UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

NATIONAL SECURITY AND
INTERNATIONAL AFFAIRS DIVISION

B-205019

SEPTEMBER 23, 1983

The Honorable Verne Orr
The Secretary of the Air Force

Attention: Assistant Deputy Auditor
General (AFAA/AI)

122473

Dear Mr. Secretary:

Subject: Potential for Reducing Costs by Using More JT3D Engines in the KC-135 Reengining Program (GAO/NSIAD-83-47)

The Air Force has determined that it needs additional aerial-refueling capability and that a way to do this is to replace J57 engines on KC-135 airplanes with more fuel efficient engines. It is doing this under two programs: one uses new, current technology CFM56 engines, and the other uses JT3D engines from used Boeing 707 series airplanes. We made this review to determine whether the Air Force selected the more cost effective mix of programs.

Air Force estimates provided to the Congress show the CFM56 program to be more cost effective than the JT3D program. However, the Air Force would have reached the opposite conclusion if it had compared alternative mixes of CFM56- and JT3D-equipped KC-135s and used a sound estimating methodology that computed the present value of future costs. Our present value cost analysis shows that the Government could save between $238 million and $327 million by expanding the JT3D program to 200 KC-135s, with offsetting reductions in the CFM56 program.

KC-135 REENGINING PROGRAMS

In 1978, the Air Force identified the need for new engines on the KC-135 and in 1980 selected the CFM56 engine after considering other new engines. It awarded a contract to the Boeing Company in 1981 to begin the program. Flight tests were begun

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on the first CFM56-equipped KC-135 (designated the KC-135R) in August 1982. The Air Force expects the CFM56 engines to increase the KC-135's fuel offload capability by 50 percent by improving fuel efficiency. The new engines consume less fuel than the old engines, leaving more of the on-board fuel available for offloading to receiver aircraft. Also, the CFM56 engines provide significantly more engine thrust which, along with changes to strengthen the landing gear, permits the KC-135 to carry additional fuel. Over the next 8 years the Air Force plans to reengine about 400 KC-135s with CFM56 engines.

The JT3D reengine program resulted after American Airlines submitted an unsolicited proposal to sell the engines to the Air Force. The airline proposed increasing the performance and fuel efficiency of C-135 series aircraft by reengining them with engines from aircraft available on the used aircraft market. The Congress directed the Air Force to implement the JT3D program on Air National Guard KC-135s.

So far 18 special mission C-135s and 28 KC-135s have been reengined. The Air Force plans to reengine a total of 88 KC-135s (designated the KC-135Es) under this program. The program involves buying used Boeing 707 airplanes, removing and overhauling the engines, and then installing them and selected other 707 components, such as engine struts and the horizontal tail, on the C/KC-135s. The Air Force estimates that the JT3D engines' fuel efficiency increases the KC-135's fuel offload capability by 20 percent.

OBJECTIVES, SCOPE, AND METHODOLOGY

Our objective was to evaluate whether the Air Force had correctly computed life-cycle costs for the JT3D and CFM56 reengining programs and whether it had selected the more cost effective program or mix of programs.

We analyzed program records, including life-cycle cost estimates and methodology, and segregated recurring from nonrecurring costs. We used the recurring and nonrecurring costs to determine life-cycle costs of alternative program quantities and production schedules. We also interviewed program officials at various locations. The work was done at

--Air Force Headquarters, Washington, D.C., which has overall Air Force planning, budgeting, and oversight responsibilities for tanker aircraft programs;

--Strategic Air Command Headquarters, Offutt Air Force Base, Nebraska, which determines tanker aircraft requirements and operates the Air Force fleet of KC-135s;

--Air National Guard Headquarters, Washington, D.C., which oversees the operation of Air National Guard KC-135s;

--Air Force Logistics Command, Wright-Patterson Air Force Base, Ohio, which has prepared or processed program cost estimates;

--Oklahoma City Air Logistics Center, Oklahoma City, Oklahoma, which manages KC-135 logistical support programs and the JT3D reengining contracts and prepared JT3D and CFM56 program cost estimates;

--Air Force Systems Command, Aeronautical Systems Division, Wright-Patterson Air Force Base, which manages the CFM56 reengining contract and prepared program cost estimates; and

--Boeing Military Airplane Company, Wichita, Kansas, the prime contractor for both reengining programs.

We calculated life-cycle costs based on Air Force cost estimates for the programs and for KC-135 operations and support. We scheduled the costs, including inflation, expected to be incurred over the 20-year life cycle for each reengined aircraft. We also calculated the present value of those costs by using a discount rate based on the average yield for long-term Federal Government borrowings--Treasury bonds with maturities of 10 years or longer.

Our review was made in accordance with standards for auditing governmental activities and programs, except, we used cost estimates for the CFM56 program without verifying them. However, we did review data that the Oklahoma City Air Logistics Center had compiled as support for its September 1982 cost estimate. This data included contract prices for reengining the first nine airplanes.

AIR FORCE DID NOT USE SOUND ESTIMATING METHODOLOGY

The Air Force did not use appropriate methodology to determine the more cost effective engines considered for upgrading the KC-135 airplanes. The Air Force compared costs for only one JT3D-equipped KC-135 and one CFM56-equipped KC-135 and did not compare alternative mixes of KC-135s. Furthermore, the Air Force estimated 20-year life-cycle costs but did not compute their present value. Consequently, the estimates do not consider the time value of money to the Government. Properly discounting costs for alternative mixes of JT3D- and CFM56-equipped KC-135s to their present value would have shown that a mix with 112 more JT3Ds than the Air Force now plans would save about $283 million of life-cycle costs totaling about $28 billion.

We used two alternative KC-135 force mixes in our analysis. One is based on current Air Force reengining plans (88 JT3Ds, 415 CFM56s, and 112 unreengined KC-135As.) The second is based on reengining 200 KC-135s with JT3D engines and would include 370 CFM56s and 45 KC-135As. Both alternatives would provide the same amount of aerial-refueling capability, the equivalent of 840 unreengined KC-135s.

Incorrect life-cycle cost comparisons

In a December 1981 letter to the Chairman of the Senate Committee on Armed Services, the Air Force stated that based on the following cost comparison, the CFM56 program was more cost effective.

	20-year unit costs	
	JT3D	CFM56
	(millions of 1981 dollars)	
Modification costs	$ 5.0	$15.9
Operation and support costs:		
Fuel	15.0	12.5
Other	21.3	21.3
Total	41.3	49.7
Equivalency factor (note a)	1.2	1.5
Cost per unit of existing KC-135A capability	$35.0	$33.1

a/This factor shows the fuel offload capability of the reengined KC-135s in relation to the capability of the KC-135A.

Although the preceding figures, which are for one JT3D-equipped KC-135 and one CFM56-equipped KC-135, show the CFM56 to be more cost effective than the JT3D, they are misleading. The

Air Force computed life-cycle costs only in terms of constant dollars and did not discount the costs to present value. To apply the present value methodology, the Air Force would have had to consider an appropriate discount rate and the timing of modification and operating expenditures for alternative quantities of JT3D- and CFM56-equipped aircraft.

Air Force Regulation 178-1 and Department of Defense (DOD) Instruction 7041.3 require agencies to discount life-cycle costs to determine the present value of future costs. But the officials who made this comparison said they had not used present value methodology in this case.

By not discounting, the Air Force limited its consideration to the impact of expenditures on its appropriations. It did not consider the alternative programs' Government-wide cost impact, including interest. Present value methodology provides a convenient way of recognizing Federal interest costs that are a consequence of agency expenditures. Interest costs result from Federal expenditures because the expenditures cause the Government to increase borrowing or to forgo an opportunity to reduce borrowing--in either case, to incur more interest than it otherwise would.

GAO computation of life-cycle costs

GAO's present value analysis of the costs, including inflation, shows that the Government could save millions of dollars by reengining more KC-135s with JT3D engines and fewer with CFM56 engines. Our analysis compares the life-cycle costs for two KC-135 fleet mixes, one with 88 KC-135Es and 415 KC-135Rs and the other with 200 KC-135Es and 370 KC-135Rs. As the following table shows, the mix with 200 KC-135Es produces a savings of $283 million over the mix with 88 KC-135Es.

	Fleet mix		
Costs	88 KC-135Es 415 KC-135Rs 112 KC-135As	200 KC-135Es 370 KC-135Rs 45 KC-135As	Difference
	(millions)		
Modification	$ 6,967.6	$ 6,750.0	$217.6
Operation and support:			
Fuel	9,590.9	9,590.0	0.9
Other	11,714.7	11,650.5	64.2
Total	$28,273.2	$27,990.5	$282.7

The savings would result because the KC-135R has higher modification costs, which occur in the early years and are subject to high present value factors. The KC-135E has higher fuel costs, but they are spread out over the entire life cycle at a lower present value. For example, at the 10.63-percent discount rate we used, $1,000 spent 2 years after the start of the program has a present value of $817.10. However, $1,000 spent at the 10-year point has a present value of only $364.10.

Because the Air Force did not base its cost comparisons on alternative mixes of KC-135s that included varying numbers of KC-135Es--the JT3D-equipped version--we selected the above two mixes for our analysis. The mix with 88 KC-135Es is based on the Air National Guard's plans to reengine 88 of its KC-135s with JT3D engines and a recently completed Air Force cost estimate for reengining 415 KC-135As with CFM56 engines. Also, the estimate cited a long-term objective of reengining 415 KC-135s with the CFM56 engine. Therefore, 112 unreengined KC-135As are left from the present 615-airplane fleet.

The mix with 200 KC-135Es is based on information we obtained at Air Force Headquarters, the Air Force Logistics Command, the Oklahoma City Air Logistics Center, and the Boeing Military Airplane Company that enough suitable used Boeing 707s will be available to reengine at least 200 KC-135s. Using the remaining 415 KC-135s to complete the 840-capability amount provided for in the first mix results in 370 KC-135Rs and 45 KC-135As.

The costs under both mixes include operations and support from 1982 through a period ending 20 years after each aircraft's reengining. For unreengined KC-135s, the costs continue for 20 years after refurbishing three existing engine parts that the Air Force considers as safety-of-flight problems. We computed life-cycle costs using Air Force reengining program and operations and support cost data. The JT3D modification costs are based on the contract for the first 28 KC-135s and Air Force estimates of costs to modify additional KC-135s. The CFM56 program costs are based on an Air Force estimate of the cost to reengine 415 KC-135s. The estimate includes contract prices for the first nine production aircraft. The operation and support costs are based on Air Force Headquarters estimates.

Oklahoma City Air Logistics Center reengine office officials said that a reasonable combined JT3D/CFM56 production rate would be 72 aircraft per year, the highest rate currently planned for the CFM56 program. We assumed that if both programs were underway, annual production would be 36 of each. Where the existing Air Force schedule, as shown in the 415-aircraft estimate, called for fewer CFM56 aircraft, we increased the JT3D production rate accordingly. Also, we assumed in our funding schedule that (1) funds to expand the JT3D program would come from the 415-aircraft CFM56 program and (2) no additional funds or earlier funding would be needed.

Life-cycle cost sensitivity

The life-cycle costs are sensitive to several estimating factors, including the discount rate, annual flying hours, and engine fuel efficiency.

In the previously cited life-cycle costs, we used a discount rate based on long-term Government borrowings as of November 1982. The table on page 8 also shows the results using discount rates about 1.5 percent higher and about 1.5 percent lower.

Our basic computations also assumed 335 annual flying hours per aircraft--the 1982 rate. The Air Force plans to increase the rate to 384 hours by 1986; the table on page 8 shows how that increase affects life-cycle costs.

The Air Force estimated that the KC-135R and the KC-135E will be 25 percent and 12 percent, respectively, more fuel-efficient than the KC-135A. We used those assumptions in our basic computations. The table on page 8 also shows the results if (1) the KC-135R's improvement is 2 percent better than expected while the KC-135E's improvement is 2 percent poorer and (2) the KC-135R's improvement is 2 percent poorer than expected while the KC-135E's improvement is 2 percent better. Sufficient historical data are not yet available to determine the actual improvement.

In the following life-cycle cost chart, the "basic assumptions" amount includes a 10.63-percent discount rate, 335 annual flying hours per aircraft, and 25-percent and 12-percent fuel efficiency increases for the KC-135R and KC-135E, respectively. The other amounts are based on the variations listed.

Cost Comparisons for Mixes of KC-135 Aircraft
Providing Equivalent Capability of 840 KC-135As
(Present Value Costs)

Cost estimate assumptions	415Rs, 88Es, and 112As	370Rs, 200Es, and 45As	Difference
	-----------------	(millions)	-------------
Basic assumptions	$28,273.2	$27,990.5	$282.7
9-percent discount rate	32,440.1	32,145.4	294.7
12-percent discount rate	25,439.4	25,167.2	272.2
384 flying hour rate by 1986	29,526.1	29,233.3	292.8
Fuel efficiency: KC-135R + 27 percent and KC-135E + 10 percent	28,182.6	27,944.5	238.1
Fuel efficiency: KC-135R + 23 percent and KC-135E + 14 percent	28,363.7	28,036.4	327.3

The mix that has 200 KC-135Es is the least costly alternative in all the above cases; the estimated savings range from $238.1 million to $327.3 million.

Uncertainties exist about the amount of aerial refueling needed

The amount of aerial-refueling capability that the Air Force needs in the long term--1990 and beyond--is presently uncertain. The uncertainty involves precisely how much aerial-refueling support the B-1B and advanced technology (Stealth) bombers will require, when existing bombers will be retired, and how many B-52s will carry how many of what type cruise missile and when. Also, changes in DOD guidance on war planning affect tanker "requirements."

Strategic Air Command officials said they believed tanker requirements would increase in future years to the extent that it would be necessary to put CFM56 engines on all KC-135s. However, based on Air Force Headquarters May 1982 projections of long-term requirements, reengining about 200 KC-135s with JT3D engines and 370 with CFM56 engines, together with the Air Force's planned buy of 72 KC-10 tanker aircraft, would go a long way toward meeting those requirements and would provide as much capability as the fleet mix currently planned by the Air Force.

Based on the funding assumptions in our life-cycle computations, completing a program of reengining 200 KC-135s with JT3D engines and 370 with CFM56 engines will take until 1991. By that time, the Air Force should be in a much better position to evaluate the need for any additional capability.

A force of 200 KC-135Es, 370 KC-135Rs, 45 KC-135As, and about 72 KC-10s will provide a tanker capability equivalent to about 1,056 unreengined KC-135As. This is a considerable increase over the tanker force that recently consisted of only 615 KC-135As. If future tanker capability is needed, the Air Force could choose from such alternatives as putting CFM56 engines on the remaining 45 KC-135As, replacing the JT3D engines with CFM56 engines, or buying new tanker aircraft.

CONCLUSIONS

The Air Force could save millions of dollars and still substantially increase aerial-refueling capability by reengining more KC-135s with JT3D engines and fewer with CFM56 engines. A KC-135 fleet mix that includes 200 KC-135Es provides the same capability as the Air Force's currently planned mix that includes 88 KC-135Es. Neither mix may meet the Air Force's forecasts of future tanker aircraft requirements. However, we believe the uncertainties involved in those forecasts warrant expanding the JT3D program to achieve the life-cycle cost savings.

RECOMMENDATION

We recommend that the Secretary of the Air Force expand the JT3D program--to the extent that the used Boeing 707s are available at reasonable prices--to cover reengining 200 KC-135s and make offsetting reductions in the CFM56 program.

AGENCY COMMENTS AND OUR EVALUATION

DOD and Air Force officials did not agree with our recommendation, stating that the currently planned mix of tankers best fulfills the long-term air-refueling shortfall. In providing official oral comments on July 7, 1983, they stated that detailed cost comparisons by both the Air Force and GAO show that the comparison of potential cost savings is so small that force structure decisions should be made on other considerations, such as air-refueling shortfalls and potential fuel cost growth. The officials stated also that they had made present value cost comparisons.

We believe that a $283 million savings, even though it represents only about 1 percent of total costs, is a significant amount and should be a major factor in deciding on the composition of the tanker aircraft fleet. Even if the costs were not discounted, the savings would be $176 million. Such savings are especially important to the Government in these times of high and increasing deficits. Furthermore, the discounted savings are equivalent to the life-cycle costs for nine KC-135A airplanes.

Concerning fuel costs, our estimates recognize the growth in these costs. The estimates are based on inflation forecasts for petroleum products made by a reputable firm (Data Resources, Inc.). If the inflation rates were doubled, the overall savings still would be large--$148 million. The DOD officials did not provide us with any data to support using higher inflation rates.

As for aerial-refueling shortfalls, we believe that the uncertainties concerning future requirements and the substantial increase in capability that our proposed fleet mix provides over present aeriel-refueling capabilities makes it reasonable to pursue the savings possible with our proposed mix. Furthermore, our proposed mix provides the same amount of capability as the alternative mix based on current Air Force reengining plans.

The DOD officials furnished us charts comparing the life-cycle costs of various tanker aircraft to support their statement that present value cost comparisons had been made, and the CFM56-equipped KC-135 was more cost effective than the JT3D-equipped KC-135. We noted, however, that the comparisons were made on a per unit basis and did not compare the costs of alternative fleet mixes. In our opinion, the latter would have been the more valid comparison. Also, the officials acknowledged that the cost comparison presented to the Senate Committee on Armed Services was not based on a present value analysis. The officials said that DOD does not submit present value cost data to the Congress unless specifically requested.

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As you know, 31 U.S.C. § 720 requires the head of a Federal agency to submit a written statement on actions taken on our recommendations to the House Committee on Government Operations and the Senate Committee on Governmental Affairs not later than 60 days after the date of the report. A written statement must also be submitted to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

We are sending copies of this report to the Secretary of Defense; the Director, Office of Management and Budget; the Chairmen of the above committees; and the Chairmen, House and Senate Committees on Armed Services.

Sincerely yours,

Frank C. Conahan

Frank C. Conahan
Director