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GAO

Report to the Chairman, Subcommittee on Oversight of Government Management, Committee on Governmental Affairs, U.S. Senate

June 1991

COMMERCIAL PRACTICES

Opportunities Exist to Reduce Aircraft Engine Support Costs

RELEASED

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National Security and
International Affairs Division

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June 28, 1991

The Honorable Carl Levin
Chairman, Subcommittee on
Oversight of Government Management
Committee on Governmental Affairs
United States Senate

Dear Mr. Chairman:

This report was prepared as part of your request that we compare commercial logistics practices with similar Department of Defense operations. It summarizes the results of our first comparison: aircraft engine maintenance concepts. We plan to continue our efforts in this area, as well as other aspects of defense logistics operations.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 10 days from its issue date. At that time, we will send copies to appropriate congressional committees; the Secretaries of Defense, the Army, the Navy, and the Air Force; the Director, Office of Management and Budget; and other interested parties.

If you have any questions, please call me on (202) 275-8412. Other major contributors are listed in appendix I.

Sincerely yours,

Donna M. Heivilin
Director, Logistics Issues

Executive Summary

Purpose

The value of the Department of Defense's (DOD) secondary inventories increased $60 billion between 1980 and 1988. Secondary inventories include spare parts and components for aircraft, ships, and general supplies. Because of this increase, the Chairman, Subcommittee on Oversight of Government Management, Senate Committee on Governmental Affairs, asked GAO to compare DOD's logistics operations with similar private industry practices. As a first step in this analysis, GAO selected the F-108 engine, which is used by both the Air Force and commercial airlines. GAO's specific objectives were to (1) compare the Air Force's inventory and maintenance practices for the F-108 engine with those used by commercial airlines and (2) identify commercial practices the Air Force could adopt to reduce its logistics costs for the F-108. In addition, GAO reviewed the Air Force's budget request for its program to modify the KC-135 air refueling tanker aircraft by replacing original engines with the F-108.

Background

The Air Force is modifying the KC-135 aircraft—its primary air refueling tanker aircraft—to extend its useful life into the next century. Approximately 50 percent of this $12 billion modification effort involves replacing the existing engine with a commercially derived engine designated the F-108. The Air Force plans to purchase and install over 2,200 F-108 engines on 552 aircraft.

As of October 1990, the Air Force had ordered 1,418 F-108 engines for the KC-135 program. Similar versions of this engine will also be sold to the Navy and foreign governments for use on their military aircraft. When the Air Force received the first modified KC-135, commercial airlines had logged approximately 700,000 hours using the commercial version of this engine.

Results in Brief

Although it followed standard policies and procedures, the Air Force bought millions of dollars of excess engines and spare parts for the F-108 engine. These excesses occurred due to the Air Force and manufacturer underestimating engine reliability, the Air Force buying engines earlier than needed for any unanticipated needs, and delays in the KC-135 modification schedule. For several years, the Air Force used the same engine removal rate in estimating the F-108 requirements, although actual reliability data indicated the rate used was too high. In contrast, commercial airlines estimate their requirements computations to more closely reflect actual experience and rely more heavily on the manufacturer to provide spare parts to cover unanticipated needs. The

Air Force could take advantage of some commercial practices to avoid purchasing excess engines and spare parts and to reduce inventory costs.

Also, the Air Force did not use preexisting commercial maintenance facilities to minimize its investment in an F-108 maintenance facility. It also overestimated engine repair requirements. As a result, the Air Force acquired excess support equipment for the F-108 engine.

The Air Force has taken some actions to reduce excess quantities of F-108 engines due to Air Force Audit Agency recommendations, such as reducing requirements for the F-108 engine and reducing some planned purchases. However, potential still exists to (1) reduce the fiscal year 1992 budget request of $325 million for the KC-135 modification program by $225 million to avoid funding premature delivery of engines and modification kits and (2) rescind prior years' funding by $10.2 million due to favorable contract negotiations. The Air Force, however, has accelerated its installation schedule for the modification kits since the President's budget was submitted and has plans to use prior years' funding for other needs.

Principal Findings

Inventory of Spare Engines and Parts Is Excessive

The Air Force purchased excess F-108 spare engines and parts. In fact, the Air Force now estimates that the current inventory of some spare parts will satisfy its requirements through the mid-1990s. These excess inventories were caused by the Air Force not using reliability rates that reflected the actual commercial and military experience, buying engines earlier than necessary, and having aircraft modification schedule changes. In addition, for 6 years, the Air Force used the same key factor rate—engine removal rate—in estimating F-108 requirements, although actual reliability experience indicated this rate was too high. In contrast, commercial airlines adjust engine reliability rates to more closely reflect actual experience and planned usage. They also rely on the manufacturer to supply spare parts to cover unanticipated maintenance requirements.

Commercial airlines have reduced their inventories in a number of ways. For example, they rely on the engine manufacturer's parts distribution center to deliver spare parts to the airline maintenance facilities when

parts are needed. This practice enables the airlines to maintain a minimum level of spare parts inventory. One airline sells spare parts that have not been used within 18 months, which allows them to recover some of their investment. In addition, commercial airlines have reduced inventory costs by buying whole engines and using them for parts, rather than buying individual parts. For example, GAO was told dismantling whole engines rather than purchasing the parts individually saves from $2 million to $3 million per set of parts. It costs about $13,600 to dismantle the engine. In commenting on this report, DOD cited concerns with legislative requirements that might prevent it from adopting commercial practices.

Air Force Has Excess Engine Maintenance Capability

The Air Force developed its own maintenance capability for the F-108 engine but created and opened more maintenance facilities than were needed. Originally, the Air Force opened four separate maintenance facilities—three facilities for minor repairs and one for major engine repairs. Since those facilities were opened, the Air Force has reevaluated the need for them and decided to close two of the minor repair facilities.

Unlike the Air Force, commercial airlines minimized their investments in maintenance facilities for engines similar to the F-108 engine by relying more on the manufacturer. For example, the largest single user of this engine among U.S. airlines contracts with a maintenance organization, rather than investing in a maintenance facility. General Electric and some airlines have established maintenance facilities that may be available to the Air Force.

The Air Force Budget and the KC-135 Modification Program

As a result of Air Force Audit Agency recommendations, the Air Force has taken action to reduce the number of excess spare engines, parts, and maintenance equipment. For example, it suspended spare engine purchases from 1988 through 1991 and is examining ways to sell or otherwise reduce the spare parts inventory levels. It also may sell some support equipment to a foreign government. However, GAO found that the fiscal year 1992 budget request contains $225 million for engines and related modification kits that may be delivered prematurely for requirements. Also, rescissions of prior years' funding totaling $10.2 million are possible. DOD officials said they plan to accelerate the schedule for modifying KC-135 aircraft that is in the President's budget and plan to reprogram prior years' funds for other needs. They said if

the accelerated modification schedule is achieved, then these additional engines and kits will be needed.

Recommendations

To minimize the premature and possibly excessive investment in inventory and maintenance facilities when other commercially derived engines are purchased by the Air Force, GAO recommends that the Secretary of the Air Force direct program managers in the future to consider:

- relying more on demonstrated engine reliability,
- ensuring that adjustments are made in engine buys when schedule delays occur,
- using whole engines for spare parts when cost-effective,
- drawing down the inventory of spare parts and relying to some extent on the engine manufacturer's parts distribution center after the inventory is reduced, and
- using preexisting commercial engine maintenance capability in future Air Force purchases of commercial engines, where practical, and ensuring that the maintenance capability is compatible with the level of aircraft purchases and the actual performance of the engine.

Matter for Congressional Consideration

If the schedule submitted by the Air Force to support the fiscal year 1992 President's budget request is used as a basis for evaluating the fiscal year 1992 request, the Congress may want to consider reducing the fiscal year 1992 budget request for KC-135 modifications by $225 million due to premature deliveries of modification kits and engines and related installation costs. However, Air Force officials plan to accelerate the installation schedule included in the President's budget and install these prematurely delivered kits and engines by fiscal year 1994. In addition, the Congress may want to consider rescinding $10.1 million in prior years' funding for the KC-135 modification program if it does not want the Air Force to use the funds for other purposes.

Agency Comments

GAO did not obtain official written agency comments on this report. However, GAO discussed a draft of this report with DOD officials and incorporated their comments where appropriate.

Contents

Figures

Abbreviations

DOD	Department of Defense
GAO	General Accounting Office

Introduction

The Air Force is modifying the KC-135 aircraft to extend its useful life into the next century. About 50 percent of this $12 billion modification program involves replacing the existing engine with a commercially derived engine designated the F-108. The Air Force plans to purchase and install 2,208 engines on 552 aircraft. To support these engines over their expected life, the Air Force has developed its own maintenance capability, which includes facilities, spare engines, replacement parts, and support equipment.

The KC-135 Program

The Boeing Company built the first KC-135 aircraft 35 years ago and delivered the first aircraft to the Air Force in 1956. The KC-135 was originally powered by four Pratt & Whitney engines that provided approximately 13,750 pounds of thrust each. The Air Force considers the KC-135 critical to successful Air Force operations. Because of the critical nature of the KC-135 mission, the Air Force has placed high priority on the maintenance and support of the aircraft and its engines.

In 1977, the Air Force decided to modify the KC-135 aircraft with new engines and other improvements to extend the aircraft's life and increase the aircraft's fuel efficiency and the amount of fuel it can supply to other aircraft during aerial refueling. Originally, the Air Force planned to modify a total of 334 aircraft from 1981 to 1988, for a total cost of $7.8 billion. The Air Force now plans to modify a total of 552 aircraft over the period 1981 to 2003, for an estimated cost of $12 billion.

The F-108 Engine

The engine selected by the Air Force to replace the original Pratt & Whitney engine is designated the F-108. The Air Force plans to buy approximately 2,200 of these engines for the modification program and over 100 additional engines as spares. The first F-108 was delivered to the Air Force in 1984. As of October 1990, the Air Force had ordered a total of 1,418 engines and taken delivery of 1,114.

The F-108 was developed as a commercial engine, manufactured by Commercial Fan Motor International (CFMI), which is a company jointly owned by General Electric and SNECMA,[1] a French corporation. The F-108 provides approximately 22,000 pounds of thrust; commercial airlines first used it in 1982. When the Air Force first received the F-108 in

[1]Societe Nationale d'Etude et de Construction de Moteurs de Aviation or National Society of Studies and Construction of Aviation Motors.

1984, commercial airlines had logged approximately 700,000 flying hours on this engine. As of the end of fiscal year 1990, 7,269 of these or similar engines were in commercial service or on order. The Air Force will buy about 20 percent of the total engines produced for use on the KC-135 with the remainder going to other aircraft used by the U.S. Navy, commercial carriers, and foreign governments.

Problems Identified by Prior Audits

Since 1989, the Air Force Audit Agency reviewed the requirements for F-108 engines[2] and maintenance facilities.[3] It found the Air Force was buying more spare engines than required and recommended actions to reduce these excess inventories. It also recommended additional spare engine purchases be suspended and changes to the spare engine requirements computation methodology.

The Air Force Audit Agency also found engines being purchased for installation on the KC-135 were being acquired before they were needed. It recommended delaying delivery of engines on contract to reduce these excess engines.

Finally, the Audit Agency examined the maintenance facilities acquired to support the F-108 and found the Air Force had invested in excess facilities and equipment. It recommended the Air Force close one of the facilities to reduce this excess.

Objectives, Scope, and Methodology

On August 2, 1990, the Chairman, Subcommittee on Oversight of Government Management, Senate Committee on Governmental Affairs, asked us to compare the Department of Defense's (DOD) logistics operations with similar private industry practices. We selected the F-108 engine for our initial comparison. Our specific objectives were to:

- compare the Air Force's inventory and maintenance practices for the F-108 engine with those used by commercial airlines and
- identify commercial practices the Air Force could adopt to improve its logistics operations for the F-108 engine.

[2]F-108 Spare Engine Requirements (Project No. 8126115, Jan. 13, 1989) and Follow-up Audit—F-108 Spare Engine Requirements (Project No. 0126125, Feb. 8, 1991).

[3]Recoverable Spares and Maintenance Organizations Needed for F-108 Engine Support (Project No. 8126123, July 11, 1989).

We were also asked to examine the fiscal year 1992 budget request for the KC-135 program because of the excessive inventories of F-108 engines and parts.

To identify specific commercial practices that DOD could adopt in its operations, we compared the Air Force's and the private sector's inventory and maintenance practices. We did not analyze the cost impact of using commercial practices in DOD operations, although we have identified those practices that have reduced inventory costs for some commercial airlines.

We sampled 21 spare parts for the F-108 engine to examine the relationship of inventory on hand and amount required. The value of these parts represents about half of the value of all repairable F-108 parts.

We visited the Office of the Secretary of Defense and Headquarters, Air Force Logistics Command, to obtain engine management guidelines. We discussed engine management issues with the Aeronautical Systems Division and the Oklahoma City Air Logistics Center. We examined the F-108 spare engine requirement computations, spare parts requirement computations, and support equipment requirement decisions to determine the basis for Air Force purchases of engines, parts, and support equipment.

In the private sector, we visited the engine manufacturer as well as two users of commercial versions of the engine. At the manufacturer, we obtained commercial and military engine sales history, engine reliability data, engine repair capability information, and engine parts stockage and inventory management practices. We toured the General Electric parts distribution center and observed how the manufacturer supports its engine.

The two commercial engine users we visited were Delta Airlines and USAir. We obtained information on the size of their fleets using commercial versions of the F-108 engine, the number of engine hours the fleets fly in a year, the number of installed and spare engines, the type and value of their inventories, and the value and location of support equipment.

We conducted our review from September 1990 through May 1991 in accordance with generally accepted government auditing standards.

F-108 Engines and Parts Inventories Exceed Requirements

The Air Force bought millions of dollars of excess engines and parts for the F-108 engine. Air Force guidance dictates that the procurement and inventory of aircraft engines and parts be kept at minimum levels. In determining its requirements for spare engines and parts, the Air Force and manufacturer underestimated the reliability of the engine and failed to adjust engine purchases to match the slowed modification program. In addition, the Air Force decided to buy additional engines early in the acquisition process for unanticipated needs. In contrast, commercial airlines estimate their requirements computations to reflect more closely actual experience and rely on the manufacturer to cover unanticipated requirements.

In addition, commercial airlines use several practices that help them to reduce their inventory levels and costs for aircraft engines and parts. These practices include (1) purchasing whole spare engines to provide spare parts at a lower total cost, (2) relying more on the manufacturer for parts support, and (3) selling excess parts to other users.

The Air Force Overestimated Spare Engine and Parts Requirements

The Air Force determines spare engine and parts requirements using several different guidelines. Air Force Regulation 400-1, as supplemented, emphasizes that spare engine levels should be held at a minimum during the early stages of the acquisition process. This is important because production changes or other situations may lower requirements. This regulation provides a method to calculate the needed level of spare engines and parts. This calculation relies heavily on factors such as the engine removal rate, engine flying hours, estimated number of aircraft in repair at one time, and the aircraft basing structure.

One of the key factors the Air Force uses to determine spare engine and parts requirements is the engine removal rate. This rate reflects the expected number of times an engine will be removed from the aircraft for maintenance for each 1,000 engine flying hours. Until 1988, the Air Force used a .45 engine removal rate to determine spare engine and parts requirements. It calculated this rate by combining two different factors. First, it calculated that the engine would be removed from the aircraft for unplanned repairs at a rate of .23 times per 1,000 flying hours. Second, it estimated that the engine would be removed from the aircraft an additional .22 times per 1,000 flying hours for regularly scheduled maintenance overhauls. These regularly scheduled maintenance overhauls will not be necessary until late in the program, when the engine has been used to the point where parts begin to wear out.

The Air Force included the additional rate for scheduled removals because of what it believed to be the more strenuous mission of military aircraft. Since then, actual experience has confirmed that this estimated removal rate was too high.

Table 2.1 compares the engine removal rates used by the Air Force with the actual reliability of the engine when operated by the Air Force and commercial airlines.

Table 2.1: Engine Removal Rate Comparison

Removals per 1,000 engine flying hours

Fiscal year	Used for requirements[a]	Actual Air Force experience	Commercial experience
1982	.45	[b]	.42
1983	.45	[b]	.29
1984	.45	[b]	.17
1985	.45	.14	.13
1986	.45	.21	.14
1987	.45	.10	.15
1988	.12	.07	.18
1989	.10	.07	.18
1990	.11	.26[c]	.18

[a]The Air Force suspended spare engine purchases from fiscal years 1988 through 1991. The lower engine removal rates shown for these years were therefore the basis for identifying excess spare engines.

[b]There was no actual experience for these years.

[c]This removal rate is abnormally high because of a runway problem at one operating base. In fiscal year 1990, 51 of 67 aircraft with engine removals were from Malmstrom Air Force Base in Montana where a runway broke apart and debris was thrown into the engines of parked aircraft.

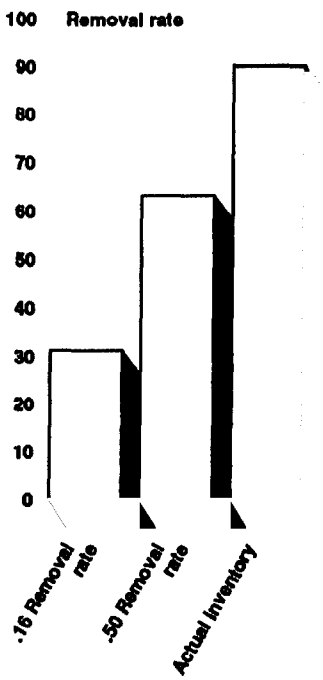
As table 2.1 shows, the actual experience rates by both commercial airlines and the Air Force were significantly lower than the .45 rate used by the Air Force to calculate its requirements. The Air Force chose not to rely on the lower commercial rates for several reasons. First, the Air Force believed the commercial experience for the engine, although representing about 1.4 million flying hours by early 1985, was not sufficient to reach conclusions about future reliability. Second, the military mission was determined to be more demanding due to exposure to extreme climatic conditions and differences in the way the Air Force

uses the aircraft. Third, the Air Force's past experience with a comparison engine indicated that the actual number of repairs performed usually exceeded the projected level. However, as shown by the actual rates in table 2.1, these reasons did not prove valid.

More F-108 Spare Engines and Parts Bought Than Needed

The Air Force bought more F-108 spare engines than required. Figure 2.1 compares the amount of spare engines in the Air Force inventory with the amount required based on (1) the commercial reliability record and (2) higher requirements calculated by the Air Force.

Figure 2.1: Spare F-108 Engine Requirements Versus Inventory (As of September 30, 1990)



The Air Force Audit Agency calculated these requirements using various removal rates. The requirement using commercial experience is 31 engines. Using the Air Force removal rate, the requirement is 63 engines, as of September 30, 1990. The Air Force had actually purchased 90 spare engines, but allocated some of them for different uses because of the identified excess.

The Air Force has also purchased excess amounts of spare parts. The F-108 contains 367 repairable parts. Of these 367 parts, 18 are major modules, 40 are components, and the remainder are other repairable parts. To examine the relationship between on-hand inventory and the amount required, we looked at 14 modules, the 6 most costly components, and a fan blade (a part that breaks often). These 21 parts represent about 51 percent of the value of all repairable F-108 parts.

The Air Force had excess inventory for 20 out of 21 repairable parts we examined. Figure 2.2 compares the total value of our sample of spare parts on hand as of September 1990 with the value of parts required for the same time period. The difference between the $54 million requirement and the $144 million of parts on hand is because the Air Force overestimated its removal rate and bought parts too early.

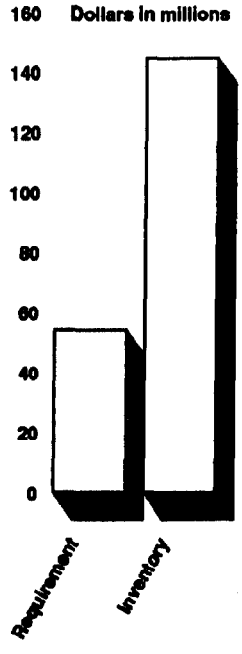


Figure 2.2: F-108 Spare Parts Requirements and Inventory (As of September 30, 1990)

As of September 1990, the Air Force had enough spare engine modules and spare parts to satisfy many of its requirements through the mid-1990s. Some of these are expensive parts that are designed to be repaired and reused several times. For example, in September 1990, the Air Force had 430 fan blades in its inventory, 75 of which required

repair. At that time, however, the Air Force estimated that it needed only 45 blades. Because of these excess blades on hand, the Air Force has calculated it will not need to repair any broken blades until September 1994.

The Air Force purchased these excess engines and parts for three primary reasons. First, although it followed standard estimating procedures, the high engine removal rate used by the Air Force overstated the spares requirement. Second, the Air Force bought extra engines to compensate for unforeseen problems that could adversely affect the mission of the aircraft. Finally, it slowed the pace of the modification program but ordered spare engines based on the more accelerated program. The Air Force is examining alternatives to reduce the level of spare parts through the use of the Defense Reutilization and Marketing Service.

The Air Force has significantly changed the scheduled modifications of KC-135 aircraft since the original program schedule was developed in 1981. At that time, the Air Force estimated it would modify a total of 334 aircraft by 1988. Peak production was to be 72 aircraft per year. By 1986, the Air Force increased the number of aircraft to be modified to 641, with production lasting until the year 2000 and peaking at 50 aircraft per year, the current level. The December 31, 1990, Selection Acquisition Report production plan includes a proposal to modify a total of 552 aircraft and extend production until 2003. Figure 2.3 illustrates the difference between the original and current program.

Figure 2.3: KC-135 Modification Schedule Comparison

Lengthening the modification schedule and reducing the number of aircraft modified in a given year reduces the number of operational aircraft with the F-108 engine. Fewer aircraft require fewer spare engines and parts to support the aircraft fleet. Because the engines and spare parts are ordered at least 2 years in advance, more engines and parts were being ordered and delivered than required to meet the reduced modification schedule.

Commercial Practices Could Further Reduce Inventory Costs

We spoke with representatives of two airlines using the commercial version of the F-108. They identified three techniques to minimize inventory costs: (1) using whole engines for parts, (2) utilizing the General Electric parts distribution center, and (3) selling excess parts on the secondary market. In commenting on this report, DOD cited concerns with legislative requirements that might prevent it from adopting commercial practices.

Whole Engines for Parts

Both commercial carriers surveyed said it was a standard practice to dismantle whole engines rather than purchase the parts individually.

This technique is recommended by the commercial carriers and saves $2 million to $3 million per set of parts. It costs about $13,600 to disassemble the engine. The Air Force does not follow this practice to obtain spare parts. In discussing the possibility of using this practice in the future, especially for buying initial spare parts, Air Force officials cited the following concerns:

- Additional manpower may be required to disassemble the engine.
- Some excess parts may be acquired because whole engine purchases would result in more of certain parts than needed.
- It is difficult to change to new methods of acquiring parts.

Manufacturer's Parts Distribution Center

The General Electric parts distribution center in northern Kentucky supports all commercial engines General Electric manufactures. The center maintains an inventory of spare parts valued at about $1 billion. Commercial airlines can purchase parts through the company's catalogs and have the parts shipped in as little as 4 hours from receipt of an order. Even major engine parts can be obtained in shorter periods than the Air Force's current procurement time. General Electric officials stated a similar service could also be provided to the Air Force.

The distribution center allows airlines to keep parts inventories low, which reduces the airlines' inventory costs. Product support representatives visit customers and forecast their parts demand based on actual part life, product improvements, historical engine reliability of the entire fleet, and maintenance level changes. Purchases are then scheduled to arrive at customer facilities close to the time when they will be needed. In emergency situations, spare engines can also be obtained in a period shorter than the standard lead time for obtaining spare parts.

The Air Force does not use General Electric's parts distribution center to minimize its inventory of spare parts. The time required for delivery of parts to the Air Force is significantly longer than for commercial airlines. For example, the Air Force allows 20 months for the delivery of fan blades from the day the supplier receives the order. A commercial user, on the other hand, is guaranteed delivery of the same item within 2 months from the day the order is received. We have not examined the precise cost impact of using the accelerated delivery times available through the catalog system. For example, some savings would result from eliminating the cost of 18 additional months of fan blade inventory.

Secondary Parts Market

Commercial carriers rely on the secondary parts market to dispose of excess or unused inventory. One carrier said that if a part was not used for 18 months, it was automatically identified as excess and sold on the secondary market.

The Air Force does not use the secondary parts market directly because it must follow other procedures. It is required to use the Defense Reutilization and Marketing Service to reduce inventory levels. This Service canvasses other DOD components, as well as other federal and state agencies, for possible government users. If those efforts prove futile, it sells the excess inventory items.

Conclusions

The Air Force purchased excessive amounts of spare engines and engine parts for the F-108 engine. This happened because the Air Force was slow to adjust to actual reliability, bought extra engines, and was slow to adjust for changes in the aircraft modification schedule. In contrast, commercial airlines estimate their requirements computations to more closely reflect actual experience and rely more heavily on the manufacturer for delivery of parts when needed. In addition, commercial airlines use several practices to reduce inventory quantities and costs that are not used by the Air Force.

Recommendation

We recommend that the Secretary of the Air Force direct program managers in future purchases of commercial engines in other programs to rely more on demonstrated engine reliability, ensure that adjustments are made in engine buys when schedule delays occur, and more fully utilize commercial practices to acquire and store spare engines and parts. Specifically, we recommend the Secretary of the Air Force consider:

- using whole engines for spare parts when it is more economical than buying individual parts and
- drawing down the inventory of spare parts and relying on the engine manufacturer's parts distribution center after the inventory is reduced.

F-108 Maintenance Capability Exceeds Requirement

The Air Force invested in unnecessary maintenance facilities for the F-108 engine. The Air Force did not use preexisting commercial maintenance facilities that would have satisfied Air Force requirements until program uncertainties were resolved and engine reliability was demonstrated in a military environment. Instead, the Air Force decided to acquire its own maintenance capability for the F-108 engine because of the high priority of the aircraft's mission and the anticipated high maintenance requirements during wartime. As a result, the Air Force purchased too much support equipment and prematurely activated F-108 maintenance facilities. The Air Force is using some excess support equipment for other programs, is attempting to sell some support equipment to a foreign government, and has closed two maintenance facilities.

The Air Force Developed Its Own Maintenance Capability

When the Air Force places a new aircraft into service, it must decide whether to develop its own maintenance capability for the aircraft and its subsystems, such as engines, or to contract for maintenance.

The Air Force decided to establish its own F-108 maintenance capability for several reasons. First, it has placed a high priority on the KC-135 logistics support due to the critical nature of the aircraft's mission. Second, it had excess maintenance capability at the Oklahoma City repair depot that could accommodate the estimated F-108 repair requirements. Third, the Air Force did not see any significant advantage in using contractor support for the engine because it believed the Air Force would have to buy support equipment for the contractor to repair the engine. Also, the Air Force believed a contractor would have a limited capability to meet the accelerated repair needs of the Air Force during wartime operations. Because the Air Force saw no significant advantage in using contractor maintenance, it also did not conduct a cost analysis to compare the cost of using a contractor with operating its own maintenance facilities.

Once the Air Force decided it needed its own maintenance capability, it used a standard Air Force maintenance concept for the F-108 engine that required the use of three separate types of maintenance facilities:

- a facility at each operating base to provide for routine maintenance of the engine while it is still installed on the aircraft;
- three intermediate maintenance facilities, located in the eastern, central, and western regions of the United States, to provide for removal and replacement of major engine parts after the engine is removed from the aircraft; and

- one central facility, called a depot, where the engine can be completely disassembled, repaired, and reassembled.

Facilities Activated Too Early

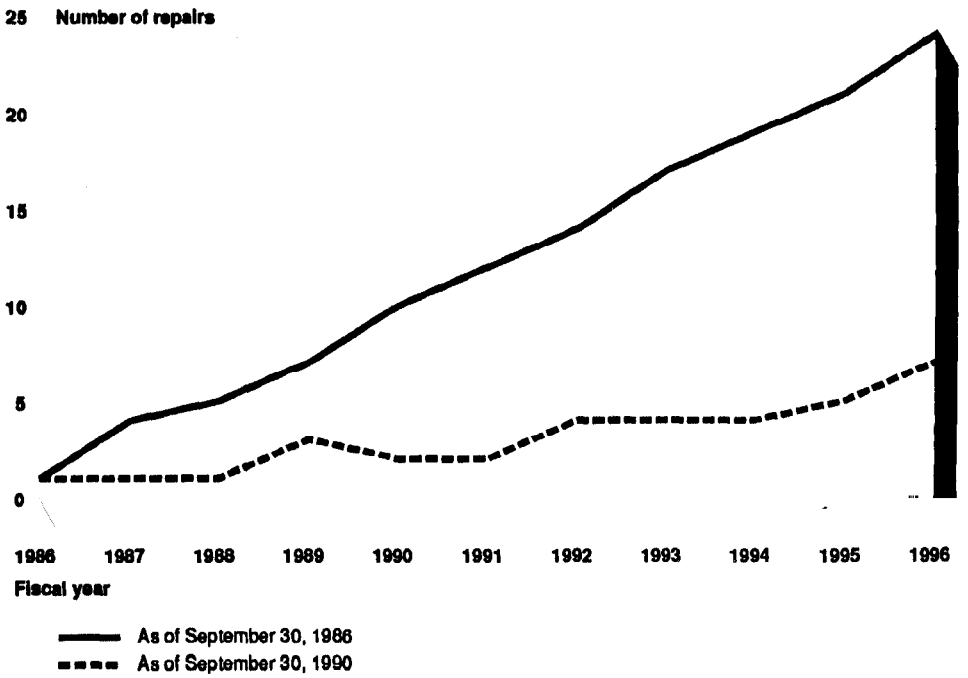
The first intermediate maintenance facility was established at McConnell Air Force Base in 1984 with support and test equipment valued at $7.9 million. Next, the Air Force opened the depot repair facility in 1987 at Tinker Air Force Base for about $40 million. Finally, the Air Force opened two other intermediate facilities in 1987 and 1988 at Griffiss and Fairchild Air Force Bases.

Air Force Logistics Command Regulation 800-9 states that "delivery requirements for...support equipment must be on a schedule based on programmed delivery use, deployment, and operational need date of the system/end article." However, by the time the third intermediate facility was opened, the Air Force had invested approximately $64 million in maintenance facilities and support equipment, enough to maintain all future KC-135 aircraft—a total of 552 aircraft. At that time, however, the Air Force had received only 129 modified KC-135 aircraft.

Excess Maintenance Capacity

The Air Force based its decisions on the number of maintenance facilities required, when they would be needed, and on the estimated engine removal rates discussed in chapter 2. The Air Force's predicted engine removal rates caused excessive engine maintenance facilities to be acquired. Figure 3.1 shows the Air Force projections for depot F-108 repairs for 1986 through 1996 using two removal rates: the .45 removal rate for 1986 and a reduced rate for 1990.

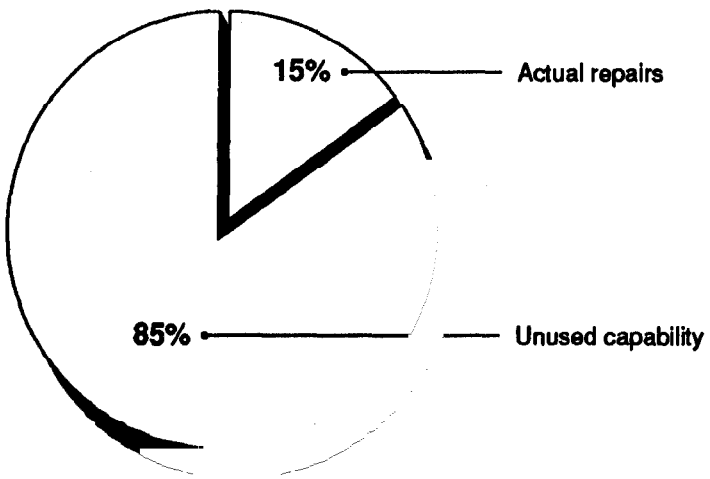
Figure 3.1: Projected Engine Repairs



After the Air Force lowered its projected F-108 engine removal rate in 1988, the Air Force began to identify excess repair facilities and equipment in its possession. By 1990, the Air Force closed two of the three intermediate facilities and took initial action to sell some of the excess equipment to the Royal Saudi Air Force.

Also, because of the few repairs required for this engine, the one intermediate facility still in operation has more equipment than required to perform all of the peacetime intermediate maintenance functions for the entire fleet. The same is true at the depot, where repairs are occurring at a level far below capability, as shown in figure 3.2.

Figure 3.2: Average Annual Use of F-108 Depot Repair Capability (1986 Through 1990)



The depot has enough support equipment to repair an average of 34 F-108 engines per year. Since 1986, however, the Air Force has repaired an average of five engines per year. Because of the low level of maintenance activity for this engine, the Air Force has placed some of the support equipment in storage and is using F-108 support equipment to repair other aircraft engines.

Commercial Maintenance Facilities Could Be Used

The Air Force may be able to reduce engine maintenance costs by using commercial facilities. For example, the largest commercial user of this engine only performs the most routine engine maintenance tasks using its own facilities and personnel. The airline uses a maintenance contractor to perform major engine maintenance and to store most of the airline's spare parts at the maintenance facility. This airline does not plan to invest in its own maintenance facility and equipment until its aircraft become older and nonwarranted repairs are frequent enough to justify the necessary investment.

Currently, there are commercial engine repair facilities in the continental United States that could accommodate the F-108 engine repairs. General Electric's engine maintenance facility, located in Arkansas City, Kansas, has excess engine maintenance capacity and is expanding. Another contractor, Aviall, performs repairs on engines similar to the F-108, as do several major airlines. In June 1990, the Deputy Secretary of Defense advised the service secretaries to prepare for maintenance

competition among the services and between the services and private industry.

When we discussed using commercial maintenance facilities early in the acquisition of a new engine with Air Force officials, they said that this is similar to the Air Force's practice called interim contractor support. This is the concept of using the manufacturer's facilities and personnel to maintain the engine until the Air Force develops its own capability. The Air Force could utilize interim contractor support until the acquisition of aircraft and maintenance history warrants investments in facilities and equipment. This approach will minimize the potential for excessive and premature investments. Although it is too late to use this approach for the Air Force's purchase of this engine, it could be used in future purchases of commercial engines.

Recommendations

To minimize the premature and possibly excessive investment in maintenance facilities when other commercial engines are purchased by the Air Force in future programs, we recommend that the Secretary of the Air Force direct the program managers to consider:

- using preexisting commercial maintenance capability, where practical, and
- ensuring that the maintenance capability is compatible with the level of aircraft purchases and the actual performance of the engine.

The Air Force Budget and the KC-135 Modification Program

The Air Force has taken some actions to reduce the quantities of spare engines and parts for the F-108 due to Air Force Audit Agency reports. When fully implemented, these actions should eliminate the excess spare engines. Nevertheless, we have identified premature deliveries of engines and aircraft modification kits, based on the modification schedule supporting the fiscal year 1992 budget request for the KC-135 modification program. Air Force officials, however, said they have accelerated the modification schedule since the budget request was submitted. If this new schedule is achieved, then these additional engines and kits will be needed. In addition, we identified contract savings from prior years' engine purchases that DOD officials said they plan to use for other needs.

The Air Force Took Some Action to Reduce Inventories

After the Air Force Audit Agency reviewed the F-108 engine inventories held by the Air Force, it recommended that steps be taken to reduce the number of F-108 spare engines. In response to these recommendations, the Air Force

- suspended spare engine purchases beginning in fiscal year 1988,
- plans to install 34 excess spare engines between 1991 and 1993, and
- has revised spare engine requirements downward to reflect the actual reliability of the engines and its parts.

When fully implemented, these actions should eliminate the excess spare engines.

Potential Premature Deliveries for Fiscal Year 1992

Although actions taken in response to Air Force Audit Agency reports eliminated excess spare engine inventories, the fiscal year 1992 budget request contains amounts for installation engines and modification kits that exceed Air Force requirements based on the modification schedule submitted with the budget request.

Table 4.1 uses information from the President's fiscal year 1992 budget request to compare modification kit purchases with the KC-135 modification schedule for the fiscal years 1989 through 1992 budgets. The aircraft will be modified in fiscal years 1991 to 1994. Each kit contains the items necessary to make the modifications to the aircraft, except for the engines themselves. For each kit ordered, the Air Force has also ordered four F-108 engines. For fiscal year 1992, the Air Force is requesting $325 million to modify the KC-135 aircraft.

Table 4.1: KC-135 Modification Kits Available Based on Installation Schedule in President's Budget

	Fiscal year			
	1991	**1992**	**1993**	**1994**
On hand at beginning of year	28	30	19	16
Plus deliveries	49	29	26	18
Total available	**77**	**59**	**45**	**34**
Less installation quantities	47	40	29	18
Total on hand at end of year	**30**	**19**	**16**	**16**

In commenting on this report, Air Force officials said they have accelerated their planned installation schedule for the KC-135 modification program since the President's fiscal year 1992 budget was submitted. Table 4.2 uses this accelerated schedule.

Table 4.2: KC-135 Modification Kits Available Based on Revised Air Force Installation Schedule

	Fiscal year			
	1991	**1992**	**1993**	**1994**
On hand at beginning of year	28	30	16	12
Plus deliveries	49	29	26	18
Total available	**77**	**59**	**42**	**30**
Less installation quantities	47	43	30	24
Total on hand at end of year	**30**	**16**	**12**	**6**

As table 4.1 shows, according to the installation schedule in the 1992 President's budget, 16 kits ordered in fiscal year 1992 for installation in fiscal year 1994 will not be installed by the end of 1994. However, as table 4.2 shows, under the revised schedule, only six kits ordered in 1992 will not be installed by the end of 1994.

In commenting on this report, Air Force officials stated that the six uninstalled kits remaining at the end of 1994 are required in the beginning of fiscal year 1995 to support the modification program. If they are not available, then the Air Force would either have to slow or completely stop the modification program until new kits ordered in 1993 begin to be delivered. We have not determined if an accelerated schedule is feasible. If the schedule supporting the President's budget is followed instead of the accelerated schedule, 10 kits and the related engines and installation costs will not be needed.

According to the fiscal year 1992 President's budget, the anticipated cost for 10 kits, related engines, and installation costs is $225 million, as shown in table 4.3.

Table 4.3: Modification Costs

Dollars in millions

	Unit cost	Total cost
Kit	$7.60	$7.6
Engine (four per aircraft)	3.45	13.8
Installation	1.10	1.1
Total cost per aircraft		**$22.5**
Total cost for 10 aircraft		**$225.0**

In commenting on this report, Air Force officials expressed concern that if the level of kits authorized in fiscal year 1992 is too low, their production base may be affected, and the unit cost will increase as quantities are reduced.

Contract Savings Occurred in Prior Years

As shown in table 4.4, the contract amounts for F-108 engines for fiscal years 1989 and 1990 have been less than the budgeted amount.

Table 4.4: Comparison of Budget and Contract Amounts for Fiscal Years 1989 and 1990

Dollars in millions

	Fiscal year	
Fiscal year 1992 President's budget	**1989**	**1990**
Engines	$505.8	$320.1
Contract amounts		
Engines	497.7	318.1
Difference	**$8.1**	**$2.0**

Prior years' funds of $10.1 million ($8.1 million for fiscal year 1989 and $2 million for fiscal year 1990) can be considered for rescission. In commenting on this report, DOD officials said they have submitted a reprogramming request for the fiscal year 1990 amount and have plans to use the fiscal year 1989 amount for other needs.

Matter for Congressional Consideration

If the schedule submitted by the Air Force to support the fiscal year 1992 President's budget request is used as a basis for evaluating the fiscal year 1992 request, the Congress may want to consider reducing the fiscal year 1992 budget request for KC-135 modifications by $225 million due to premature deliveries of modification kits and engines, and related installation costs. However, Air Force officials told us they plan to accelerate the installation schedule included in the President's budget. In addition, the Congress may want to consider rescinding $10.1 million in prior years' funding for the KC-135 modification program if it does not want the Air Force to use the funds for other purposes.

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