Audit Report

OFFICE OF THE INSPECTOR GENERAL

REPAIR OF WEAPON SYSTEMS CONTAINING ADVANCED COMPOSITE MATERIALS

Report Number 92-139 September 28, 1992

Department of Defense

INSPECTOR GENERAL
DEPARTMENT OF DEFENSE
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REPORT
NO. 92-139

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MEMORANDUM FOR ASSISTANT SECRETARY OF THE NAVY (FINANCIAL MANAGEMENT)
ASSISTANT SECRETARY OF THE AIR FORCE (FINANCIAL MANAGEMENT AND COMPTROLLER)
INSPECTOR GENERAL, DEPARTMENT OF THE ARMY

SUBJECT: Report on the Audit of Repair of Weapon Systems Containing Advanced Composite Materials (Project No. 1LB-0050)

Introduction

We are providing this final report for your information and use. Our objective was to evaluate the Military Departments' capabilities to repair weapon systems containing advanced composite materials. A composite is two or more materials that are combined to form a useful material. Advanced composite materials generally refer to composite materials that combine high strength and low weight, such as graphite-epoxy, which is the most common advanced composite material used today. Boron, aramid (includes kevlar), and assorted glass fibers are advanced composite materials that are also widely used. We also evaluated the effectiveness of applicable internal controls.

Summary of Audit Results

Our audit of six weapon systems showed that each Military Department has improved its capability to repair components constructed of advanced composite materials. When repair problems have occurred, the Military Departments have initiated appropriate management actions. Special problems relating to the underutilization of repair equipment at a Navy intermediate repair facility, Army repair safety issues involving kevlar, and the need for a new Air Force repair training facility were addressed in separate OIG, DoD, reports issued during the audit, which are summarized in Enclosures 1, 2, and 3. Potential monetary benefits of $15.1 million and benefits to the health of Army personnel and the environment were agreed to by management based upon the three quick-reaction reports.

Scope of Audit

The audit was performed at the Military Departments' headquarters and selected repair and training activities. We evaluated records covering the period from FY 1985 through FY 1993 relating to the repairs and planned repairs of advanced

composite components of the AH-64, AV-8B, B-1B, F-15, F/A-18, and UH-60 aircraft weapon systems. Activities visited or contacted are listed in Enclosure 4.

This economy and efficiency audit was made from October 1991 through April 1992 in accordance with auditing standards issued by the Comptroller General of the United States as implemented by the Inspector General, DoD, and accordingly, included such tests of internal controls as were considered necessary.

Internal Controls

We evaluated the effectiveness of internal controls established by the Military Departments to comply with applicable guidance and establish safe, cost-effective, repair capability for repairing components made from advanced composite materials. We evaluated the Military Departments' internal controls over procurement of the equipment, materials, and training needed to make the repairs and the safety and environmental controls that were in place.

The audit identified material internal control weaknesses as defined by Public Law 97-255, Office of Management and Budget Circular A-123, and DoD Directive 5010.38. The Military Departments' internal controls did not always ensure that requirements to achieve repair capability were met in a cost-effective and safe manner. Recommendations in the quick-reaction audit reports issued during this audit, if implemented, will assist in correcting these weaknesses. A copy of this report will be provided to the senior officials responsible for internal controls within the Military Departments.

Background

The Military Departments are among the largest consumers of advanced composite materials. The Military Departments use these materials in tanks, ships, and other weapon systems. The major use of advanced composite materials, however, has been in aircraft. More than 10 types of aircraft make significant use of these materials, and the percentage of advanced composite materials used in military aircraft is increasing. The reason for the increased use of these composites is the strength and lightweight characteristics of the materials, which enable the aircraft to be more survivable and carry more armament.

Prior Audits and Other Reviews

During the audit we issued three quick-reaction audit reports related to repair of weapon systems that contain advanced composite materials. Summaries of those reports are in

Enclosures 1, 2, and 3. There has been no other audit coverage of this specific issue in the last 5 years.

Discussion

Our review of six weapon systems showed that each Military Department has taken actions to improve its capability to repair components constructed of advanced composite materials. For the weapon systems reviewed, problems have occurred, but except as noted in the three quick-reaction reports issued during this audit, the Military Departments have generally initiated appropriate management actions.

Army advanced composite repair capability. We reviewed the Army's capability to repair the AH-64 and UH-60 helicopters at the depot, intermediate, and field levels.

Army depot level repair capability. The Army has had problems transitioning its capability to repair components on the AH-64 and UH-60 helicopters, including components constructed of advanced composite materials, to its organic depot at Corpus Christi, Texas. OIG, DoD, Audit Report No. 90-100, "Audit of Phased Organic Maintenance," August 15, 1990, addressed some of the reasons for the Army's difficulties on the AH-64 helicopter, including funding shortfalls, frequent configuration changes to the aircraft, and the Army's inability to obtain technical data from the contractor. As a result of these problems, the Army relied on contractors to perform the repairs that it was not yet capable of performing. The Army initiated corrective actions that provided for upgrades of existing facilities and equipment and the purchase of new equipment to meet advanced composite repair needs. Additionally, the Army was providing adequate training in advanced composite repair technologies to its repair personnel at Corpus Christi Army Depot.

We determined that a portion of the requirement for additional advanced composite repair equipment at the Corpus Christi Army Depot could be satisfied through the transfer of an underutilized autoclave (pressurized oven used to heat patching materials) located at the Naval Air Station, Lemoore, California. IG,DoD, Report No. 92-101, "Quick-Reaction Report on Equipment Used in the Repair of Advanced Composite Materials at the Naval Air Station, Lemoore, California," June 12, 1992, (see Enclosure 1) recommended that the autoclave be transferred from the Navy to the Army. We estimated that the transfer would result in a one-time cost avoidance of $200,000 and a savings of $3.5 million over the FY 1992 through FY 1997 Future Years Defense Program. Both the Army and the Navy concurred in the recommendation. The Army also concurred with the estimated $3.7 million of monetary benefits

Army intermediate and field level repair capability. We visited 4 intermediate Army repair activities and 14 field level units collocated at the intermediate facilities. These activities and field units performed repairs of components constructed with advanced composite components in sheet metal repair facilities, usually located within a hanger. Advanced composite materials, used during repairs of the components, as well as the fibers that are generated during the repair process, are hazardous to personnel and the environment. We noted that protective equipment and clothing was not always used during repairs. We also noted problems in the disposal of the adhesives. In Report No. 92-103, "Quick-Reaction Report on the Army Repair of Components Made of Kevlar and Disposal of Materials Used During Kevlar Repair," June 17, 1992 (see Enclosure 2), we addressed the Army's need to improve controls covering health and safety procedures during the repair of advanced composite components. The Army agreed to take corrective actions.

Navy advanced composite repair capability. We reviewed the Navy's capability to repair the F/A-18 and the AV-8B aircraft at the depot, intermediate, and field levels.

Depot repair capability for the F/A-18 aircraft. The Navy is fully capable of repairing advanced composite components on the F/A-18 aircraft at its Naval Aviation Depot, North Island, California.

To repair advanced composite materials on the F/A-18 aircraft, the Navy procured extensive repair capability for its depot at North Island. However, the work load during the time of audit and the projected work load did not fully support the need for the facilities or justify the large amount of depot equipment. The Navy overestimated the repair work load when it justified procurement of the equipment and facilities. At the time of audit, the Navy had initiated actions to provide for alternative uses for the excess facilities and equipment.

In 1975, the Navy depot at North Island was designated the depot-level maintenance, remanufacture, and repair point for 1,366 F/A-18 aircraft. At that time, the Navy and DoD did not have any graphite-epoxy composite (the principal advanced composite material used on the F/A-18) remanufacture and repair facility. To meet the requirement, a $23 million ($13.5 million for the building and $9.5 million for equipment), 108,000-square-foot advanced composite repair facility was built. The justifications and scope for building the facility were based on the maintenance and repair work load that would be required for 282 F/A-18 aircraft per year and a work force of 280 personnel.

The Navy has not made full use of the facility or the equipment. Work load for the F/A-18 in FY 1991 consisted of 56 aircraft. Projected work load for FY 1992 is 78 aircraft, and 50 aircraft are scheduled for depot repair in FY 1993. Depot maintenance personnel said that approximately 20 percent of the repair work load at that facility was for advanced composite repairs. The other 80 percent was for metal repair.

At the time of audit, the Navy had initiated various alternative uses of the excess capability. In 1990, metal repair work was moved into the advanced composite repair facility to utilize the space. The depot reduced maintenance personnel in 1989 from 65 to 35 personnel. Of the 35 workers, 6 were loaned to other repair facilities because of the reduced volume of work at the facility. Of the remaining workers, 21 were assigned to sheet metal repair, and 8 were assigned to advanced composite repair.

To further reduce costs, in FY 1991, the Navy terminated all weapon system specific composite training at its depots, which included training provided for the F/A-18 aircraft at the North Island depot. The Navy relied on generic instruction in composite repairs provided at Naval Air Stations in Lemoore, California, and Cecil Field, Florida.

Intermediate level repair of the F/A-18 aircraft. Our review of the Aircraft Intermediate Maintenance Department at the Naval Air Station, Lemoore, California, showed that the activity had adequate capabilities to provide intermediate level repairs of F/A-18 aircraft components that were made from advanced composite materials. Also, adequate training had been provided to maintenance personnel. Maintenance records indicated that during calendar years 1990 and 1991, personnel at Lemoore were able to repair 80 percent of the advanced composite components that required repair. The remaining components were beyond their capability of repair and either were sent to the Navy's depot at North Island for repair or were condemned.

The Navy installed an autoclave at Lemoore in October 1990 that has not been effectively used. Because of a declining work load, the Navy could not justify the additional funding needed to make the autoclave fully operational. As previously discussed, the Navy agreed to transfer the autoclave to Corpus Christi Army Depot.

Organizational level repairs of the F/A-18 aircraft. We visited organizational repair facilities at Lemoore to determine the capability of the squadrons to repair components made of advanced composite materials. Organizational level maintenance personnel were capable of performing repairs on advanced composite components. However, the typical repair at

the organizational level was limited to the repair of minor damage, such as scratches and small holes.

Depot repair capability for the AV-8B aircraft. The Navy acquired sufficient capability for repairing advanced composite materials on the AV-8B aircraft at the Naval Aviation Depot, Cherry Point, North Carolina. From FY 1984 through FY 1991, the Navy spent approximately $11 million for unique equipment needed by the depot to repair components made of graphite-epoxy, the primary advanced composite material used on the AV-8B aircraft. An additional $22 million was used to develop an advanced composite repair facility at the depot. The Navy also bought two autoclaves for use on the AV-8B aircraft at a cost of $3.5 million.

Although the repair facility and equipment were not being fully utilized at the time of audit, the depot planned to more fully utilize available capability by repairing advanced composite materials on crash damaged AV-8B aircraft. At the time of audit, the Navy had repaired only 2 of 10 repairable AV-8B aircraft that survived crashes. Three of the eight AV-8B aircraft awaiting repair were damaged in crashes in December 1989. The depot had delayed repairs of the crash damaged aircraft because operational AV-8B aircraft required safety related modifications, and the fleet users of the aircraft wanted the modifications performed as quickly as possible. As a result, the repair of the crash damaged aircraft that required structural repairs, including repairs to advanced composite components, were delayed while repair personnel worked to complete the modifications to the active aircraft. At the time of the audit, depot workload schedulers anticipated that the Navy would begin the repairs of the crash damaged aircraft in September 1992. These repairs will significantly increase the use of the advanced composite repair facility and equipment.

Intermediate and organizational repair capability on the AV-8B aircraft. Navy maintenance personnel were capable of completing repairs on advanced composite components on the AV-8B that were authorized by the technical manuals at the intermediate and organizational levels. However, the Navy had problems with spoilage of the adhesives that were used during the repair process. The Navy estimated that 40 to 60 percent of the adhesives that were procured for advanced composite repair were spoiling before they could be used. At the time of audit, the Navy was investigating materials that could be stored at room temperatures for long periods without spoiling.

Air Force advanced composite repair capability. We reviewed the Air Force's capability to repair advanced composite materials on the F-15 and the B-1B aircraft at the depot and field levels of maintenance. We also examined the need for training facilities, in view of a planned construction project.

Depot repair capability on the F-15 aircraft. The Air Force was fully capable of repairing advanced composite material components on the F-15 aircraft at Warner-Robins Air Logistics Center, Georgia. Rudder repair problems were the only significant advanced composite repair problems that existed at the time of audit. However, the Air Force had initiated actions that should improve its repair capability for rudders.

Field level repair on the F-15 aircraft. To determine their capability to make repairs to advanced composite material components, we visited five field locations where operational F-15 aircraft were stationed. The locations we visited had limited but adequate capability. Most maintenance personnel indicated that increased repair capability was not needed because advanced composite components required few repairs. However, personnel at some locations indicated they wanted to make rudder repairs but lacked the specialized training that is needed. In response to this concern, the Air Force has provided additional capability to make rudder repairs, including training and equipment, to additional locations, such as Kadena Air Force Base, Japan (Kadena had the highest incidence of problems with the rudders). The additional repair capability should alleviate some of the downtime on the aircraft.

Depot level repair on the B-1B aircraft. The Air Force was capable of repairing advanced composite components on the B-1B aircraft at its Oklahoma City Air Logistics Center. The Air Force was using an advanced composite repair facility that was procured in FY 1988 for $5.9 million. An additional $2.5 million of equipment was later procured and installed in the facility. The facility and equipment were justified based on advanced composite repair work load for the B-1B aircraft and for bonded aluminum honeycomb repair on the B-1B and KC-135 aircraft.

During justification of the facility and equipment, the Air Force estimated that work load on the B-1B aircraft would be 10,000 hours in FY 1990. The Air Force spent only 3,859 staff hours at the depot repairing B-1B aircraft advanced composite components in FY 1990. Since then, however, work load at the depot on advanced composite components has increased. In FY 1991, the staff hours increased to 6,283. The Air Force expects that as the aircraft ages, increased staff hours will be used to repair its advanced composite components.

Field level repair capability on the B1-B aircraft. The Air Force had the equipment needed to repair advanced composite components on the B-1B aircraft at the field locations we visited. However, one piece of equipment, a control console used for heat application during bonded advanced composite repairs, required continuous recalibration and was often out of service due to mechanical failures. As a result, the Air Force was making makeshift repairs on the B-1B aircraft until the control console equipment was repaired. The repairs did not threaten the safety of the aircraft, but the repairs were short-term and needed to be made more frequently. During the audit, the Air Force was taking action to acquire replacement consoles.

Adhesive materials used to repair advanced composite components on the B-1B aircraft were being wasted because the shelf life of the material was expiring before the material could be used. At the two B-1B aircraft field locations we visited, we estimated that during FY 1991 about 68 percent of the adhesive materials (valued at $6,000) spoiled. However, at the time of the audit, the Air Force and General Services Administration were restructuring the procurement methods for the materials. The General Services Administration was negotiating with vendors to package materials in smaller quantities and planned to issue quick-reaction competitive contracts to the vendors.

Training Facility. DoD's Inter-Service Training Review Organization had completed Phase 1 of a review of possible consolidation of Air Force generic advanced composite training with the Navy prior to our audit. The Inter-Service Training Review Organization reported that the Navy had adequate space at the Naval Air Stations at Lemoore and Cecil Field to accommodate Air Force training. However, the Air Force was planning to build a new facility for training at Sheppard Air Force Base, Texas. We issued Report No. 92-066, "Quick-Reaction Report on Relocation of Technical Training Courses from Chanute Air Force Base to Sheppard Air Force Base," March 31, 1992 (see Enclosure 3), recommending that the Air Force consolidate its advanced composite repair training with the Navy.

The Air Force agreed to delay making a final decision on whether to construct a new training facility until after it completed an analysis to determine whether it would be more cost-effective to consolidate its advanced composite repair training with that provided by the Navy. In July 1992 the analysis was completed. The Inter-Service task group that performed the analysis concluded that collocation of the training with the Navy was feasible and would result in savings of $11.4 million (a one-time cost savings of $10.7 million and an annual recurring cost savings of $107,140 over DoD's 6-year Future Years Defense Program).

Conclusions

The Military Departments have had problems estimating the amount of repair capability that would be needed to perform advanced composite repairs. In addition, there were problems with equipment, materials, training, and the safe repair and disposal of advanced composite materials. However, except as noted in the three quick-reaction reports issued during the audit, the Military Departments took action to correct the problems and improve their capability to repair advanced composite materials.

Management Comments

We provided a draft of this report to the addressees on June 24, 1992. Because there were no recommendations, no comments were required of management, and none were received. Any comments on this final report should be provided by October 28, 1992.

The courtesies extended to the audit staff are appreciated. If you have any questions on this audit, please contact Mr. Dennis Payne at (703) 692-3414 (DSN 222-3414) or Mr. James Kornides at (703) 692-3420 (DSN 222-3420). The distribution of this report is listed in Enclosure 6.

Edward R. Jones
Deputy Assistant Inspector General
for Auditing

Enclosures

cc:
Secretary of the Army
Secretary of the Navy
Secretary of the Air Force
Assistant Secretary of Defense (Production and Logistics)

SUMMARY OF AUDIT REPORT NO. 92-101
QUICK-REACTION REPORT ON EQUIPMENT USED IN THE REPAIR OF ADVANCED COMPOSITE MATERIALS AT THE NAVAL AIR STATION, LEMOORE, CALIFORNIA
(June 12, 1992)

Background. As part of the audit of Repair of Weapon Systems Containing Advanced Composite Materials, we reviewed the use of autoclave equipment to repair components constructed of advanced composite materials at Naval Air Station, Lemoore, California.

Objective. The audit objective was to evaluate the Navy's need for and use of autoclave equipment at its intermediate repair facility at Naval Air Station, Lemoore.

Audit Results. The audit determined that the Navy was not effectively using its autoclave at Naval Air Station Lemoore, and transfer of the autoclave to the Corpus Christi, Texas, Army Depot would reduce costs and improve the return to DoD on its investment.

Potential Benefits of Audit. Transfer of the autoclave would result in a one-time cost avoidance to the Army of $200,000. In addition, the Army could save at least $3.5 million over the FY 1992 through FY 1997 Future Years Defense Program ($582,000 annually) by repairing damaged parts with the autoclave instead of buying new parts.

Summary of Recommendations. We recommended that the Navy transfer the autoclave to the Army.

Management Comments. The Army and Navy concurred with the recommendation. The Army also concurred with the $3.7 million of estimated monetary benefits.

SUMMARY OF AUDIT REPORT NO. 92-103
QUICK-REACTION REPORT ON THE ARMY REPAIR OF COMPONENTS MADE OF KEVLAR AND DISPOSAL OF MATERIALS USED DURING KEVLAR REPAIRS

(June 17, 1992)

Background. As part of the audit of Repair of Weapon Systems Containing Advanced Composite Materials, we reviewed the repair of components made of kevlar and the disposal of materials used during kevlar repair by the Army.

Objective. The objective was to evaluate the Army's capabilities to protect the health of its personnel during the repair of weapon systems containing kevlar and to protect personnel and the environment from the residue of materials produced during the repair process.

Audit Results. The audit determined that Army repair and disposal operations involving kevlar are endangering Army personnel and threatening the environment. This condition existed because the Army had not published updated safety information and Army units were not following existing guidance.

Potential Benefits of Audit. The Army can avoid employee health and environmental problems and their associated costs by improving repair and disposal practices. The exact monetary benefits could not be determined.

Summary of Recommendations. We recommended that the Army issue additional guidance to all field repair locations alerting them to needed safety procedures during repair of components made of kevlar and during disposal of hazardous waste that is produced during the repair process.

Management Comments. The Army concurred with the recommendation.

SUMMARY OF AUDIT REPORT NO. 92-066
QUICK-REACTION REPORT ON RELOCATION OF TECHNICAL TRAINING COURSES FROM CHANUTE AIR FORCE BASE TO SHEPPARD AIR FORCE BASE
(March 31, 1992)

Background. As part of the Audit of Repair of Weapon Systems Containing Advanced Composite Materials, we reviewed the requirements for the proposed construction of a $7.9 million metals technologies training facility at Sheppard Air Force Base, Texas.

Objective. The audit objective was to determine whether the planned construction of the metals repair training facility at Sheppard Air Force Base represented the most economical and efficient method of accomplishing metals repair training. At the time of the audit, metals repair training was being provided at Chanute Air Force Base, Illinois.

Audit Results. Chanute Air Force Base is scheduled for closure by the end of fiscal year 1993; however, construction of a new metals technologies training facility at Sheppard Air Force Base is not economically justified. Navy training facilities offering similar training courses have both training space and student billeting facilities available to accommodate the Air Force's training requirements.

Potential Benefits of Audit. At the time of the audit, we estimated that prompt action to consolidate and collocate the Air Force metals repair training courses at Navy training facilities could save the estimated $7.9 million cost to construct the new training facility and $4.0 million to construct supporting student billeting facilities. Additional reductions in support costs were also expected but not projectable.

Summary of Recommendations. We recommended that the metals technologies training facility and supporting student billeting facilities not be constructed and that the metals repair training be consolidated and collocated at Navy training activities.

Management Comments. The Air Force agreed to delay making a final decision on whether to construct a metals technologies training center until after it completed an analysis on the most cost-effective means of providing metals repair training. In July 1992 the analysis was completed. The Inter-Service task group that performed the analysis concluded that collocation of the training with the Navy was feasible and would result in savings of $11.4 million (a one-time cost savings of $10.7 million and an annual recurring cost savings of $107,140 over DoD's 6-year Future Years Defense Program).

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Secretary of the Army (Deputy Chief of Staff for Logistics), Washington, DC
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U.S. Army Tank-Automotive Command, Warren, MI
U.S. Army Aviation Systems Command, St. Louis, MO
Corpus Christi Army Depot, Corpus Christi, TX
Fort Campbell, Lexington, KY
Fort Hood, Killeen, TX
Fort Eustis, Newport News, VA
Fort Steward, Hinesville, GA
Fort Bragg, Fayetteville, NC

Department of the Navy

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Headquarters, Naval Air Systems Command, Arlington, VA
- Naval Aviation Maintenance Office, Patuxent River, MD
- Naval Aviation Depot, Cherry Point, NC
- Naval Aviation Engineering Center, Lakehurst, NJ
- Naval Air Development Center, Warminster, PA
- Naval Aviation Depot, North Island, CA
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  Oklahoma City Air Logistics Center, Tinker Air Force Base, OK
Headquarters, Tactical Air Command, Hampton, VA
McConnell Air Force Base, Wichita, KS
Dyess Air Force Base, Abilene, TX
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