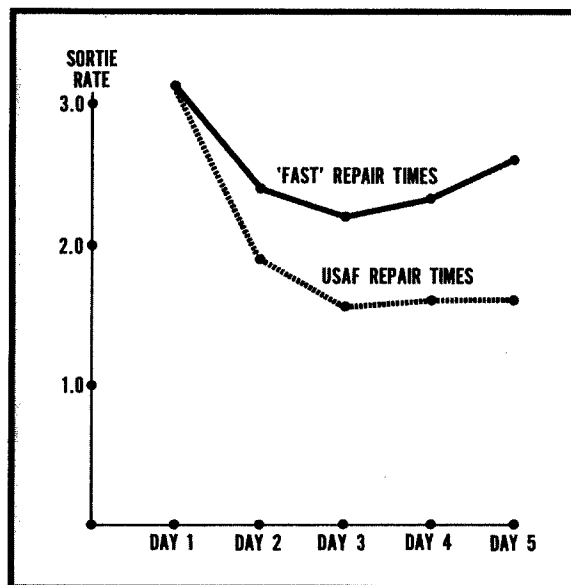


Figure 2.

Support Squadron repair teams should be capable of accomplishing the following tasks:

- Assess the extent of the damage and the impact it would have on the aircraft's mission capabilities, to include the need to repair.

- Assess the capability of the team to repair the damage given the available tools, materiel, facilities and manpower.

- Estimate the time to repair so that proper scheduling can be accomplished for the next mission.

- Accomplish repairs.

- Evaluate adequacy of the repair.

- Identify operational/mission limitations placed on the aircraft due to the nature of the damage and of the temporary repairs accomplished (i.e., airspeed, G-load limitations).

- Reassess previous quick repairs to assure continued air-worthiness.

### Technical Orders

To adequately support repair team activities and allow them to be trained in their repair tasks, aircraft battle damage repair technical orders are being developed to provide the repair guidance. A basic ABDR technical order will be developed to cover typical damage assessment and repairs applicable to all aircraft. A specific weapon system technical order, to be completed on a staggered basis throughout 1980, will address peculiar battle damage assessment and specialized structural and systems repair information pertinent to each individual aircraft. These ABDR technical orders are intended to provide the necessary level of information to trained ABDR technicians and assessors to allow them to accomplish most types of rapid repairs in the absence of engineering assistance. The technical orders will be as simple, basic and general as possible and give the technician latitude to apply innovative repair techniques, ingenuity, and initiative to effect timely repairs which may not be covered in the technical orders. This approach represents a significant departure from the peacetime dependency upon detailed, structured, voluminous, and very restrictive technical data. However, this innovative approach is essential to support the Air Force ABDR objective of rapid repair in combat. Procedures for corrosion control, repair longevity (fatigue), and virtually all cosmetic considerations for repairs will not be included in ABDR technical orders.

ABDR technical orders will concentrate on rapid repairs for both airframes and systems. The repairs support the minimum ABDR objective of returning as many damaged aircraft as possible to service in time to contribute to the on-going air battle, with sufficient mission capability and structural integrity to fly at least one additional combat sortie. However, the ultimate goal of ABDR is to effect the best possible repairs and to return damaged aircraft to as full an operational condition as possible within the time available.

The basic ABDR technical order will be used to establish initial ABDR training courses for both operational units and CLSSs, and will provide the basis for determining initial equipment, tool, and material requirements. The

common damage assessment and repair criteria in the basic technical order will afford all repair technicians and assessors throughout the Air Force a degree of standardization in ABDR capabilities.

As mentioned previously, damage assessment is the most essential and critical task involved in repair ABDR. To provide assessors with as much weapon system specific information as possible, the following types of information will be included in each specific ABDR technical order:

- Detailed schematics of structural members differentiating between criticality of structure.

- Systems, system components, airframe panels, and structural members which need not be repaired to retain "full" operational capability, or which need not be repaired to retain a "limited" operational capability.

- Peculiar systems and structural damage assessment and repair requirements unique to that aircraft.

- Listing of acceptable missing panels, fasteners, latches, etc.

- Critical requirements for particular aircraft systems, such as flight control balance requirements and critical stress structures, which may not be appropriate for quick fix ABDR repairs.

- Mission, operational and flight limitations imposed by various degrees of temporary and/or partial ABDR repairs on the various aircraft structure and systems.

Maximum coordination and participation among the technical order developers, industry, and ABDR research and development activities is required to ensure all current and future state-of-the-art repair technology is considered and included in the technical orders.

### Training

Traditional aircraft maintenance training courses have trained individuals to perform specific tasks in strict accordance with detailed technical data. The innovative, inventive approach, and the rapid, temporary and partial repair philosophy of the USAF ABDR concept represents a significant departure from current aircraft maintenance and repair philosophy. Therefore, there will be an extensive training requirement to educate not only ABDR assessors and repair technicians in rapid repair procedures and techniques, but all maintenance personnel in the new attitude or frame of mind under the new concept. Specific courses will be designed to meet the following training requirements:

- Initial and follow-on training for maintenance personnel - an orientation course intended to familiarize maintenance personnel with the ABDR concept and philosophy.

- Specialized training for ABDR assessors and repair technicians.

- Unit proficiency training - a "hands-on" training program for ABDR assessors and repair technicians which includes periodic ABDR exercises emphasizing a simulated wartime environment.

ABDR assessment and repair concepts will be incorporated into existing aircraft maintenance officer courses. ABDR familiarization training will be given to aircraft engineering personnel (AFSC/AFLC) who are tasked, or might be tasked, to augment unit assessor

capability in wartime. In addition, all aircrews and operational personnel will be indoctrinated in the concepts of rapid ABDR, as to how it represents a major departure from traditional air worthiness and systems/mission capability criteria. Training mockups of airframe structures and systems, together with salvaged airframe hulks, will be used in ABDR training programs to provide realistic "hands-on" experience for ABDR assessors and repair technicians.

A prototype ABDR training course started July 1979 at McClellan AFB to train A-10 and F-111 CLSS personnel. ATC has been developing similar programs for the remaining CLSS units, and will eventually train maintenance personnel worldwide in the ABDR concept.

### **Evaluations and Exercises**

No proposed program would be complete without some way to evaluate and validate its adequacy. Periodic evaluations and exercises to determine each unit's capability to accomplish rapid aircraft battle damage repair should be conducted. Methods and procedures for evaluating this capability should be established by each command and should be standardized as much as possible throughout the Air Force and with allied Air Forces. Approaches to evaluate ABDR assessment and repair capabilities should consider the following:

- Exercise unit ABDR capability, including CLSS augmentation, during unit mobility exercises, practice ORI/TAC evaluations, and joint command exercises. Whenever possible, crashed/reclamation aircraft or airframe sections will be used to simulate battle damaged aircraft in these evaluations.

- Evaluations during actual ORI/TAC evaluations may include practical hands-on repairs to measure unit capability.

- ABDR evaluations should be conducted under simulated combat conditions which may include wearing the chemical/biological ensemble.

- Methods for evaluating the adequacy of repair, such as using AFLC/AFSC engineering resources, should be developed.

### **Research and Development**

A program of this magnitude and scope requires the support of an active research and development program not only to improve the existing capabilities to accomplish rapid repairs, but to investigate, in a long-term effort, new and more effective materials and techniques. The basic objectives of this type of program are to expand the data base which currently exists for rapid repair actions, to develop new and innovative materials and techniques which will reduce repair time, increase standardization, and improve the capability to perform ABDR under wartime conditions. The proposed research and development program should, as a minimum, assist in improving current capabilities in the following areas:

- Actual tests of various projectile damage on airframe and system components plus initial research on the ability to assess the damage with rapid ABDR in mind.

- Assessment of the ABDR technical orders to determine

areas where significant improvements in our ability to perform rapid repair could result through the development of advanced technology. Areas addressed should include airframe, engines, avionics, and system components.

- Development of materials, processes, tools, and devices which will reduce repair time, increase repair integrity, or improve standardization for all the areas mentioned above.

- Evaluation of rapid repair concepts on both metallic and nonmetallic (e.g., aluminum, titanium and boron/graphite epoxy composites) structures.

- Investigation of ways to decrease nonrepairable areas of the aircraft structure.

- Investigation of the use of commonly available materials in a substitute role to effect ABDR.

- Evaluation of economically feasible ways to reduce the extent of battle damage experienced by aircraft. Major thrusts of this effort would be to develop techniques to slow or stop projectile velocity, and to minimize the effects of onboard fire.

- Evaluation of human factors as they relate to ABDR. These factors include training, technical orders, and proficiency measuring techniques.

The long-term R&D effort will be geared to expanding investigation to remaining aircraft systems to address unique repair considerations not resolved by the previously mentioned efforts. In addition, the long-term efforts will investigate innovative design concepts and materials for new systems which will facilitate battle damage repair as well as reduce the effects of hostile fire. New aircraft design specifications and criteria may need to be modified to provide for ABDR. Factors which should be addressed for future systems include:

- Modular construction for easy removal and replacement of damaged major structural components.

- Interchangeability of major structural components and propulsion systems to facilitate cannibalization of serviceable components from severely damaged aircraft.

- Development and application of materials which are tolerant to damage and easy to repair.

- Airframe access provisions to allow for improved damage assessment and subsequent repair.

- Continuous identification of systems and subsystems throughout the aircraft to facilitate rapid identification and repair.

An active near and long-term research program should help improve reparability in future aircraft design.

### **FUTURE APPLICATION**

The application of the Aircraft Battle Damage Repair Program to several important areas should be considered and expanded upon as the program progresses.

The first area involves joint service cooperation. Serious consideration should be given to a joint services program on battle damage repair in order to consolidate and exchange information on rapid repair programs presently underway in the Army and the Air Force. The Army has already completed work on various repairs to helicopters and is continuing to expend efforts in vulnerability analysis of their various helicopter systems. A joint

services program would avoid duplication of effort, and could lead to a much better program for all of the services.

Internationally, we should continue to work with NATO to establish a rapid repair program of commonality. Various member nations (United Kingdom, The Netherlands) presently have their own programs. But the ultimate aim of all NATO nations should be a program that uses a common training program, common techniques, technology and materials, and has the long-range goal of repairing each nation's aircraft at any base in Europe. These are viable objectives and should be actively pursued through U.S./NATO agencies.

### CONCLUSION

To meet the high sortie rates required by various operational plans, battle damaged aircraft must be quickly repaired and returned to service in time to contribute to the on-going battle. In some cases rapid repair could mean the difference between victory or defeat.

Our peacetime repair of battle damaged aircraft normally takes weeks rather than a few hours and

therefore cannot be expected to meet wartime needs in a surge sortie environment. Past studies have indicated that a capability to accomplish battle damage repair had the greatest influence on the ability to surge aircraft in wartime. If we are to effectively multiply our force capabilities in an intense wartime environment, there is an overwhelming need now to create, plan for, and identify procedures to expedite the repair of battle damaged aircraft. The program outlined in this article represents the first step toward meeting that need.

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### *Air Logistics Center Item of Interest*

#### **The Government Furnished Material Transaction Reporting System**

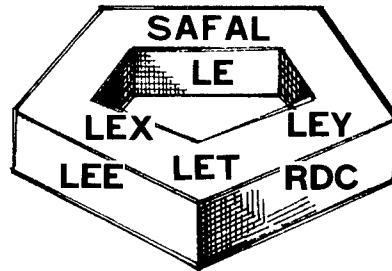
Increased attention has been directed toward management of Government Furnished Material (GFM) on repair/overhaul contracts over the past several years. In 1974, the Government Accounting Office issued a highly critical report citing gross irregularities in the management of GFM. The basic deficiency was attributed to lack of visibility over contractor GFM inventories. San Antonio Air Logistics Center (SA-ALC) was assigned the responsibility in November 1975 to design and service test a system that would provide the required visibility.

This system was service tested from January 1977 to June 1978 at Warner Robins ALC and SA-ALC on contracts with Teledyne-Neosho and Hamilton Standard. Results of the service test proved the system capable of fulfilling our objectives.

This new system, the Government Furnished Material Transaction Reporting System (G009), began in late 1978 to provide line item visibility of material in the hands of overhaul/repair contractors. The main objectives of the G009 system are:

1. Timely, accurate and comprehensive data relative to GFM and end item inventory, issue, and monetary activity.
2. Electrical transmission and mechanized processing of data submitted by the contractor.
3. Prepare necessary products and reports which will improve inventory and accounting visibility over GFM and Contractor Acquired Property (CAP) used in contract support involving government owned or funded material.
4. Provide inventory usage and cost data for life of contract.
5. Eliminate manual reporting in favor of mechanical interface for existing data systems.

At the present time, the Air Force Logistics Command has 7 contracts under the G009 system, with 26 additional contracts anticipated in the near future. All contracts with \$100,000 or more anticipated GFM issues require G009 system reporting. However, contracts with lesser amounts of GFM issues may also require G009 system reporting when warranted by the Production Management Specialist. The G009 system provides a reliable, clear and effective management tool to use as a source of positive control of GFM in contractors' hands. (SA-ALC/MMMS, Trisha Woodworth, AUTOVON 945-6975)



# USAF LOGISTICS POLICY INSIGHT

## **FY 1982-1986 Program Objective Memorandum (POM) Logistics Perspective**

The FY 1982-86 POM departs from the Air Force's previously planned program, as reflected in the Jan 80 FYDP, by placing greatly expanded emphasis on near-term capability for force readiness, sustainability and supportability. This decision is reflected in increased funding for such logistics areas as spares, depot-purchased equipment maintenance (DPEM), and "modern" munitions. This emphasis has been programmed to realize the full warfighting potential of our forces by redressing support deficits incurred in force modernization.

The DPEM program has been increased above that planned for in the FYDP to eliminate the repair backlog in FY 1985. To improve our peacetime readiness and wartime sustaining capability, the investment in spares has been increased in the funded level of the POM. The aircraft replenishment spares program provides for all peacetime operating requirements as well as initial sustaining wartime requirements. The POM Real Property Maintenance Activity (RPMA) is programmed to reduce the backlog over the Five Year period to about \$200 million, a reasonable approach to decrease the facilities repair backlog. Military construction funding for readiness, modernization, energy conservation and quality of life provides for only modest increases over the FY 81 levels.

As an item of special interest, the POM includes decisive steps to increase Rapid Deployment Force (RDF) capabilities by increasing funding for O&M, spares, munitions and training accounts. Senior Air Force leadership has attempted to achieve a balanced program, in terms of readiness and mobilization, within established fiscal constraints.

## **Logistics Long-Range Planning**

On 29 Apr - 2 May 80, senior logisticians representing HQ USAF, AFRES, and MAJCOMs, participated in a Logistics Long-Range Planning Seminar at Homestead AFB. Entitled FUTURE LOOK 1980, the group identified a number of concerns which the logistics community will be forced to cope with in the year 1995. These concerns are directed at readiness capability, manpower shortages, energy conservation, industrial base, surge capability, C<sup>3</sup> survivability, scarcity of raw materials, and the ability to quantify and access our logistics capability. These concerns will soon be presented to Gen Poe, AFLC/CC, Lt Gen Minter, AF/LE, and Dr. Hermann, SAF/AL. Based upon their review, specific direction of logistics will be established. The results will serve as a basis for the initial publication of a logistics annex to the USAF Global Assessment. This document will open the door to the planning process of the Planning, Programming and Budgeting System (PPBS).

## **Policy on the Peacetime Use of War Reserve Materiel (WRM)**

In April of this year, the DCS/L&E changed Air Force policy to give major air commanders more authority in using WRM during peacetime. Except for Harvest Bare, munitions and long term use of WRM equipment/vehicles, peacetime use will be at the discretion of the MAJCOMs. Use must meet certain emergency, training and humanitarian criteria such as support disaster relief operations, operational readiness inspections and exercises.

The new "Buck Stop" policy does not, however, preclude commanders from establishing more stringent controls nor exercising judicious control over precious WRM resources.

### **Improved WRM Management**

Over the past year, the DCS/L&E and the DCS/Plans and Operations have been jointly developing An Approach for Improved WRM Management. Subsequent to briefings on the basic concept to the Combat MAJCOMs and AFLC in September and October 1979, representatives from the MAJCOMs and the Air Staff met in November and December 1979 to expand the concept into a viable, implementable approach. The Approach combines Logistics and Operational requirements to provide a coherent funding strategy to bridge the gap between budget formulation and program execution. To make this possible, a two dimensional set of operations priorities was developed which defines achievable increments of war-fighting capability in terms of days of support that would be provided to force packages. These priorities are to be used throughout the programming, budgeting, appropriation, procurement and distribution processes. This methodology necessitates the specific tasking of units, precise capability assessment and accurate requirement sizing models. The Approach will require Logistics and the Operations Planners work closely together to provide a logistically supportable war-fighting capability more attuned to planned wartime activity. In addition, since we will tie funding directly to specific wartime capability, the Approach will allow the Air Force to better defend its requirements to OSD, OMB and Congress.

### **Air Force Energy Program Policy Memoranda**

The Air Force Special Assistant for Energy (AF/LEY) has implemented the publication of Air Force Energy Program Policy Memoranda (AFEPPM) for the purpose of promulgating energy policy to the field. The AFEPPM will be used to implement energy policy developed by the Department of Energy, the Department of Defense and official internal Air Force policy. The memoranda will be developed and controlled by the Air Force Energy Office, (AF/LEYSF) and approved by the Air Force Special Assistant for Energy.

The AFEPPMs are not intended to become a bureaucratic burden to our energy managers. They will streamline our energy policy guidance, and serve as a focal point to assist our personnel responsible for implementing Air Force energy policy.

The implementing memorandum (AFEPPM 80-1) was signed and forwarded to the MAJCOMs on 21 Apr 80. The AFEPPMs will provide a useful tool to enhance their own energy management programs.

### **GSA Furniture Management Policy Changes**

Major changes are underway in the management of office and household furniture used by the Military Departments and across the Federal government. The primary result will be increased emphasis on repairing used furniture to avoid making new purchases. Base Supply Officers should expect close scrutiny of furniture requirements, reported excesses, local repair programs, and reutilization of furniture assets. Base Budget Officers can expect to project furniture expenditures annually for recurring and non-recurring requirements. Data from Air Force bases will be used to compile a combined annual expenditures plan for GSA and OMB approval. Air Force inspectors and auditors will be participating in various GSA-sponsored visits to validate requirements and evaluate furniture rehabilitation programs. This all adds up to a major effort to control furniture costs in the Federal government.

### **Dudley C. Sharp Award**

Chief Master Sergeant Samuel C. Monroe, a HQ AFLC Maintenance Superintendent, has been named the first recipient of the Air Force's Dudley C. Sharp Award for significant achievement in logistics. Selected by the Secretary of the Air Force and the Air Force Chief of Staff from 14 other MAJCOM nominees, Chief Monroe was recognized for his contributions to the development of AFLC's Combat Logistics Support Squadrons.

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## Packaging For Fragile Aircraft and Missile Guidance Components

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The "trial and error" packaging design methods of previous years have given way to more systematic and analytical approaches which prevent unnecessary damage to expensive/fragile aircraft and missile guidance components and eliminate excessive costs due to overpackaging. Fragile items can be damaged within a protective pack without evidence of damage to the external container or protective covering. To assure reasonable shock and vibration protection for fragile items, packaging engineers and specialists now have numerous guidelines, instrumentation, and test equipment available for designing adequate cushioning systems and containers at the lowest possible cost.

Damage to fragile items can occur during packaging and unpacking, routine handling, maintenance repair operations, or as a result of the transportation environment. Occasionally damage is difficult to determine without the use of expensive diagnostic instrumentation or time-consuming operational checkout procedures involving the installation of the avionics unit in the aircraft or missile system. Often damage cannot be immediately determined by inspection procedures. This so-called "hidden damage," which becomes apparent only after hours of operational use, can be indirectly measured by changes in the Mean Time Between Failure (MTBF) and Time Between Overhaul (TBO).

By means of realistic performance testing as well as instrumented field tests, potential damage problems can be eliminated or reduced prior to the full scale adoption of a packaging system in our logistics system.

To achieve maximum results with limited resources, the Air Force Packaging Evaluation Agency (AFPEA) has developed a rational step-by-step procedure for the analysis and design of protective packaging systems. The success of the procedure has been due primarily to the development of a unique miniature shock recording device. In the past, it had been very difficult, if not impossible, to accurately measure the total shock and vibration environment experienced by small packs shipped throughout logistics system. Instrumentation and shock recording devices were formerly limited by both measurement capability and the size of the container to be instrumented. The recently developed transportation shock recorder is an all solid state device which has the capability of measuring and recording shock, temperature, humidity, and elapsed time of operation. In addition to recording individual shocks along three mutually perpendicular axes, the resultant value of these components is electronically computed and recorded.

The availability of this new type recorder has made

possible the recent initiation of a packaging environmental survey of the shock and vibration encountered throughout the logistic system. This study, scheduled for completion in July 1980, will provide field test data which together with historical environmental data will enable packaging personnel to design more economical and effective packaging.

An additional benefit of the environmental survey program has resulted in the development of a series of computer programs for use with the recorder. The computer programs read out the field trip data and a data analysis program compiles and statistically summarizes the data.

The benefits and cost savings of adequate packaging for avionics equipment are substantial. Some routine overhaul costs of guidance components exceed \$10,000 per item. If proper packaging is available significant cost savings are realized by reducing maintenance overhaul and replacement costs. Other benefits of using proper packaging techniques include the elimination of costly overpackaging, a reduction of replacement parts in the inventory system, and improved operational readiness.

### The Evaluation Technique

Effective packaging evaluation of avionics equipment requires an analysis technique which allows for a complete study of the item's maintenance record, packaging specifications, the performance characteristics of the existing packaging, and a quantitative definition of the shipping and handling environment. The technique developed and utilized by AFPEA requires the following actions in the areas indicated:

a. *Maintenance Records:* Review available maintenance records to determine if packaging is a potential cause of excessive maintenance and repair costs of the item.

b. *Instrumentation:* Select the proper instruments to accurately measure the shock and vibration the item will encounter during shipment. Certification of instrument accuracy (calibration) is extremely important.

c. *Performance:* Conduct appropriate rough handling and environmental tests to determine if the packaging is providing adequate protection for the item. In most cases carefully constructed simulated models are used for these tests in lieu of the actual item; this avoids damaging costly equipment during tests and simplifies location of recording instrumentation.

d. *Field Test:* Monitor actual shipping and handling conditions by the use of the self-contained transportation environment recorder, previously described, which is

concealed in a simulated model of the item. The instrumented test load is packaged in a manner identical to that used for the actual item.

The two types of recorders used in our packaging analysis are shown in Figures 1 and 2. The Transportation Environment Recorder (Figure 1) electronically stores the data which is then recorded, at the completion of the test, using a separate readout device. The second type, called a "bump" recorder (Figure 2), produces a permanent printed record. The "bump" recorder has the additional capability of recording the exact time of the shock or vibration event. Figure 3 indicates the method used to insert a recorder in the cavity of a wood simulated model of an item.

e. **Packaging Redesign:** If the existing packaging does not provide the required environmental protection the packaging designer can modify the existing pack or design a new pack. Numerous design guidelines are available such as manuals, handbooks and computer design programs.

f. **Performance Verification:** Compare maintenance cost and the MTBF of items shipped in the existing packs with those in the new or prototype packs. This is the most effective method of monitoring pack performance. Although this type of reliability study requires a nine to twelve month monitoring period, it has proven very successful in evaluating the effect of pack design changes on item performance. Studies of this type have been conducted by the Aerospace Guidance and Metrology Center (AGMC), Newark Air Force Station, Ohio, in cooperation with the AFPEA.

### Application of the Technique

During 1977, a preliminary survey of the C-5 Inertial Measurement Units (IMUs) maintenance records revealed that 29% of all the C-5 IMUs were overhauled as a result of

**Transportation Environment Recorder (6 1/2 lbs)**

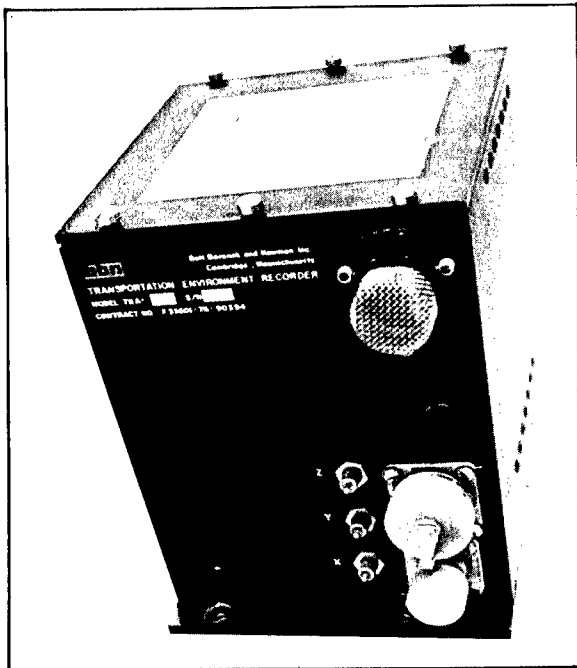


Figure 1.

### Packaging Improvement Data for the C-5 IMU

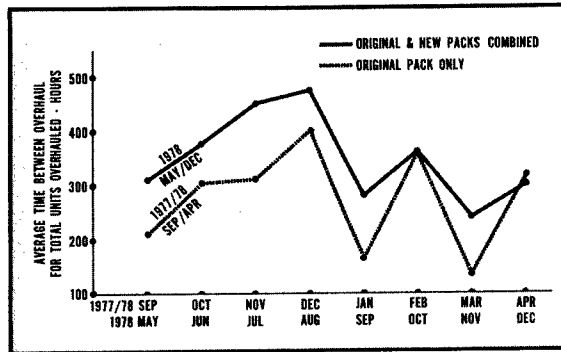


Figure 4.

low operational hours (zero and short time items) when shipped in the wooden container originally furnished with the item. A new pack, developed by AFPEA, which employs a standard Air Transportation Association (ATA-300) reusable plastic container and a redesigned inner cushioning system, has resulted in a 15% reduction in the number of overhauled IMUs with low operating hours. After 57 of these new pack designs were added to the logistics inventory, AGMC's reliability study revealed significant improvement in the IMU performance. Their study revealed a 71% improvement of TBO with the new packaging for this item. During the period September 1977 to April 1978, the average TBO was 82 hours for the C-5 IMU shipped in the original container. However, a survey during May 1978 to December 1978 revealed the TBO had increased to 140 hours per unit when shipped in the new pack. The improved packaging performance is graphically illustrated in Figure 4. Even though the improved TBO data for the new pack is combined with data for the original pack, the upward trend in the TBO is still evident.

Limited maintenance data is also available for the **Bump Recorder (13 1/2 lbs)**

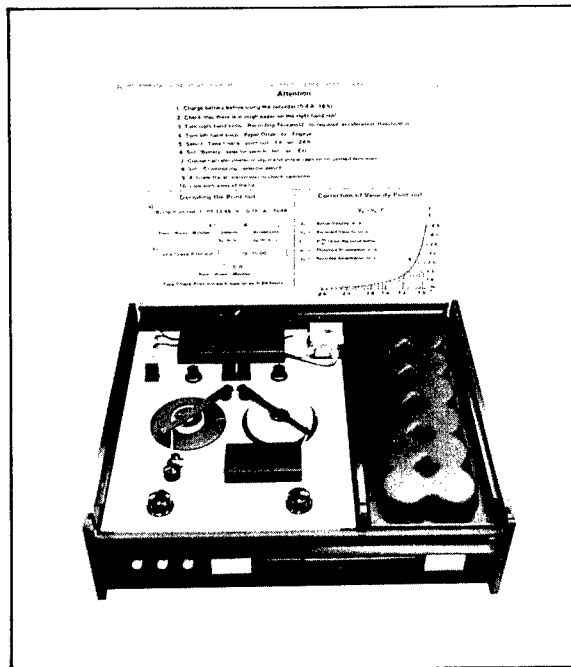
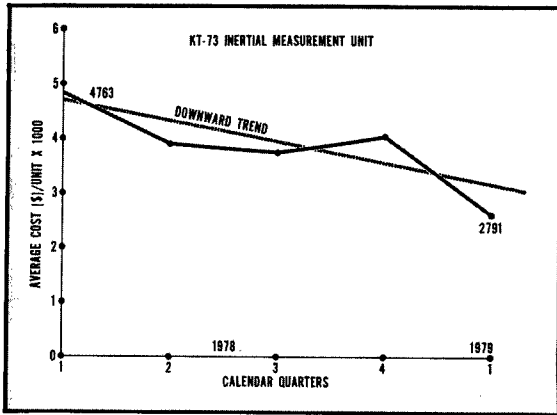


Figure 2.

**Average Maintenance Cost Data for the KT-73 IMU**

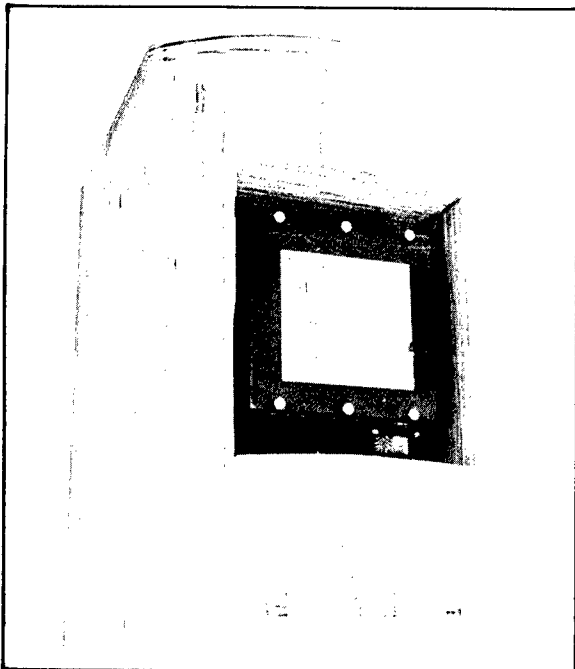


**Figure 5.**

KT-73 IMU. During 1978, improved packs for the KT-73 were used in conjunction with the original packs. A combination of data for the original and modified packs revealed a downward trend in the average maintenance cost of this item. Figure 5 reveals this trend.

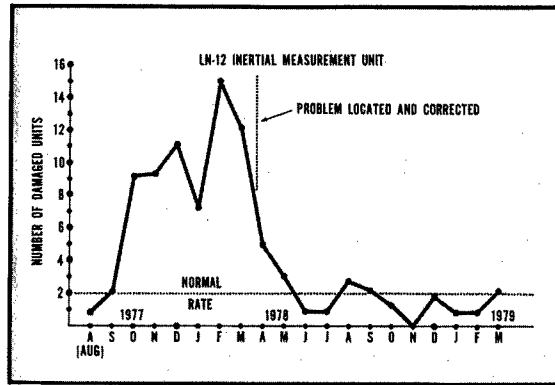
The effects of substandard as well as adequate packaging are dramatically reflected by the graph of Figure 6. In 1977, replacement packs for the LN-12 IMU (F-4 aircraft) were received which did not conform to our Transportation Packaging Order (TPO) specifications. Our packaging evaluation indicated that the cushioning material was substandard. The normal damage rate for the LN-12 was two units per month. However, in October 1977 the damage rate increase was significant. AGMC hosted a meeting to determine the cause of the damage and the Air Force Packaging Evaluation Agency was assigned the responsibility to evaluate the packaging. Figure 7 indicates the type of damage typically occurring to the IMUs prior to initiation of our recommended corrective measures. The dents in the Gyroscope casing are

**Simulated Test Model with Recorder**



**Figure 3.**

**LN-12 Damage Rate (Per Month)**



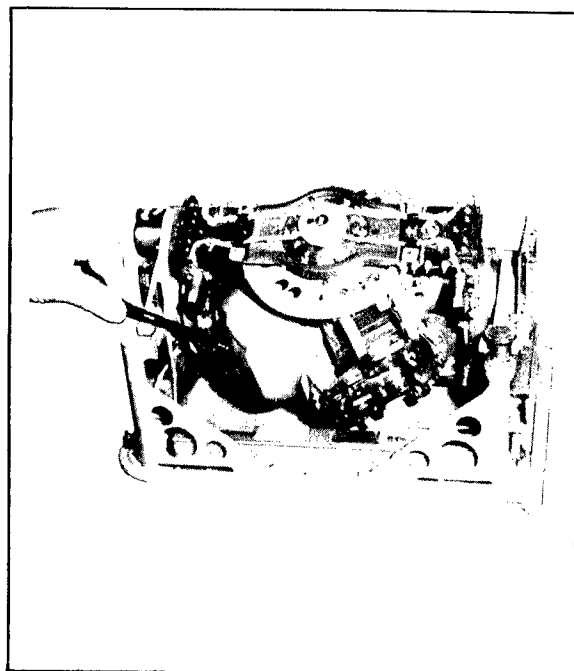
**Figure 6.**

indicative of the damage that would result from a severe "bottoming" shock produced when a package is accidentally dropped and the cushioning material does not provide adequate shock absorption capacity.

AGMC's immediate response to AFPEA recommendations resulted in a drastic decrease in the damage rate as can be seen in the graph of Figure 6. Three months after the problem was identified and corrected the damage rate decreased substantially, from the peak rate of 15 units a month, to an average rate of 1-1/2 units per month which was even below the previous normal rate of 2 units per month.

The estimated cost savings resulting from the packaging improvements cited above were: KT-73, \$38,000; C-5, \$178,000; LN-12, \$250,000. These cost savings represent only a fraction of the cost benefits possible if procedures such as described in this study are vigorously applied by all packaging activities having responsibility for shock sensitive high value equipment items.

**Damaged LN-12 IMU**



**Figure 7.**

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## What's New in Lessons Learned?

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### Background

One of the keys to developing logistically-supportable weapon systems, featuring designed-in reliability and maintainability and built to the lowest life cycle-cost, is the application of lessons learned from deployed systems and past acquisition programs. The Air Force has not yet reached the point where flightline maintenance personnel and retired program managers look over the shoulders of new systems designers to insure that they duplicate past successes without falling into past pitfalls. However, the next best thing does exist in the Air Force Acquisition Logistics Division's Directorate of Performance Feedback Systems (AFALD/PTQ). This directorate, now in its fourth year of operation, is the corporate memory for all Air Force acquisition lessons learned. After an initial setting-up period, in which its people concentrated on the collection, analysis, and storage of lessons, the Directorate has now made strides in its real function - applying the lessons to today's acquisition programs.

What is a lesson learned? It is an experience of proven value in the conduct of future programs. Normally, a lesson learned is recorded and eventually incorporated in applicable regulations, technical manuals, specifications, standards, handbooks, and contracts. The sources of these lessons are numerous. Inputs come from program offices, laboratories, product improvement efforts, maintenance data collection system reports, and flightline and shop maintenance personnel. Logisticians and equipment specialists in the Directorate of Performance Feedback Systems and functional experts in other directorates analyze these experiences and provide the research needed to document whether a lesson has really been learned. Validated lessons, in the form of a concise summary sheet and back-up documentation, are put on file, where they can be retrieved, manually or automatically, by keyword.

### Application

No lesson, regardless of how valid or eloquently written, can have any effect unless two events occur. First, decision-makers in program offices must know that the lesson exists. Then, they must make sure that it is actually applied on their programs. It is in this vital area of application that the Directorate of Performance Feedback Systems has been involved during recent months. For the past two years, the Directorate has been putting together and sending tailored packages of lessons learned to program offices. Now, a number of innovative approaches are being implemented to insure the actual application of lessons. Many of the acquisition programs in the Air Force

now have a lesson learned monitor in the Directorate of Performance Feedback Systems. This monitor is responsible for tracking assigned programs and for making sure that the program office receives relevant lessons learned at the appropriate phase for application. The Directorate is currently working to establish closer contact with existing and future program offices. A network analysis has been developed which shows the events in a program that require lessons learned support, and all the lessons currently on file in the data bank (a total of 800 as of 1 April 1980) have been categorized according to program phase. To insure that lessons can be directed to the proper offices of prime responsibility (OPR), personnel in the Directorate of Performance Feedback Systems have identified each lesson in the data file with the Integrated Logistics Support (ILS) or acquisition management element that it discusses.

As a means of aiding Deputy Program Managers for Logistics (DPMLs) and Integrated Logistics Support Managers (ILSMs) in applying lessons the Directorate of Performance Feedback Systems has developed a new, more easily-used type of lessons learned package, the Application Guide. Guides are prepared expressly for individual programs, and the lessons selected for each guide are germane to specific program events. A separate volume of the Guide is prepared for each program phase. Since ILSMs are usually associated with a particular functional specialty, the lessons in the guide are arranged by the ILS or acquisition management element to which they pertain. Many of the individuals in the Directorate of Performance Feedback Systems have extensive technical backgrounds and are well-acquainted with the types of decisions that must be made during an acquisition cycle. These people update the Application Guide as a program progresses through the acquisition phases, and they also help ILSMs implement individual lessons in contractual documents, such as the Request for Proposals (RFP) and the system specification.

Two excellent examples of how this process is helping to make future Air Force systems more logistically supportable can be seen in the next generation trainer (NGT) and the airlift (CX) acquisition programs. The Directorate of Performance Feedback Systems has put together an Application Guide for each of these programs; and, as an additional means of assistance, Directorate personnel have assisted in the review of RFPs and system specifications to insure that pertinent lessons were incorporated. The topics of these lessons ranged from screws to computer software.

One such lesson included in the CX Request for Proposals was a stipulation that shutoff valves be used on

both the primary and emergency landing gear hydraulic systems. On some earlier cargo aircraft, such as the C-141, the primary hydraulic system was protected by a shutoff valve, but the emergency system, which comes on line below the valve, was left unprotected against loss of fluid. Such a design is used in smaller aircraft to prevent loss of braking power in the event of a valve failure. However, in large cargo aircraft, with their many independently-fused lines to the landing gear, it is virtually impossible that loss of all brakes on one side will ever occur due to multiple (i.e., four in the case of the C-141) shutoff valve malfunctions. What is likely, however, is that in the event of any line rupture below the valve, 10 or more gallons of flammable hydraulic fluid will flow unchecked from the large reservoir of the emergency system and very likely cause a fire. As a result of the improved design feature validated from a time-proven modification of the C-141 to correct the original problem, the next Air Force cargo aircraft should be less prone to hydraulic fluid fires than its predecessors. The many other lessons applied on the NGT and CX will also aid making these aircraft more logistically supportable.

### **File Opened to Aerospace Industry**

Furthermore, as another means of applying lessons, the Directorate of Performance Feedback Systems has opened its lessons learned file to the aerospace industry. The information provided to industry is the same as that provided to Air Force organizations, except that lessons sent to industry are sanitized (i.e., specific references to systems and contractors are removed). The enthusiastic response by industry is promising, since most of the lessons they have received concern equipment design. The contractor is usually in a better position to apply such lessons than is the ILSM. Deputy Program Managers for Logistics and ILSMs can aid in this process by using the following application plan:

1. During the conceptual phase, the DPML would require the contractor to review an Air Force-supplied lessons learned package and consider the lessons during his conceptual design. This package would cover a fairly broad area. For example, on a program such as the Advanced Conventional Standoff Missile (ACSM), the package would cover such areas as remotely-piloted vehicles, jet engines, navigation systems, avionics, airframes.

2. During the validation phase, the DPML will provide the contractor with a more detailed package, covering specifics on both systems design and detailed design (use of fasteners, location of servicing access points, etc.). Each lesson should be accompanied by a specific contractual entry. The DPML would include appropriate systems design considerations as specific contract requirements. The contractor would also be required to review the lessons learned which involve detailed hardware design and to consider them during validation-phase efforts.

3. During Full Scale Engineering Development, the detailed design lessons learned would be included as contractual requirements in the same manner as the systems design considerations were handled during

validation. In addition, lessons learned on such aspects as production techniques and deployment would be provided for contractor review and consideration.

4. During production, the DPML could submit a final lessons learned package covering production, deployment, follow-on support, and other areas as deemed appropriate.

These innovations reflect the most significant recent and on-going developments in lessons learned. One other significant effort also continues. The Directorate of Performance Feedback Systems has been helping to make sure that lessons which point up the need for changing passages in military specifications and Air Force Systems Command (AFSC) Design Handbooks are applied. Lessons that can impact design concepts are directed to the appropriate offices for review, comment, and action. A number of changes have been or are being made in handbooks and specifications as a result of this effort.

### **Feedback**

The Directorate is obviously concerned with the feedback of information to acquisition program offices and defense industry contractors. However, its personnel also seek to close the loop by getting feedback from those organizations that receive and apply lessons learned. To assess the value of the lessons learned feedback process, the Directorate has developed various questionnaires to obtain opinions and comments on the value of the lessons learned to the users and their agency. The Directorate of Performance Feedback Systems is attempting to define the degree of use and/or whether lessons are being applied to insure that we are benefitting from our investment in the lessons learned process. This feedback also concerns maintaining the currency of individual lessons learned. Occasionally, lessons require updating or deletion. Feedback from users helps to insure that all the lessons in the data file are useful, accurate, and current.

### **Lessons Learned Outlook**

In retrospect, the task of setting up a lesson learned data bank has not been difficult. However, the follow-on task appears to be more challenging than when the USAF lesson learned program was started a little over three years ago. What the Air Force is facing today is a question of how to capitalize on experience by applying lessons learned. The challenge is to seek every opportunity to apply what we have learned, to carry forward the things we have done right and to avoid the mistakes of the past. The keys for success in the application effort are closer contact between the directorate and program offices from the time that they are established, inclusion of lessons learned in contractually-binding documents, and a careful tailoring of each Application Guide to fit program schedules and tasks. At the same time, the Directorate of Performance Feedback Systems seeks to preserve the credibility of the lessons learned file by keeping it accurate, nonduplicative, and pertinent. All these efforts represent an overall attempt to make sure that lessons learned become an integral part of system design, not just another buzzword.

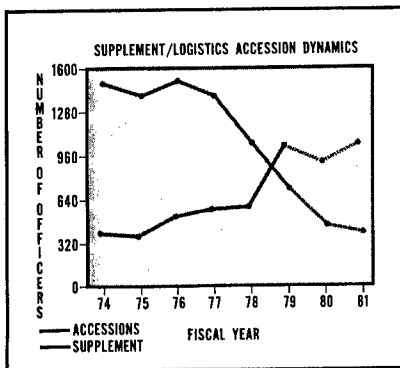


# CAREER AND PERSONNEL INFORMATION

## Logistics Officers: The Challenge of a Young Force

In the Winter 1980 issue of this journal, we explored the dynamics of the line support officer force . . . the historical development, the dynamics of its management, and looked toward the end of the fiscal year to see the development of significant undermanning in the grades of captain through lieutenant colonel. We also discussed the fact that experience shortages, grade substitution and the lengthy assignment waiver process will be the mode of operation for the next few years.

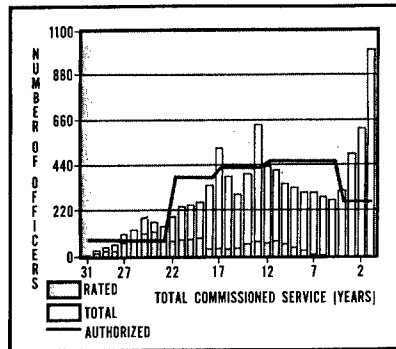
Figure 1.



Supplement/Logistics Accession Dynamics

The logistics officer subset of the support force faces similar challenges for the future. With the authorization base we have had over the last few years, the decreasing inventory of rated supplement officers to meet rated shortages has caused a corresponding increase in the accession of second lieutenants. The dynamics of this situation is plotted in Figure 1. In addition to rated shortages, the Air Force has been unable to compete with industry to acquire sufficient technically educated 2LTs to alleviate shortages in the R&D specialties. Thus, in order to meet end strength, we are accessing more non-flying, non-technically educated lieutenants into the non-R&D skills . . . like logistics . . . than are really necessary to sustain the force.

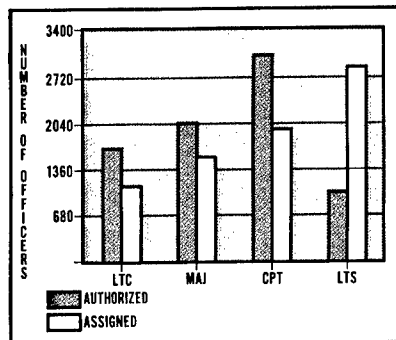
Figure 2.



Logistics Force by Year Group

Figure 2 shows the resultant logistics officer force. The one to four year groups reflect the building inventory of lieutenants, our future experience. The valley in the four through twelve year groups (generally captains) is the result of reduced post-Vietnam accessions. Loss of rated officers in these year groups will make the valley even deeper. The 12 to 17 year groups (majors) appear in good shape, but we must use this inventory to grade substitute and fill the gaps in the lieutenant colonel inventory, basically the

Figure 3.



Overall Logistics Force Manning End FY80

17-22 year group. The lieutenant colonel year groups have a high percentage of rated officers, many with more logistics than operational experience. The Air Force has decided to leave most of this type lieutenant colonel in supplement duties because of our senior grade shortages. However, this also means we will be able to offer logistics experience to even fewer rated captains and majors. This helps our senior experience gap in the short term, but in the longer term may adversely impact our ability to provide logistics experience to our future senior leadership.

By the end of FY80, logistics, like the rest of the support force, will be undermanned in grades captain through lieutenant colonel (Figure 3). Mathematically, if we use total grade substitution, nearly 30% of our lieutenant colonel positions will be filled by majors, 35% of our major positions will be filled with captains, and lieutenants must fill nearly 60% of the captain positions. However, this is a mathematical perspective, not reality. Reality is that second lieutenants should be assigned at the lowest possible level . . . in operational wings . . . to learn logistics from grassroots levels. Thus, if we spread manning to keep all organizations at total worldwide manning averages, instead of 60% of captain positions being filled with lieutenants, the percentage could be 90-95% at squadron level. One could conclude, though it would be impossible to measure, that such a high level of inexperience will have adverse readiness impacts.

As a result, we are placing priority on manning our operational organizations . . . to include the air logistics centers . . . to help keep readiness at as high a level as possible. In many cases, this will mean wing level manning will be higher than world-wide averages with staffs absorbing the shortage. Our objective for the next few years is to insure one to four experienced officers in each squadron, in addition to the commander. From an individual officer perspective, this means extensions in staff jobs and staff to staff

moves will be severely curtailed. Thus, if you are serving in staff duties today, expect your next assignment to be at unit level to help us maintain our readiness posture until the lieutenant population can gain the experience to carry on from there. From a supervisory perspective, overlap in jobs is generally a thing of the past. In fact, expect some staff positions to either be empty, be filled by a lower quality officer, or by an officer with less experience. To help PALACE LOG and yourselves, please prioritize your positions. Pass the priorities though your command personnel counterparts to AFMPC.

The simple fact is that by the end of FY81, lieutenants will be nearly half of the maintenance, munitions, supply and transportation career fields. Contracting will have less lieutenants as a percentage of the career field, but will be driving toward 30%. These experience levels will be exacerbated by the fact that each year career fields that get second lieutenants are levied to help other career fields; such

as, ROTC instructors, Recruiting Service and OTS instructors, plans officers, AF Academy instructors, and installation commanders or deputies . . . these fields that cannot take 2Lts. The logistics share for FY81 could be over 200 . . . "a fair share," but representing 2% of the logistics resource.

These same career fields must feed the logistics plans and programs resource (AFSC 66XX). We have seen nearly a 25% growth in logistics plans over the past few years, with most of the new positions above unit level and nearly all of them calling for background in one of the "hard" logistics disciplines. In order to protect our wing level readiness posture and insure we accomplish our priorities, we are intentionally keeping logistics plans manning at about 85%. Thus, expect even more difficulties in acquiring logistics plans expertise. Each supervisor should closely examine each position, looking at what the officer actually accomplishes, and where possible, convert the position

to maintenance, munitions, supply, transportation or contracting.

In summary, the problems facing logisticians in the short range will be compounded by inexperience at all levels. At the higher levels, we must be willing to accept younger officers in some of our key positions and not expect these officers to perform like the field graders they will replace. Expecting higher levels of performance could, in fact, lead to frustrations and disappointments that will adversely impact the now high logistics officer retention levels. At lower supervisory levels, we must strive to create an environment where our young officers are allowed to make decisions and learn from the mistakes they will make. If we cannot accept this challenge, we cannot expect our young force to stay with us long enough to mature and gain the needed experience.

Likewise, in these times of experience shortages, the ability of personnel resource managers to satisfy the personal

*Continued on page 24*

## Mobility in the Logistics Executive Force Inventory: Fears and Reality

As used in this article, the term mobility means geographic relocation in connection with the individual's employment. The Logistics Civilian Career Enhancement Program (LCCEP) does not require an employee to be mobile or agree to be mobile in order to participate in the program or to be selected into the Logistics Executive Cadre (Cadre).

The registration permits the registrant to identify only those specific geographic locations for which consideration is desired. This may be restricted to a single Air Force installation (including the base where the employee is currently assigned) or expanded to include any number and combination of geographic locations up to the worldwide totality of Air Force operations. The registrant also indicates the lowest acceptable grade at each location. For example, the employee might be willing to accept lateral reassignment at the present location or some other location which is considered to be particularly desirable but would only be willing to move to some other location for a promotion.

Although mobility is not required for registration in the LCCEP, mobility is mandatory for participation in certain aspects of the program, such as broadening assignments and long term full-time training. Specific broadening positions were created for the express purpose of providing developmental work experience for competitively selected employees who have high managerial potential. These assignments are for a limited duration of two years and are tailored to the specific needs of the individual employee. Mobility is required in this instance primarily to vacate the position and thus permit others requiring

this experience to obtain it. Long term full-time training such as the Graduate Logistics Program at the Air Force Institute of Technology also requires a mobility agreement. The rationale for the mobility in this instance is that the Air Force has invested a considerable sum of public money, both in actual outlay of funds and in decreased productivity, in the development of an employee in the expectation of significantly increased productivity after completion of the training. It is incumbent upon both the Air Force and the employee to use that training where it will most effectively meet the needs of the Air Force in carrying out its assigned mission. To do otherwise would be a violation of the public trust.

Mobility is an integral part of the Senior Executive Service (SES), which under provisions of the Civil Service Reform Act of 1978, supplants most GS-16 and above positions. Therefore, those who aspire to positions in the SES or in the Air Force's Candidate Development Program must accept mobility and be prepared to move to SES positions under SES regulations. As GS-15 members of the Cadre will be the prime source of logisticians for the SES Candidate Development Program, there are mobility implications for GS-15 Cadre applicants.

For the total LCCEP, it is obvious that an

employee's opportunities for consideration increase with an expansion of job mobility which may entail geographic relocation. We are all familiar with many sound reasons for resistance to mobility. Separation from family and friends, costs of selling a home and acquiring a new one, children in school, etc. However, there are many benefits to be weighed as well. The ability to allocate resources where and when needed enhances the Air Force's ability to accomplish its assigned mission. Therefore, the employee who is available to be assigned to another area when the need arises, becomes more valuable to the Air Force. In addition, the variety of experiences enables the employee to envision and appreciate the interrelationships among the various logistics functions. This aspect assumes ever increasing importance as the employee progresses toward the higher executive grades. For these reasons, the employee is encouraged to pursue a broadened background with different job experiences. This may, in some instances, require geographic movement.

Many employees understand and appreciate the need for mobility. This is evidenced by the fact that of the approximately 5188 registrants who applied for the Cadre, 78 percent expressed a willingness to accept an assignment which would involve a physical relocation (PCS move).

**Table 1.**  
**Mobility of Cadre Applicants**

GS GRADE	APPLICANT	NUMBER MOBILE
11	2218	1637 (74%)
12	1982	1609 (81%)
13	689	551 (80%)
14	218	173 (79%)
15	81	67 (83%)
Total	5188	4037 (78%)

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## Ridenour Report Revisited

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Thirty years ago the Ridenour Committee suggested splitting the Air Materiel Command (AMC) into two commands. Dr Theodore von Kármán, then Chief of the Scientific Advisory Board, supported the split. Initial separation took place in 1951 when the Air Research and Development Command (ARDC) was formed; about ten years later acquisition functions were moved from AMC to ARDC. Overall, the separation achieved excellent results, but some knotty problems continue to recur with each Program Management Responsibility Transfer (PMRT). The following examines PMRT as the possible cause of the recurring problems; compares the Ridenour Committee's recommended management structure to the management structure that actually evolved from the command split; and explores eliminating PMRT by shifting a few command responsibilities.

### Background

When the split took place, in the fifties and early sixties, the cold war with Russia was intense. The cold war brought a whole series of Inter-Continental and Intermediate Range Ballistic Missile (ICBM and IRBM) systems: Thor, Atlas, Titan and Minuteman. These new systems were designed, developed and deployed at a feverish pace. To speed weapon system acquisition the Air Force adopted an acquisition technique best described, in a word, as "concurrency". Concurrency didn't require the complete demonstration of a prototype weapon system before production was started, but allowed the buying of the total weapon system in independent sub-systems. The sub-systems were then joined to form the unified total system. Numerous interface problems resulted from this technique. To cope with these problems the Air Force formed inservice engineering to keep the weapons operational. Further, to free Air Force Systems Command (AFSC) for work on the next generation missile, the Air Force pushed the transfer of management responsibility for completed weapon systems from AFSC to Air Force Logistics Command (AFLC). AFLC established system managers to manage the transferred weapon systems. These new functions, system manager and inservice engineer, found a permanent home in AFLC and PMRT became a permanent part of the Acquisition process.

### Ridenour Committee Report

The Ridenour Committee used a fly-before-buy acquisition technique to set the command responsibilities contained in their report to the Scientific Advisory Board,

September 1949. Fly-before-buy requires a complete demonstration of a prototype weapon system before production is started. This technique is again in vogue with DOD. The committee never considered concurrency so the assignment of responsibilities that evolved from the command split was not exactly what they had in mind.

The Committee recommended a management structure made up of three functionally distinct commands: Using, which itself is divided by task into separate commands, Research and Development (R&D) and Logistics. To avoid the duplication of functions that had been prevalent in the Air Materiel Command, they separated the commands by the job each would perform. Evidence of job separation and the absence of PMRT can be seen throughout their report. For instance, they discuss job separation in the following excerpt. "Development resulting from service use almost always occurs. When a new device is put into the hands of those who must use it in operation, unexpected weaknesses and deficiencies are likely to be uncovered. Such deficiencies will lead to design changes which must, in general, be made either by those responsible for the engineering design, or else by others who work in close cooperation with them." (1:II-3:Para B). This excerpt comes from a section of the report that defines the R&D function, hence the phrase, "who work in close cooperation with them", must refer to a group of engineers, possible troubleshooters, from the R&D command.

On the other hand, the committee kept R&D out of the production business. They make their point as follows:

The responsibility of the Research and Development command would usually extend through the construction and testing of experimental weapons. The Logistics command would take on the production responsibilities as soon as a decision has been reached to procure equipment for use by the Operational commands (1:V-6:Para E).

This passage indicates that the committee wanted the logistics command to come in early in the acquisition process to actually buy the weapon system.

The committee, in bounding command responsibilities, effectively fixed the disciplines needed by each command to carry out their respective responsibilities. For example, they talked of disciplines when they addressed the procurement effort of the Logistics command. "The methods and procedures that have proved workable for the expenditure of large sums of money for USAF equipment involving competitive bids, close monitoring,

and careful checking against specifications—these methods and procedures are inappropriate for research and for most initial development” (1:V-5:Para E). The committee gives their reasoning under the paragraph titled, “Liaison with Production Activities,” stating that strict adherences to the separation of the R&D command from the Logistics command “is far less formidable than the danger of crippling research and development in competition with the urgent production problems which must always be the first concern of a command that is responsible for procurement and mobilization (deployment), as well as research and development” (1:V-10:Para I).

The Committee’s adherence to fixed disciplines is again evident in the following passage:

Although the technical understanding of such new systems is most advanced in the scientist and engineers who developed them, the Committee believes it would be a grave and fundamental mistake to assign the tactical evaluation function to the Research and Development command. The true, ultimate value of a weapon will be proven in combat use. A tactical evaluation should continuously approach such use. This means that the weapon must be employed by operational officers and airmen, suitably trained to its use. Technical experts cannot simulate operations of that type, nor can they be expected to be entirely unbiased with respect to their own products (1:V-9:Para H).

Many years later the Air Force implemented this concept by forming a separate test and evaluation command to ensure that new systems meet design goals. And, this separate command is doing an excellent job. The foregoing excerpts have been provided to show the Committee’s conscious consideration of the disciplines needed by each command and to set the stage for showing that PMRT is not an essential requirement in the life cycle of a weapon system.

### Command Boundaries

Though not spelled out per se in their report, it appears the Committee used three imaginary boundaries to divide acquisition responsibilities; boundaries that match the states of existence of a weapon system or end item in its acquisition cycle.

Because the R&D command and the Using command would be working in concepts and ideas whose final form was yet to be defined, the Committee separated these commands by a boundary best described by the term “abstract”. Similarly, R&D and Logistics were separated by the boundary “transit”, because they would be bringing ideas from a potential existence to an actual existence. The boundary “concrete” was used between the Logistics and Using command because they would be working with systems that are physical and real.

Using Figure 1, let’s examine how these boundaries intermesh with their particular acquisition phase. The abstract boundary contains the initiation phase. Communication in this phase concerns concepts and ideas that need not have a final physical form. The concept can be as complex as the MX missile system or as simple as replacing a troublesome meter with a warning light. The latter being a modification to a fielded weapon system. In either case the commands discuss these concepts in terms of what could be.

On the other hand the transit boundary contains the development phase. The aim in this phase is to achieve a physically producible item that can be reasonably manufactured by industry. Unlike the abstract boundary, communication here is directed toward achieving physical existence; a final form to serve as the basis for the production decision. Here the Committee held to a strict separation of disciplines, making Logistics the producer of items described by engineering data, provided by R&D. This separation conforms to the accepted industrial practice of breaking out the functions of engineering from those of production. As the Committee viewed it, Logistics worked production contracts, manufacturing techniques

Command Functional Separation

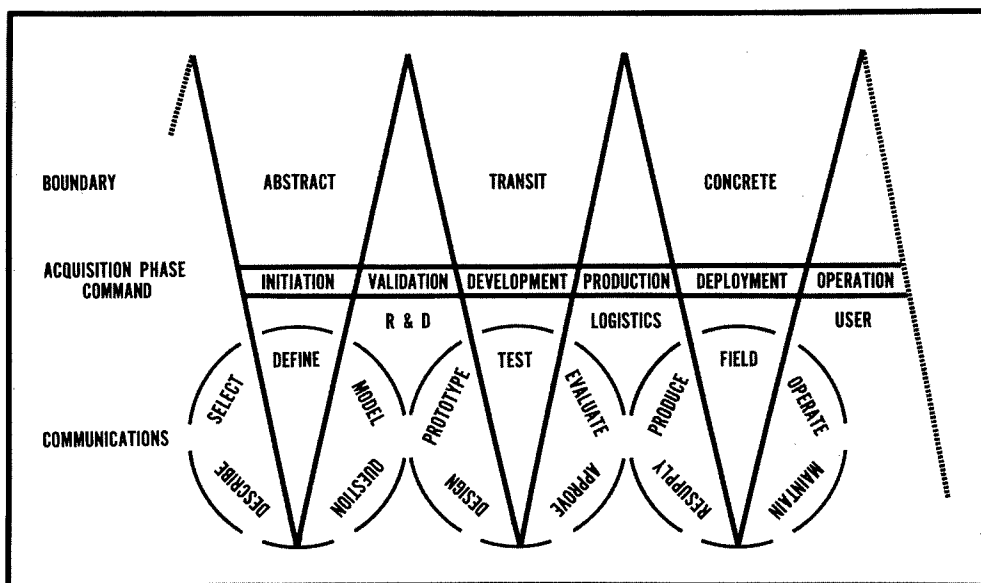


Figure 1.

and supply distribution systems. They would never be given system management or design responsibilities because these functions need different expertise than those needed in production. System management and engineering design were to remain with R&D for the life of the weapon system to make sure that the option of modifying proven weapon systems was considered along with proposals for totally new weapon systems as an alternative to a statement of need.

While previously discussed boundaries allow for the flow of ideas or the making of changes the concrete boundary does not. The concrete boundary contains the deployment phase which deals with a sterile product, one that has a firm configuration; a system, sub-system, assembly, component or piece part that can be delivered to the Using command. In the Committee's opinion this boundary remains inflexible because configuration changes are not developed by the Logistics command. This is not to say that they cannot request the investigation of design changes to reduce costs or that they are not involved in the installation of modifications. They can and do; they just don't develop the change. Thus, communications between Logistics and Using commands consists of filling supply demands, answering maintenance requests, preparing kit installation schedules and arranging repair schedules.

By holding clear job governing boundaries, the Committee holds communication between commands to the minimum needed to get mutual tasks accomplished. In so doing, the Committee guaranteed that the proper feedback would continue to flow to the command in need of that information. Along this line they recommended that deficiencies found in fielded systems be referred to the R&D command for resolution. In that way, lessons learned from latent deficiencies would be fed into the command responsible for developing new systems. A dynamic corporate body of knowledge would thus be built in the R&D command and this knowledge would be carried forward to the development of new weapon systems by the normal career progression of R&D personnel.

## Acquisition Participation

The advantage of separate commands can best be seen by comparing the Committee's recommended command participation in acquisition with our present practice. These are shown in Figure 2.

Under our management structure (Acquisition with PMRT) AFSC assumes a passive role until the requirement for a new weapon is brought to them in the form of a Statement of Need. They then take the lead in the Initiation, Validation, Engineering Development, Production and the Deployment phases. Following PMRT they return to a passive role.

The Ridenour Committee's proposed management structure, Acquisition without PMRT, would involve AFSC throughout the life cycle of the weapon system. AFSC would work out the concept of a new system with the Using command, be active in development, but begin to withdraw to a less active role letting AFLC take the lead during production. They would increase their participation during deployment, returning to actively assess design deficiencies in the operational system during its remaining life cycle. Upon finding a design deficiency or when a mission essential change is needed, the Acquisition cycle would be repeated for the needed modification. Since modifications usually employ the same acquisition phases used for a new weapon system, it follows that modification engineering and management would provide excellent training for future R&D program managers and in turn ensure that lessons learned on fielded systems get fed back to the development of new weapon systems.

AFLC, under acquisition with PMRT, plays a limited role during the initiation, validation and development phases, with activity increasing during production and deployment. After AFLC assumes management responsibility, those latent defects, which invariably occur in the use of all weapon systems, are corrected by modifications. However, these modifications are initiated, validated, developed, produced and deployed in virtually

Acquisition Phase Participation Chart

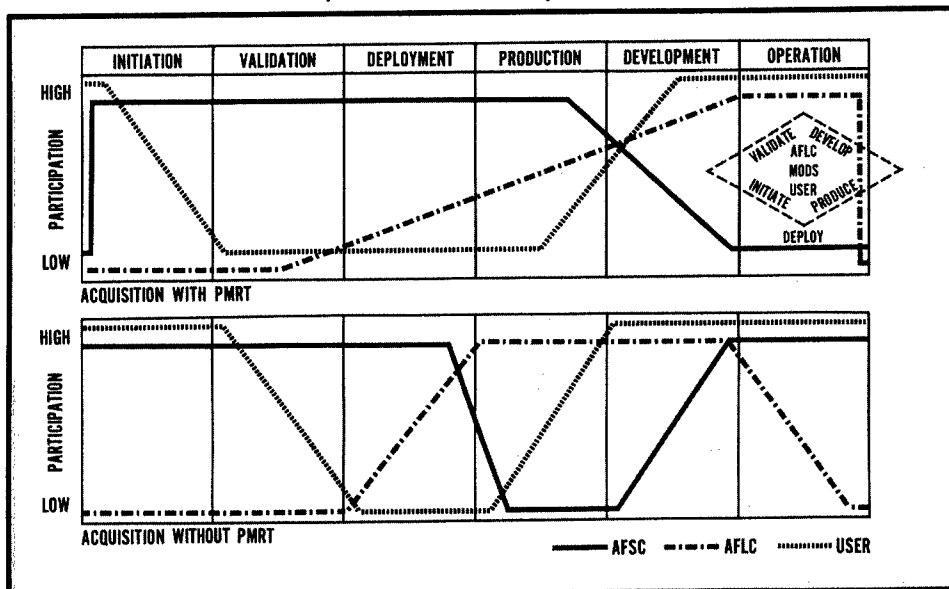


Figure 2.

total isolation from AFSC.

Under acquisition without PMRT, AFLC would have the job of buying, resupplying and maintaining weapon systems. They would be less active during the initiation and validation phases, but they would move into the driver's seat when an affirmative decision is reached to proceed with production. Their active participation would continue throughout deployment and become one of resupply during the operational phase. Their role is classical logistics: "the aspect of military science dealing with procurement, maintenance and transportation of military materiel, facilities, and personnel" (2:677).

The Using command performs the same function under Acquisition with PMRT as Acquisition without PMRT. However, under Acquisition without PMRT the User would have a single point of contact for all deficiencies; whereas with PMRT the User now deals with several different Air Logistics Centers. In this respect the User may find acquisition without PMRT simpler.

### Other Considerations

There are other considerations from outside the Air Force that support the Ridenour Committee's recommendations. In their 21 June 1977 report (3:22) the House Appropriations Committee took issue with inappropriate budgeting of research and development effort. Here is a key paragraph from their report to illustrate Congress' view of the acquisition process.

In the considered view of the Committee, any tasks designed to produce, improve or to increase the producability, reliability, maintainability and availability of weapons and equipment are a function of the research and development program. Such efforts encompass design and engineering as well as the testing of the weapons and equipment, or subsystems and components thereof, selected for improvement. The procurement budget was established primarily to fund the procurement and production of weapons and other military equipment which have successfully completed their development and test program, met military specifications, and are ready to be placed in the operational inventories of the military services. The procurement language in appropriation bill permits the expenditure of funds for modification and modernization of military hardware. This is meant to imply that the procurement appropriations may be used to purchase kits to modify and modernize such hardware, after completion of their successful

development, testing and evaluation utilizing research and development funds (3:22).

In NATO, the division of acquisition work between member nations for new weapons is a first order initiative. Yet, our participation in the development of some systems has been turned down. The *International Defense Review*, September 1979, in the article, "Behind the Scenes at Farnborough", contains an interesting comment by a European industrial official. When asked why US participation was being turned down he responded,

Meaningful US/European collaboration in early stages of a program will be possible when the United States is willing to change its defense procurement system. We don't want a new US partner each time the development of a program goes into a new phase (4:1438).

His statement, with but a few words, shows that our management of weapon system acquisition is out of phase with accepted government/industrial management procedures.

### Conclusion

We need to accommodate the fly-before-buy acquisition technique by redistributing responsibilities to eliminate PMRT. This won't be easy, but expanding into special management groups to cover problems caused by PMRT only creates more and more management interfaces, duplicates functions, and needlessly gobbles up our budget. A quote from Alexander Clark seems appropriate: "Let us watch well our beginnings, and results will manage themselves." The Ridenour Committee followed this philosophy when they laid out their management structure for weapon system acquisition. They stripped management to its essentials. They separated commands by fixed boundaries. They limited the number of disciplines in each command. Then and only then did they define the responsibilities of each command. We would do well to revisit the wisdom of the Ridenour Committee.

### References

- (1) "Research and Development in the United States Air Force," Report of a Special Committee of the Scientific Advisory Board to the Chief of Staff USAF, 21 Sep 49.
- (2) *Webster's New Collegiate Dictionary*, G&C Merriam Co., Copyright 1975.
- (3) U.S., Congress, House. *Department of Defense Appropriations Bill*, 1978 Report No. 95-451, 95th Cong., 1st Sess., to Accompany H.R. 7933, June 21, 1977.
- (4) "Behind the Scenes at Farnborough (Weapon Systems)", *International Defense Review* 9/1978.

### *Most Significant Article Award*

The Editorial Advisory Board has selected "The Soviet Air Force Supply System" by Major George F. Kalivoda, USAF, as the most significant article in the Spring 1980 issue of the *Air Force Journal of Logistics*.

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## **Program Management by Intent**

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The duties of a program manager generally fall into two major areas: new business development and management of assigned programs. This article will primarily address management of assigned programs and the techniques which I believe are valuable in directing a successful program. It is based on early experience as Deputy Technical Manager for the Pave Knife, Electro-Optical Target Designator System and, more recently, as Program Manager of the Pave Tack, Day/Night FLIR/Laser Target Designator and Fire Control System. Although the functions of the government program manager or SPO and the industry program manager are necessarily different, the techniques of good management apply to either role.

### **The Proper Beginning**

Planning the successful initiation of a new program should take place well before a contract is awarded. A well planned initiation is the key to a successful program and a poorly initiated program immediately puts the program into a recovery mode with a strong probability that the program will continuously deteriorate rather than recover.

Generally speaking, program organizations are established during the proposal phase of a program and are usually driven by the customer's requirements and desires. The most important factor in structuring the program organization is the quality of the people that are acquired to staff the organization. A strong program team is essential to conducting a successful program, and a great deal of effort put into this endeavor will yield good dividends during the course of the program.

One can draw a comparison between a program manager and an orchestra leader. An orchestra leader must select musicians who are capable of playing their instruments proficiently before he can fuse his orchestra into a single unit capable of playing music to his orchestration. All the orchestration talent in the world cannot make up for musicians who do not have the capability or the talent to play their respective instruments well. It is just as important to select a competent and expert program team; however, selecting and staffing individuals who are competent and expert at their respective roles is not an easy task. Selection of deputy program managers and other program office staff personnel is reasonably direct. The program manager has a direct involvement in selection of the candidates and if he is valued by his own management, he can usually staff his team with individuals he selects and believes are capable of handling their assignments. Assuring that he has a capable team of engineering, manufacturing,

reliability and other support personnel is a much more difficult task. Most program managers, whether in government or industry must work within the framework of a Matrix organization and as such the line management within the Matrix organization usually staff and select personnel for the program.

It is important for the program manager to be directly involved in the selection of all key personnel on the program and not just those that organizationally report to him. The program manager must inject himself into and be part of the selection process or he is liable to be saddled with a mediocre team of people who will not be capable of carrying the load during the course of the program.

Too often one hears program managers both in government and industry complain about the quality of their personnel and tend to put the blame for the assignment on higher management or on someone else. Comments like, "These people get assigned to the program and I have to accept whoever they give me," "The engineers don't work for me," etc. are just a poor excuse for not doing an adequate job in convincing the Matrix organization or one's own management of the need to be part of the selection process in order to assure successful accomplishment of program objectives. It is well to remember, particularly for government program managers, that it is far more difficult to replace an individual established in an organization than to make the proper assignment initially.

### **Qualities of a Program Manager**

The three qualities I like best in a program manager are common sense, intuition and tenacity - and being smart helps a lot. Being able to lead and motivate people is a very important attribute. One leads by consensus of the individuals being led and motivation cannot be demanded nor can leadership be pontificated. A group acknowledges a leader because they want to follow him. He is respected because he makes individuals in his program feel a part of a team, a part of something special, and essential contributors to an important objective that only their combined talents can accomplish.

It is not possible to be an expert in every specialty required within a major development program since the overall expertise involved spans all the varied technical disciplines such as electrical, mechanical, electro-optical, systems engineering, reliability, logistics, etc.; manufacturing, finance, and contract administration expertise is required as well. It is, however, important to have a working knowledge of all these varied disciplines.

The majority of decisions made are based on selecting the best alternative. These decisions are rarely obvious or clear-cut and are made on data that is often incomplete in order that they can be implemented in a timely manner. Too often managers wait "for all the facts" before they reach a decision, not recognizing that while they are waiting they have in effect made a decision by default and have consciously or subconsciously decided to do nothing. This does not imply that decisions should be made without an understanding of the factors involved, but common sense should dictate when waiting for more information can do more damage than selecting and pursuing a prescribed course of action.

Intuition is a characteristic that is difficult to explain. It is in effect sensing the right course of action, without being able to really explain or justify that action to someone else. It is the ability to sense an impending problem when experts are telling you a situation is well in hand and things are in great shape. Some individuals have it and some don't, and intuition is the one aspect of program management that cannot be taught.

Tenacity is a characteristic that succeeds beyond any other characteristic I can envision. A tenacious individual with reasonable ability will generally out-perform an individual with outstanding potential unless that potential is accompanied with a corresponding inner drive. In a development program, tenacity is a characteristic that equates very well with schedule achievement, and achieving schedule objectives generally means that the cost objectives will also be met.

There are other attributes of a program manager that are also important: being good at communicating with one's team, the customer and internal management; being good at prioritizing objectives and problems; and last but not least, having the stamina to withstand a fair amount of physical and emotional stress in a graceful manner.

### **Program Management by Intent**

I am sure most of you have heard of management by objectives. Several important milestones are established during the program life and progress is measured against those objectives or milestones. In order to meet the program objectives, it is necessary to manage by intent. What that means very simply, is that management must be a conscious, involved process and that the program manager must guide and influence the course of events and not merely react to or report these events. There are generally speaking, two categories of program managers: the manager who shapes and guides the events in a program and the manager who reacts to and can articulately relate program problems but rarely formulates necessary and timely solutions.

The program manager must start with a set of objectives and infuse these objectives into the program team including his subcontractor personnel. In a development program, I think the prime objective should be deployment of the system that is being developed, and that the *USER* must be satisfied that the system performs the functions it was designed to perform and that the system design, reliability and supportability satisfies the *USER* requirement.

The *USER* is stressed because it is important for both the government and contractor program manager to remember that design and development of a system within the specifications established by the developing agency is not an end objective in itself.

A constant evaluation must be conducted during the test program to assure that the system being developed will function as was intended and that the *USER* is satisfied with its usability. Modifications to the specification requirements and design should be made if it is necessary to satisfy the functional objectives.

It is not uncommon for a system to satisfactorily meet the specification requirements, but fail to obtain a positive production decision and be deployed. One of the primary reasons this occurs is failure of a developing agency to obtain full user support of the system.

Below is a summarization of a few techniques that, if used effectively, will aid the program manager in meeting his program objectives.

#### *Organize an Effective Team*

Staffing the program organization with high quality personnel cannot be overstressed. A program manager must put forth the necessary effort to make it happen because it just does not occur automatically.

#### *Motivate that Team*

Talent without motivation is akin to having excellent tools without the knowledge to use them. The program manager must work at making the program organization be part of a team whose desire is to produce the best results their bodies and minds can muster.

#### *Respect the Ideas of Your Experts*

It is important to recognize that there are numerous means to accomplish any given task. In order to encourage creative thinking and a sense of accomplishment in your subordinates, responsibility should be delegated to as low a level as practical, consistent with effectively satisfying your program objectives. If a subordinate presents a plan that you believe will get the job done, accept it! Resist the urge to fine tune it for him. Allow him the latitude and the satisfaction of knowing he has been creative and effective in formulating a course of action. If necessary, suggest or direct an alternative course of action, but only if necessary. By encouraging talent and permitting independent thinking and latitude of action to your subordinate you will generally have a satisfied, motivated, involved team member and not just an employee.

#### *Have a Working Knowledge of All Aspects of Your Program*

Previous experience obviously helps, but get involved and acquire knowledge in each area so that the decisions and compromises that often must be made can be made with an understanding of the tradeoffs involved.

#### *Assess Your Risks and Plan to Avoid Them*

Risks should be periodically evaluated so that a course of action can be directed to minimize that risk. If, for example, you feel that a specific subsystem may be the

high risk item on the program, you may elect to build an early demonstration test article, or you may decide to accelerate the development schedule of that subsystem to allow a longer period of development testing and corrective action. If you adequately assess your risks, you can avoid the pitfalls of being surprised, missing schedules, or incurring cost overruns because you have consciously decided to manage rather than fall into a reactive mode.

#### **Maintain Plans and Schedules**

Prepare plans and schedules that are working tools with measurable milestones and treat every milestone as a commitment. If a milestone is missed, immediately prepare a recovery plan to complete that milestone and recover the schedule in a timely fashion. Do not fall into the trap of believing that you can miss milestones but hold all the completion dates just because they are 18 or 24 months in the future. You will be fooling yourself and as well work the program into a corner that will result in late deliveries and cost overruns.

#### **Be Decisive**

Be decisive! Be decisive! Be decisive!

#### **Don't Tolerate Incompetence**

If a mistake has been made in staffing a position, correct it as soon as you are convinced that for whatever reason, the individual in that position will jeopardize the program. There are usually other positions within a program that the individual can perform well. Failure to

correct it will be unfair to your organization, your team members, your management, your customer, and as well the individual involved.

#### **Be an Independent Thinker**

There are no laws, books or sets of rules and regulations that cover every situation you will face during the course of a program. Working within the framework of your charter is the proper course to follow. However, there is a significant degree of latitude in interpretation of these regulations and guidelines. You will not be forgiven for managing a poor program by rigidly citing all the reasons and regulations that prevented you from successfully meeting your program objectives.

#### **Never Forget Your Objectives**

Once you establish your program objectives you should make a concerted effort to abide by them. It is relatively easy under the strain of program pressures to make expedient decisions; poor decisions that allow you to handle the immediate problem by patchwork or incomplete solutions in order to conserve schedule or costs. Although cost consciousness is essential, decisions should be made within the framework of satisfying the program objective of successful deployment of the system being developed.

One final suggestion - convince yourself that you are totally responsible for the success or failure of your program and that the responsibility for performance cannot be shifted. The gravity of that thought and the knowledge of the inner agony that failure will bring will help you manage your program by intent.

### ***Air Force Logistics Command Item of Interest***

#### **Zero Overpricing**

Impossible? Maybe, but it is the goal of Air Force contracting activities. The Air Staff initiated the Zero Overpricing Program by asking all components of the supply chain to help in reducing overpricing.

Generally, overpricing exists if the Air Force pays a higher price for something when a less expensive alternate is available or can be readily developed. It can be caused in several ways. For example, restrictive specifications can eliminate commercial supply sources. Priority requisitions cause producers to pay acceleration premiums and disrupt production lines resulting in excessive prices. Contracting personnel working with insufficient information may enable more than a fair and reasonable price to be charged.

Whatever the cause, Air Force personnel are encouraged to report suspected cases of overpricing. Overpricing of local base supplied items or services should be reported to the local chief of supply. Overpricing on centrally acquired items should be reported to the price monitors listed in AFM 67-1, Volume I, Chapter 7. The price monitors will need to know why a price is considered excessive. They will verify the accuracy of the stock list price before sending their referral to an *ad hoc* zero overpricing committee. The zero overpricing committee will conduct a thorough investigation of the circumstances surrounding the acquisition of the item or service. If the review supports the overpricing charge, other potential avenues of supply will be studied. The initiator of the referral will receive notification of the committee's findings and of any actions taken. Referrals which result in substantial savings to the Air Force will receive a reward. (HQ AFLC/PMPP, Robert Hill, AUTOVON 787-6861)



# CURRENT RESEARCH

## AIR UNIVERSITY LOGISTICS RESEARCH IN THE PME CLASSES OF 1979-80

The logistics related research papers and projects completed by the students of Air War College and Air Command and Staff College during the 1979-80 academic year are identified below.

In general, titles in quotations marks are research papers, reports or articles prepared for publication while italicized titles are handbooks, guides or theses. Loan copies can be obtained by writing to the Air University Library, Interlibrary Loan Service (AUL/LDEX), Maxwell AFB, Alabama 36112.

### Air War College

"An Analysis of Logistics Shortfalls in Vietnam: 1965-68" - Lt Col John T. Quirk.\*

This is an analytical, matrix-based study of three categories of logistics shortages occurring in the Southeast Asia build-up between 1965 and 1968. The author suggests some procedures for the future to minimize the impact of such shortages.

"F-16 Co-production Experience" - Lt Col Robert C. Bell

This study reviews the F-16 program experience in the areas of management of special tooling and the production of system components in different countries and identifies mistakes that should be avoided in future co-production efforts.

"The Acquisition of Doctrine Process: A Conceptual Approach" - Lt Col John T. Quirk

This study examines the linkage between the methods of acquiring technology and the development of doctrine and suggests a single-agency approach to manage the life-cycle development of doctrine.

"The Air Force Stop-Loss Program: A Conceptual Approach" - Colonel Richard W. Dush

This is a descriptive study of the Air Force inventory and warehouse management system.

### Air Command and Staff College

"Acquisition and Use of Data Processing Equipment" - Major Thomas M. Collins

"Acquisition Management of Initial Provisioning: Is it Effective?" - Major William C. Leeper

*A Guide to Logistics For Strategic Reconnaissance Aircraft* - Major

Ronald C. Hoch

*A Handbook for Auditing Logistics During Weapon System Acquisition* - Major James B. Kent

*A Handbook for Developing Effective Construction Contract Specifications and Plans* - Major Eric A. Beshore

"Aircraft Maintenance Officer Retention" - Major Paul T. Welch

"AFESC Mission Equipment Depot Maintenance Management Program" - Major Roger D. Robinson

"Air Force Management of Warranties" - Major John M. Franco

"Airlift to the Persian Gulf: A Study of the U.S. Capability" - Major Clark B. Russell

*Aluminum: Strategic and Vital Metal* - Major Paul A. Longren

*A Methodology for Determining the Applicability of a Commercial Item* - Major William E. Benjamin

"Analysis of the Competitive Environment of the U.S. Defense Industry" - Major Jack R. Runkle

"Applying Multiattribute Utility Measurement to Source Selection" - Major Robert T. Beard

"A Short Course in Software Engineering" - Major James B. Peterson

"Assessment of Japanese Aerospace Technology Development and Influence" - Major Merwin E. Spragg

"C-12 Logistical Support" - Major Sidney H. Morrow

*Civil Engineering Resources and Requirements Chiefs—What's Important* - Major James G. Novakoski

*Command of the Service Contract Environment* - Major Robert G. Kiermaier

"Commercial Acquisition: It is Worth the Investment" - Majors Michael E. Millard and Kent J. Murphy

"Contract and Purchase Order Production Administration within the Defense Logistics Agency" - Major Waymond L. Henry

"Cost Schedule Status Report Using a Programmable Calculator" - Major Rex W. Franklin

"Deploying a CONUS Joint Task Force: A Logistics Challenge" - Major Stephen G. Crane

*Electronic Security Command CEM Maintenance Officer Handbook* - Major Kenneth J. Sonnier

"Embedded Computer Systems: Implications for Fixed Price Acquisition" - Major Walter G. Murch

"Flightline Maintenance Expediter: A Better Organizational Alignment" - Major William D. Cummings

"Freedom of Information Act and Executive Privilege Impact on Safety Reports" - Major William Moorman

*Future Application of Cross Utilization Training* - Major Earl H. Geil

"Government Engineers in Air Force Contractor Plants: Do We Need Them?" - Major Blaise J. Durante

*Guidebook for DCMs* - Majors Donald B. Campbell and Andrew Timko

*Guide for Starting in the Business Management of the Program Office* - Captain Joseph R. Busek

*Guidelines for Strategic Air Command Logistics Plans Officers* - Major Robert A. Defee III

"Jet Fuel Availability in 1985" - Major Al J. Caldwell

"Lessons Learned in the Use of Microcomputers in Larger Systems" - Major Charlie D. Huskey

"Logistics Support of the Eniwetok Clean Up Project: A Log Planners' View" - Major Edward L. Williams, Jr.

"Low Rate Initial Production of Munitions" - Major Wallace T. Bucher\*

"Maintenance Officer Technical Training: A Time for Change" - Major Douglas D. Stormo

*Management of the Strategic Weapon System Acquisition Process* - Major Jacob J. Killian

*Managing Base Bucks* - Major James L. Laird

*Manpower and Personnel Handbook for SAC Aircraft Maintenance Managers* - Major Gary D. Worrell

"Military Airlift Command Strategic Airlift Departure Reliability System: A Need for Change" - Major Douglas M. Dunn

"Mission Area Analysis: A Decision Process for The Eighties" - Major Wallace B. Frank, Jr.

"Motivation in the Aircraft Armament Career Field (462X0)" - Major Jerry R. Pfeifer

"OMB Circular A-108, Major Systems Acquisition: Can it be Applied to ADP Acquisitions?" - Major Robert L. Hanley

"Operation Planning — A Logistician's Perspective" - Major Charles M. Leigh

*Planning-Programing-Budgeting System Guide for Acquisition Management Officers* - Major Paul E. Hanson

"Proposed Aircraft Test Bed Configuration for A Future Air Cushion Landing System Acquisition/Development Program" - Major Thomas R. Clapp

"Review of Competition for Jet Fuel Components and Impact on Availability" - Major Brian A. Ruchalski

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"Training Device Acquisition and Acceptance" - Major Robert W. Walkins

*USAFE Conventional Munitions Planning Guide* - Spencer W. Wilkenson

"USAF Test and Evaluation Management Problems" - Major Ronald C. Hoover

\* These two studies received the Society of Logistics Engineers' Logistics Award in the Air War College and Air Command and Staff College respectively.

*Logistics Officers continued from page 15*

desires of the individual officer are more limited. Air Force priorities and requirements many times do not fall within the personal desire sphere. All officers must understand this aberration and be counselled in this regard. We will do our part at AFMPC in our many communications vehicles. However, we need the help of supervisors throughout the force to help us insure each officer

understands. In this regard, we suggest each supervisor contact the appropriate resource manager. We will provide you with a unit analysis and discuss with you the assignment status and career development options for each of your personnel.

The next few years represent a time of challenge: logistics capability stretched to the maximum, experience shortfalls at all

levels, manning shortfalls at some. As we learn to prioritize when short of parts, O&M funds and production capability, we must also prioritize our manpower positions. We will fill the top priorities with the right kinds of experience, but the lower priorities will suffer. People are a part of the logistics system and their utilization must fall within overall logistics objectives.

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## Logistics Support of Nuclear Hardened Systems

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### Introduction

The threat of nuclear weapon effects has been and is being considered in the design of Air Force weapon systems. A nuclear hardened system is one designed to survive these nuclear effects in order to accomplish its intended mission.

While nuclear weapons are similar to more conventional high explosive weapons in that their destructive action is due mainly to blast or shock, there are several basic differences of significance to system survivability. Nuclear weapon blast and shock can be many thousands of times more powerful than the largest conventional detonations. The temperatures reached in a nuclear explosion are much higher than in a conventional explosion, and a large proportion of the energy in a nuclear explosion is emitted in the form of light and heat, generally referred to as "thermal radiation." Finally, a nuclear explosion is accompanied by high-penetrating and harmful invisible rays, called "initial nuclear radiation." Nuclear radiation also generates an electromagnetic pulse (EMP) which can degrade system performance.

The threat determines the hardening technique to be used. Highly reflective paint will minimize thermal effects. Machined parts rather than castings are used to survive shock. The effects of radiation and EMP are minimized by the use of radiation tolerant materials and electronic components, by shielding of critical components, and by compensation circuitry, shielding cables, wires and components.

Weapon systems such as the Minuteman and E-3A AWACS have been hardened. Other systems such as the Air Launched Cruise Missile and B-52 have hardness requirements. Providing the logistics support for these systems will require special consideration for the near term, but must become routine in the long run.

To further understanding of the logistics support for a nuclear hardened system, three terms need to be defined. *Hardness assurance* includes the procedures applied during the production phase to ensure the end product meets the nuclear hardness design specifications or requirements. *Hardness maintenance* includes the procedures applied during operational deployment phase to ensure that systems hardness is not degraded during maintenance actions (repair, modification, resupply). *Hardness surveillance* includes test and/or procedures used during the operational deployment phase to determine if system hardness has been acceptably maintained.

### Major Aspects of Logistics Support

The Air Force has experienced problems with supporting nuclear hardened systems. Millions of dollars have been spent to improve the support to the nuclear hardened aspects of Minuteman. Changing drawings and acquiring data after a system has been produced is more expensive than developing the data concurrent with the acquisition cycle. For example, it costs \$200 per drawing to make a change which would be negligible during original preparation.

These problems have been investigated by a Joint Logistics Commanders' group, and the major findings are presented below.

#### Item Identification

Within the logistics support arena, a prerequisite to supporting a hardened weapon system is the identification of hardness critical items (HCI) and processes (HCP). It is a relatively simple matter to identify those items or processes which are specifically designed to provide hardness. A much more difficult problem is the "inherently hard part" which is procured to an existing military or commercial specification and proven by test or analysis to be hard. The specification identifies the part but does not give specific nuclear hardness requirements. It becomes difficult to monitor specification changes and manufacturing techniques and processes which could degrade parts procured later in the system life.

Engineering drawings are used for initial provisioning, reprourement, cataloging and on and on. Because drawings are necessary for so many functions and are key for baseline identification, marking drawings is the most effective method of identifying hardness critical items.

#### Training

Another aspect of maintaining hardened systems is the awareness of personnel responsible for providing the logistics support. Everyone associated with a system should be aware that the system has been hardened and that support decisions must consider hardness. Others need to know the general features of the hardening which were incorporated and where detailed design information is available. These individuals must be able to identify the parts and procedures which make the system hard and know the procedures for obtaining review and approval of proposed changes to the system. Those who prepare

drawings, make or assemble the system or equipment, identify HCI's in initial provisioning, specify HCIs for resupply, and review data packages for reprourement, repair or servicing the equipment must also have some knowledge of the nuclear hardness details.

### Parts Management

Having hardness critical items identified and support people trained, positive parts control can be accomplished within a modified support system. The management and reprourement responsibility for the many thousands of piece parts for a weapon system is normally divided among a service's wholesale supply centers and the Defense Logistics Agency's two hardware centers. Some subsystems and piece parts which are common to two or more services, are managed by a lead service. The two parts management areas requiring attention for assuring correct hardness maintenance of nuclear hardened systems are cataloging and reprourement actions.

Every new item entering the DOD supply system is processed through cataloging and standardization activities. Cataloging assigns a national stock number, describes the item in the Federal Item Identification Guide (FIIG) and assigns phrase codes which are reflected in the cataloging management data. Then standardization technicians assign interchangeability and substitutability codes which define the degree of interchangeability. Throughout this process, precise identification of HCI's is imperative. An error during any of these activities could allow the supply system to provide unhardened substitute items where hardened items are requisitioned. Moreover, expensive hardened items could be improperly substituted to fill less stringent requirements.

During reprourement of like items over the life of a nuclear hardened system, additional parts control problems are present. Item managers and equipment specialists make many crucial decisions during the life of a system on whether to procure a like item from the same source, a like item from a different source or a substitute

item when a like item or a qualified source is not available. These decisions made in reprourement actions must consider hardness requirements; yet training all the individuals making these decisions appears to be impractical. However, by providing identification of hardened parts and assuring that a knowledgeable engineering staff reviews and coordinates on reprourements, item managers will be able to maintain hardness. This identification and awareness is especially critical for items like the gaskets in Figure 1 which appear similar in both hardened and unhardened versions.

### Configuration Control

In order to maintain the hardness designed into the system, it is essential that the configuration of the system not be altered during its lifetime without consideration of the effect of the change on nuclear hardness. Change of system configuration can be major or minor, can occur almost anywhere, and can be accomplished by anyone. Existing DOD logistics procedures need to be reviewed and changes made to insure hardness configuration control is maintained.

### Documentation

Program documentation must be procured for maintaining hardness during the weapon system life cycle. The contractor must document the nuclear hardness design features, assumptions, analysis techniques, test results, and all other features which establish a hardness baseline. These data must be such that they give a survivability engineering organization the capability to analyze and assess proposed changes or to design product improvements.

The hardness assurance documentation provides the details of production which incorporated hardness into the system. Unless this type of data is documented and well organized, a supporting engineering organization could not effectively assess or analyze proposed changes in a timely cost effective manner. Thus, data item descriptions must specify required hardness information.

### Hardened and Unhardened Items

The two pairs of unhardened and Hardened Critical Items (HCI) shown in this layout and their cost are A. Window Assembly (\$10.31); B. Glass Inspection Window (HCI) (\$244.00); C. Gasket (\$4.61); D. Gasket (HCI) (\$31.00). Items A and C are unhardened items used on -135 aircraft. Items B and D are the corresponding EMP hardened items used on the E-3 aircraft. A metal mesh layer in both the glass and the gasket is the hardening technique.

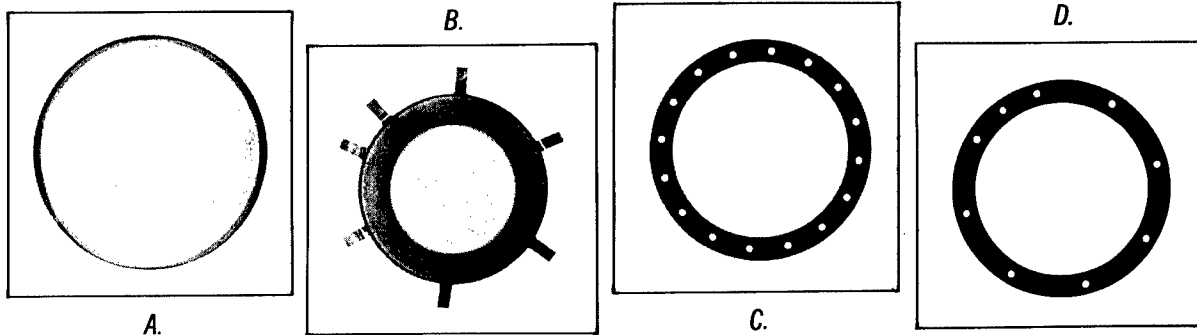


Figure 1.

## Hardness Maintenance and Surveillance

In addition to solving the above problems, we also need to foster research and development to produce usable hardness maintenance and surveillance methodology and to design supporting test equipment for use in the field and depot. Hardness maintenance and surveillance technology, including test equipment, is in early stages of development. Research and development facilities and methods such as the EMP simulators are not suited to maintenance and surveillance efforts once the user has the system. In some cases testing of EMP of individual parts of entry is possible. This kind of tester can be used for hardness maintenance and surveillance.

## The Joint Logistics Commanders Panel

The Air Force has taken action to head off problems on systems currently in the acquisition phase, but the long range problems cited above will cut across all services and the Defense Logistics Agency (DLA). The Joint Logistics Commanders (US Army Development and Readiness Command, Naval Material Command, Air Force Systems Command and Air Force Logistics Command) have established a panel to coordinate the individual services and DOD support procedures to prevent the inadvertent substitution of nonhardened piece parts into nuclear hardened systems. The panel is to provide a mechanism to identify and implement procedures for cost effective life cycle maintenance. The panel is also charged with maintaining liaison with developers for hardness maintenance and surveillance techniques and equipment.

Since the mission of the panel is ambitious and there is more work here than one group could accomplish in a reasonable time frame, four subpanels have been established.

*The Subpanel for Technical Data and Cataloging* will be responsible for implementing the changes required to identify hardness critical items and processes on engineering drawings. This subpanel will also be responsible for modification of the specification and standards which govern maintenance manuals. It will also

insure that manuals include the "do's and don'ts" of hardness maintenance. Directives governing provisioning documentation and standardization criteria must also be changed.

*The Subpanel for Configuration Control* will be responsible for reviewing existing management procedures and developing changes required to maintain the configuration control of hardness critical parts and processes during procurement, maintenance, modification or product improvement. The panel will be responsible for identifying the support documentation that must be developed to logistically support the system, then preparing the Data Item Description needed to procure the data during system acquisition phase.

The third subpanel is responsible for the coordination of research and development of nuclear hardness maintenance and surveillance efforts. This is to ensure the Service's ability to insure hardness of the system. Standardization of test equipment for field and depot use needs to be fostered since full threat level system testing will probably be too expensive to be the sole hardness surveillance technique for a system. The techniques and the equipments required are still emerging. Another task of the *Subpanel on R&D Coordination and Lessons Learned* is the development of a lessons learned network to promote exchange of information among DOD activities and industry.

*The Training Subpanel* is to prepare and coordinate the outlines for the training of all personnel involved in logistics support and maintenance of nuclear hardened systems. Changes generated by the other panels will be incorporated into the training outlines so that they reflect the most current procedures.

The tentative milestones for the panel's major tasks are shown in Table 1. Further refinement of these dates will occur as each subpanel progresses through its tasks.

Through activities like the Logistics Support of Nuclear Hardened Systems Panel, the Joint Logistics Commanders are working hard to conserve resources and assure readiness. Proper logistics support of vital nuclear hardened systems will assure the survivability of defense forces.

Table 1.

### Tentative Milestones for the JLC Panel on Logistics Support for Nuclear Hardened Systems

TASK	ESTIMATED COMPLETION DATE
I. Develop recommended changes to specifications applicable to the preparation of drawings, manuals, and provisioning data	Apr 1981
II. Develop uniform procedures for cataloging standardization, and item management	Jun 1981
III. Develop procedural changes to maintain configuration control	Jun 1981
IV. Develop and establish a methodology for exchanging information on lessons learned	Sep 1981
V. Prepare and coordinate course outlines for all levels of personnel associated with development, logistics support, use, and maintenance of hardened systems	Dec 1980

### *Air Logistics Center Item of Interest*

#### **Quality MDR Investigations Require Quality Reporting**

Many Material Deficiency Reports (MDRs) are being received by the Contact/Action Point at the Air Logistics Centers (ALC) with incomplete or missing information. This causes delays in processing and at times necessitates closing of the report without a complete investigation.

T.O. 00-35D-54, para 4-1, gives a description of the information required in each block of the MDR, most of which must be supplied by the maintenance personnel who identify the problem. Even when some of this information is not readily available to the initiator, the quality function (Screening Point), who controls the MDR paperwork, should be able to provide assistance. For the benefit of *all* personnel involved with MDRs and in the interest of improving the overall system, the following identifies the commonly missing/incomplete items on the report and the reason for their need:

*The Material Management Code of the National Stock Number (Block 5):* This code often identifies a prime ALC which differs from that indicated by the Federal Supply class.

*Manufacturer, Manufacturing Code, Shipper, Source of Repair or Overhaul (Block 7):* The manufacturer's name and/or code is very important if the item being reported is a new item. If it is an overhauled item, the name of the overhaul facility (contractor or Technology Repair Center) is required, not the original manufacturer. The action point has no other way of knowing who is responsible for the condition leading to the reported deficiency.

*Contract, Purchase Order, Document Number (Block 10):* The contract number is needed to identify the contractually specified requirements for repair or replacement of the deficient item.

*Item New or Overhauled (Block 11):* This is especially helpful when blocks 7 or 10 are unknown.

*Date Manufactured, Repaired or Overhauled (Block 12):* This information assists in locating the work control documents, identifying the personnel responsible for the deficiency and developing changes in any procedures which may have contributed to the deficient conditions.

*Operating Time at Failure (Block 13):* This is the time an item actually functioned as intended or time used to test other end items. It is an indicator of material failures, poor process or procedures, poor quality or poor design.

*End Item Type-Model-Series (TMS) and Next Higher Assembly (NHA) the Deficient Item Works On or With (Blocks 16a and b):* The End Item must be fully identified by TMS; i.e., Aircraft (F-4D, C-141A, etc.), Missile (LGM-30G, AIM-9L, etc.) and Trainer (AF 37U-T1, AN/GSQ-T32, etc.). The NHA is a system or subsystem within the End Item. If the item being reported is a structural component, the NHA would be the Wing, L.H., or Aileron, L.H., etc. If the deficient item is a component of the F-4C Fire Control System, Radar Set, the NHA would be the AN/APQ-100 System. These items are required for tracking deficiency history on the end item and the NHA.

*Description and Cause of Difficulty (Block 22b):* Statements such as "Failed to Operate," "Out of Tolerance" or "Improper Voltage" are too general and cause delays in processing, investigating and providing a meaningful response to the initiator. More details are needed. For example, was the unit received from supply and did it pass inspection/test? If so, the previous inspection agency stamp identification from the serviceable tag is quite helpful.

There is one last point that everyone should remember. In most cases the Contact/Action Point (usually the Quality Assurance office at an ALC) never sees the exhibit being reported. The Initiating, Screening and Support Points are the ALC/QE eyes, the contents of the MDR the basis of their actions. To prevent those actions from being delayed or inappropriate, be sure each MDR is complete. (OO-ALC/QEI, Richard Krebs, AUTOVON 458-6971)

## Information for Contributors

**General.** The *Air Force Journal of Logistics* is dedicated to the open examination of all aspects of issues, problems, and ideas of concern to the Air Force logistics community. Constructive criticism of logistics as it exists today is encouraged if it is issue oriented, rationally expressed and indicates the positive action necessary for future improvement. Contributions are welcome from any source inside and outside the Air Force.

**Scope.** The *AFJL* will consider for publication articles and research results that add to the understanding or improvement of any aspect of Air Force logistics from maintenance, supply, transportation, and logistics plans, to engineering and services, munitions, and contracting and acquisition; from base-level and operational units to depot-level and military and civilian industrial and production logistics; from logistics civilian, enlisted and officer personnel and manpower requirements to training and education; from internal organizational structure, policies and procedures to external relations with other services, government agencies, civilian industry and allies; from daily mission support challenges to the logistics aspects of national security objectives and Air Force strategy, doctrine and tactics.

**Special Interest.** Articles are especially invited that:

- give the results of the application of sound analytical and research techniques to existing Air Force logistics operations;
- offer possible alternatives to current operations based on a logical assessment of today's posture and tomorrow's requirements;
- demonstrate the interrelation of various parts of Air Force logistics systems internally and with non-USAF systems;
- consider basic Air Force logistics functions and issues from an unusual perspective;
- focus on logistics and Air Force mission accomplishment;
- or, provide insight into the reasons for and impact of recent or future changes in Air Force logistics.

**Original Material and Revisions.** Submitted articles are received with the understanding that:

1. They have not been published nor are being considered for publication elsewhere. Articles based on research planned for publication *only* as an in-house report or in symposium proceedings are acceptable.

2. Those articles with multiple authors have been approved by all. The *AFJL* will work with the lead author in preparing the manuscript for publication with the

understanding that any approved changes are acceptable to all.

3. To the greatest extent possible, necessary revisions in the manuscript will be coordinated with the author.

**Length.** In general, manuscripts should be between 2000-3500 words. Shorter and longer papers may be published on an exceptional basis. Formal research papers should briefly recognize the most significant research accomplished in the area of investigation and the relation of that research to the work addressed in the paper. A 50-75 word abstract should accompany each manuscript.

**Format.** Manuscripts should be typed with one inch margins, double-spaced on one side of standard size bond paper. References should be numbered and double-spaced on a separate page(s) at the end of the manuscript. The double number system for identifying references within the article should be used, i.e., (7:15), with the first number identifying the number of the source in the reference list and the second number indicating the specific page number in that source. When possible, potential textual footnote material should be incorporated in the main body of the article. Do not include a separate bibliography.

**Figures and Tables.** Supporting figures, if any, should be numbered consecutively and prepared on separate pages, one to a page. The text should clearly indicate where each figure is to appear. Tables should be numbered consecutively and be prepared within the appropriate text of the manuscript.

**Awards.** Published articles are eligible to compete for the Most Significant Article Award in each issue. The quarterly award winners will compete for the annual award from the *AFJL*. Selection is made by the members of the *AFJL*'s Editorial Advisory Board. Articles published by the Editorial staff, Contributing Editors, and Editorial Advisory Board are ineligible for the awards.

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***“The toughest job was not the production of airframes. The toughest job was production of engines, production of instruments, production of all the other components of the airframes that are required to make it a complete assembly.”***

(Brigadier General Orval R. Cook, 1946)

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