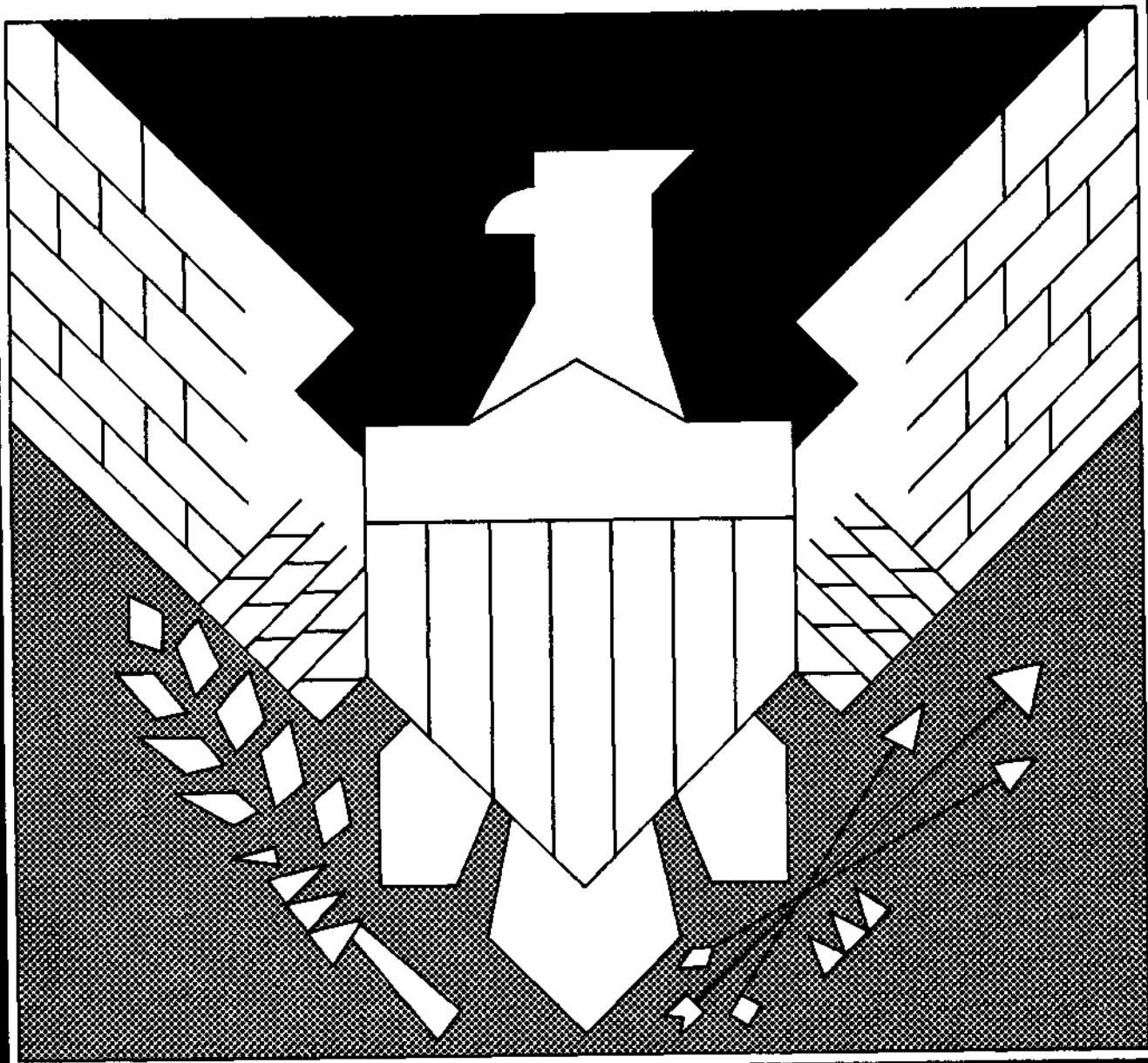




*Modernizing the
Aerial Tanker Fleet:
Prospects for Capacity,
Timing, and Cost*



CBO STUDY

Report Documentation Page

Form Approved
OMB No. 0704-0188

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1. REPORT DATE SEP 1985	2. REPORT TYPE	3. DATES COVERED 00-00-1985 to 00-00-1985			
4. TITLE AND SUBTITLE Modernizing the Aerial Tanker Fleet: Prospects for Capacity, Timing, and Cost		5a. CONTRACT NUMBER			
		5b. GRANT NUMBER			
		5c. PROGRAM ELEMENT NUMBER			
6. AUTHOR(S)		5d. PROJECT NUMBER			
		5e. TASK NUMBER			
		5f. WORK UNIT NUMBER			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Congressional Budget Office ,Ford House Office Building, 4th Floor ,Second and D Streets, SW ,Washington,DC,20515-6925		8. PERFORMING ORGANIZATION REPORT NUMBER			
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)			
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)			
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified	Same as Report (SAR)	55	

**MODERNIZING THE AERIAL TANKER FLEET:
PROSPECTS FOR CAPACITY, TIMING, AND COST**

The Congress of the United States
Congressional Budget Office

NOTE

Unless otherwise specified, all costs are expressed in constant fiscal year 1986 budget authority dollars. All dates, except those used in an historical context, refer to fiscal years.

PREFACE

The Air Force has for several years been pursuing programs to modernize and expand the capacity of its aging fleet of aerial tankers, aircraft that support combat bombers and fighters designated for both strategic and conventional missions. While the number and diversity of missions the tanker fleet might support are growing, budgetary pressures have already slowed the progress of modernization efforts. This study, undertaken at the request of the U.S. House of Representatives Committee on Appropriations, Subcommittee on Defense, examines the outlook for continued tanker modernization and improvement. In particular, it compares two alternatives to the modernization effort now being carried out by the Administration. In keeping with the Congressional Budget Office's mandate to provide objective analysis, the paper offers no recommendations.

Bonita J. Dombey, of CBO's National Security Division, prepared the study under the general supervision of Robert F. Hale and John D. Mayer. William P. Myers provided invaluable cost analysis. Jenifer Wishart and V. Lane Pierrot contributed to other aspects of the study. The author owes particular thanks to Johanna Zacharias for comprehensive editorial work. G. William Darr expertly prepared the manuscript for publication.

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September 1985

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SUMMARY

Reflecting the advantages to combat aircraft afforded by aerial refueling--such as extended range, flexibility, and autonomy--most major missions planned for the U.S. Air Force today assign a prominent role to tanker support. But while defense planning has come increasingly to rely on aerial refueling, the tanker fleet itself has diminished in size, from more than 800 aircraft over two decades ago to about 640 today. Furthermore, most of the aircraft in the present fleet are more than 20 years old and suffer from technological obsolescence.

On the basis of its current military planning, the Department of Defense (DoD) places the Air Force's minimal aerial refueling need at the equivalent of 1,000 basic KC-135A tankers ("tanker equivalent" is the unit used in measuring capacity). From this, the present shortfall is estimated to be about 200 tanker equivalents.

Awareness of these problems prompted Congressional action as early as 1979. Efforts to upgrade the tanker fleet are now under way and include the following approaches:

- o Modernizing existing KC-135As by replacing their aging J-57 engines with new **CFM-56 engines**, to produce **KC-135R tankers**;
- o Similar modernization of KC-135As, but with **refurbished JT-3D engines** salvaged from disused commercial planes, to produce **KC-135E tankers**. (The source of JT-3D engines is commercially owned Boeing 707s, which are now being phased out because of new limits on air and noise pollution.)
- o Augmenting the fleet's capacity by procuring new **KC-10 tanker/cargo aircraft**.

The continuing emphasis of the Administration's program for the tanker fleet has been on the first of these approaches. The second approach, mandated by the Congress, has been directed toward tankers in the Reserve forces. For the most part, KC-10s have been procured to expand capacity in the airlift fleet.

COMPLICATIONS IN THE OUTLOOK FOR FUTURE TANKER IMPROVEMENTS

Where should efforts to improve tanker resources go from here? Several factors complicate this question. For one, changes are being made in the fleets of bomber and fighter aircraft that rely on tanker support. For another, the variety of missions in which tanker support would figure is broadening, to include considerable conventional as well as strategic use. These patterns imply increasing pressure for tanker support, especially in the near term. At the same time, though, cost-cutting measures have been slowing efforts to improve tanker resources.

Demand--A Curving Projection That Makes Timing Central

The changing character of aerial combat fleets and the broadening scope of missions involving aerial refueling clearly suggest an increasing demand for tanker support. This is a near-term prospect, however; in fact, demand is expected to peak within only a few years. By the early 1990s, demand should begin to taper off, as the Air Force reduces the proportion of the most fuel-intensive missions for the bombers, introduces larger numbers of more fuel-efficient aircraft and retires many less efficient ones. Timing of tanker improvements, therefore, becomes a central factor.

OPTIONS FOR TANKER FLEET IMPROVEMENT-- MIXES WITH DIFFERENT EMPHASES

By itself, no one of the possible tanker upgrades tested so far would satisfy all concerns. The KC-135R tanker is a powerful aircraft with large fuel-carrying capacity, but lead time between funding approval and delivery is lengthy; moreover, investment costs for the KC-135R are quite high. The KC-135E choice, on the other other hand, can be quite economical and speedy, but it depends on the somewhat uncertain future availability of a supply of "donor" aircraft from which to salvage parts. It also yields the smallest expansion of tanker capacity per aircraft. Reliance on the new KC-10 instead could provide a great deal of capability, but the high investment costs--much more even than those of the KC-135R--would probably be prohibitive without a change of apparent priorities among modernization programs. Furthermore, the Congress may well seek to extend the considerable investment it has already made in KC-135As; this could be done only by the approaches that would modernize aircraft already in the tanker fleet. On the other hand, the Congress may want to invest more moderately in an aging plane that may have a limited remaining useful life.

Because of the harshness of such tradeoffs, the Congressional Budget Office (CBO) has examined options that would mix modernization approaches, in an attempt to moderate the negative aspects of any one choice. The options differ mainly in which approach each stresses. Summary Table 1 illustrates the procurement profiles of the options as they would proceed over the fiscal year 1986-1995 period. Summary Table 2 illustrates CBO's findings.

Option I. The Administration's Plan Emphasizing the KC-135R Tanker

Between 1986 and 1990, the Administration's plan would budget for 287 re-enginings with new CFM-56 engines. Air Force testimony suggests that CFM-56 re-engining would continue beyond the five years for the remainder of the fleet. According to present plans, the Administration would also buy another 20 KC-10 tanker/cargo aircraft, but primarily to improve airlift capabilities, not tanker resources. (These programs would be in addition to the tanker improvement programs already funded, which include re-engining with both CFM-56 and JT-3D engines and the purchase of 40 new KC-10 aircraft--again, primarily for airlift.)

The Administration program would offer the advantage of completing the re-engining of the tanker fleet with the new CFM-56 engine. Plane for plane, the KC-135R is the more capable of the two re-engining alternatives; it also avoids any uncertainties of supply associated with the KC-135E. The CFM-56 is also the quieter of the re-engining choices and offers the better smoke pollution abatement.

On the other hand, since re-engining a KC-135A with the CFM-56 takes about two and one-half years, modernization of the fleet would be slow under this option; only 58 percent of the fleet would be modified by 1990, about the time demand for aerial refueling is expected to peak. Owing to cost and competing priorities, the program is already proceeding at a much slower pace than was envisioned. The fiscal year 1986 Air Force program will fund 89 fewer tankers--from 1982 to 1988--than would the plan that was formulated for fiscal year 1983. This is the result of a consistent pattern. Even at this reduced pace, the current program would cost approximately \$6.3 billion in budget authority over the next five years, requiring substantial real growth in funding for tanker improvements, and thus perhaps exacerbating the slowdown.

Option II. Emphasizing the KC-135E Tanker

Modernizing tankers instead with refurbished JT-3D engines would solve some of these problems, because it would be much faster and cheaper than

SUMMARY TABLE 1. PROCUREMENT UNDER THE OPTIONS, FISCAL YEARS 1986-1993

Options and Items Procured	1986	1987	1988	1989	1990	Subtotal 1986- 1990	1991	1992	1993	Total 1986 to Completion
Option I										
CFM-56 Re-engining Kits	43	50	50	72	72	287	72	53	--	412
KC-10 Aircraft	12	8	--	--	--	20	--	--	--	20
Option II										
CFM-56 Re-engining Kits	36	36	36	36	36	180	7	--	--	187
JT-3D Re-engining Kits	33	48	48	48	48	225	--	--	--	225
KC-10 Aircraft	12	8	--	--	--	20	--	--	--	20
Option III										
CFM-56 Re-engining Kits	30	30	30	30	30	150	--	--	--	150
JT-3D Re-engining Kits	30	48	48	48	26	200	--	--	--	200
KC-10 Aircraft	12	8	8	8	8	44	8	8	8	68

SOURCE: Congressional Budget Office.

NOTES: Actions up to 1986 include approved purchases of 102 KC-135R re-enginings, 128 JT-3D re-enginings, and 40 of the total planned purchase of 60 KC-10 tanker/cargo aircraft.

SUMMARY TABLE 2. COMPARISON OF THE OPTIONS: CAPACITY, PERCENT MODERNIZED, AND INVESTMENT COSTS, FISCAL YEARS 1986-1995 (Capacity in tanker equivalents, costs in billions of 1986 dollars)

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Option I. The Administration's Plan Emphasizing the KC-135R Tanker										
Tanker Capacity	843	895	912	934	958	989	1,025	1,043	1,097	1,105
Percent Modernized	35	40	45	51	58	67	77	87	98	100
Investment Costs	1.27	1.13	1.02	1.42	1.45	1.39	0.99	0.03	0.03	0.00
Option II. Emphasizing the KC-135E Tanker										
Tanker Capacity	846	908	934	962	989	1,011	1,029	1,038	1,038	1,038
Percent Modernized	37	49	61	73	85	92	97	100	100	100
Investment Costs	1.29	1.04	0.93	0.92	0.95	0.18	0.02	0.00	0.00	0.00
Option III. Emphasizing the KC-10 Tanker/Cargo Aircraft										
Tanker Capacity	836	908	958	1,006	1,039	1,063	1,082	1,096	1,096	1,096
Percent Modernized	37	49	61	72	85	91	96	100	100	100
Investment Costs	1.18	1.30	1.24	1.29	1.24	0.46	0.38	0.22	0.00	0.00

SOURCE: Congressional Budget Office.

NOTES: Actions up to 1986 include purchase of 102 KC-135R re-enginings, 128 KC-135E re-enginings, and 40 of the planned total purchase of 60 KC-10 tanker/cargo aircraft. Numbers in bold type indicate capacity at or above the benchmark demand estimate of 1,000 tanker equivalents, and completed fleet modernization.

the CFM-56 re-engining program. But since it is not certain how many of some 500 potential donor aircraft would be able to be procured from commercial airlines, this option would conservatively include some CFM-56 re-engining. The final breakdown would be 225 KC-135Es and 187 KC-135Rs.

Through 1992, spanning the period when demand is expected to be highest, overall tanker capacity would be modestly higher than if the Administration's plan were followed. This option would provide a capability of 989 tanker equivalents in 1990, compared with 958 under the Administration's plan. Moreover, the pace of modernization would be significantly improved, with 85 percent of the fleet modernized by 1990 and all of it by 1993.

Re-engining with the refurbished JT-3D should not encounter major problems. As considered by CBO, this option would use only about half of the worldwide supply of potential donor aircraft. Nor should logistics problems be major, since the JT-3D is a version of an engine already in use on other Air Force aircraft. Indeed, the Air National Guard has had much better experience with maintaining JT-3Ds than with the old J-57 engines. Finally, the cost of this option over the next five years would be about \$5.1 billion, a savings of nearly \$1.2 billion compared to the Administration's plan. Total program savings would amount to \$3.4 billion.

A clear drawback, however, is that the JT-3D engine cannot provide as much performance improvement plane for plane as can the CFM-56, though under the Administration's option, that disadvantage would be evident only in the 1990s, when demand for tankers should be slackening. Nor can the JT-3D offer as much noise or pollution abatement as can the CFM-56.

Option IIA. Target Additional JT-3Ds for Reserve Forces. Despite its potential lower cost and faster completion, re-engining with JT-3Ds has never been formally supported by the active-duty Air Force, though the Reserve forces have enthusiastically supported it. Funds have already been made available to modernize all 128 tanker aircraft in the Guard and Reserve with the JT-3D. The Congress could pursue additional JT-3D re-engining along these lines by shifting 32 KC-135A tankers (about 5 percent of the fleet) from the active-duty force by eliminating two active-duty squadrons, re-engining the aircraft with JT-3Ds, and redistributing them among Reserve units. This would give additional JT-3D re-engined tankers to the units that have already used them successfully. It would also put at least ten KC-135Es in most Reserve force units and would allow those units to keep two rather than one aircraft on 24-hour alert for the strategic mission. Thus, the ratio of support tankers to alert tankers would improve

from 8 to 1 today to 5 to 1, a more efficient use of assets already owned, and the total number of alert tankers would also increase.

As a first step toward Option II, this variation would save money with the cheaper modification. Total investment savings for the 32 aircraft would amount to about \$370 million, compared to the Administration's plan. Additional operating and support costs would eventually erode these savings, but not for many years. Both advantages and drawbacks could follow from such a transfer, such as improved readiness but decreased availability for some missions. With a limited portion of the fleet being transferred, however, pros and cons might not be major.

Option III. Emphasizing the KC-10 Tanker/Cargo Aircraft

The savings achievable by economizing with some cheaper re-engining could be applied to the purchase of 48 more KC-10 tanker/cargo aircraft for use as dedicated tankers. This option would permit tanker improvements to come closer to meeting peak demand around 1990. Both types of re-engining would continue: specifically, 200 tankers would be converted into KC-135Es and 150 into KC-135Rs.

Of all the options, Option III would offer the greatest capacity in the near term. By 1989, the fleet would surpass the benchmark demand of 1,000 tanker equivalents, whereas the Administration's plan would not do so until 1992. By buying a new, modern tanker, Option III would also keep a production line open through the early 1990s, which might be important if the Department of Defense perceives a need for a rapid increase in tanker capacity.

Costs over the five years, however, would be about the same as under the Administration's plan, with higher costs in 1987 and 1988 offset by lower costs in other years. With budgetary constraints prompting cost-cutting actions in so many areas--in particular, measures to slow the growth of defense spending--the high price of Option III might invite the same problems as might the Administration's program. Should future actions slow the pace of KC-10 procurement, the tanker modernization effort could be further weakened in terms of both capacity and timing.

CHAPTER I

THE AERIAL TANKER FLEET

IN THE CONTEXT OF

PRESENT AND PROJECTED REQUIREMENTS

While the role of in-flight refueling in U.S. defense planning has grown dramatically in recent years, the Air Force's fleet of tanker aircraft has actually shrunk. Tanker aircraft were originally procured to extend the range of the Strategic Air Command's B-52 strategic bomber force; in the interim, their uses have widely diversified. Today, nearly every plane the Air Force purchases for major missions can be refueled while airborne. The Air Force now owns some 10,000 aircraft capable of being refueled while in flight--five times as many as it had two decades ago, when the technique was still relatively new. At the same time, only some 640 aircraft constitute the Air Force's present fleet of dedicated tankers, nearly 200 fewer than 20 years ago.

Furthermore, many of the tankers still in operation are almost as old as the aerial refueling technique itself, which the Air Force pioneered in the 1950s. These are KC-135s, similar to the commercial Boeing 707, and are equipped with four early-generation J-57 jet engines. (A text box on page 2 provides information on tanker aircraft and engines.) Problems of obsolescence and operational limitations combine with sharply rising demand to raise concern about the adequacy of the Air Force's tanker fleet to meet the needs implicit in the Department of Defense's (DoD) wartime plans. Ongoing Administration programs to upgrade the tanker fleet are designed to cost \$13 billion through about 1993. But despite overall growth in defense spending, the allotment for tanker modernization has been trimmed. This study examines the advantages and drawbacks associated with various mixes of choices for modernizing and expanding the U.S. tanker fleet. The study considers the choices in the context of the Administration's plans and trends in demand for tanker support.

TODAY'S TANKER FLEET-- PROBLEMS, ATTEMPTED SOLUTIONS, AND DIVERSE MISSIONS

Despite the diversity and magnitude of its assignment, the KC-135 is still able to continue safe flying. A program now under way to improve the

AIRCRAFT AND ENGINES IN THE AERIAL TANKER FLEET

The original aircraft in the fleet, the **KC-135**, was introduced in 1957 and today remains the Air Force's mainstay tanker. Built by the Boeing Corporation until the mid-1960s, the KC-135 is similar to the same firm's civilian-service 707. Referred to now as the **KC-135A**, the basic tanker has a fuel-delivery capacity of 63,000 pounds for an average mission distance of 2,500 nautical miles. It is equipped with four early-generation J-57 jet engines, manufactured by Pratt and Whitney, complemented by water-assisted thrust for take-off. Modified with other engines, this basic tanker takes on new designations. KC-135 is also used as an umbrella term applying to all tanker aircraft with like bodies, regardless of modifications.

Refitted with a **brand new CFM-56 engine** now being procured from Consolidated Fan Motors, Inc., a company formed jointly by the General Electric Corporation and SNECMA, a French firm, the KC-135A tanker is redesignated the **KC-135R**. Thus modernized, the KC-135R can deliver 94,500 pounds of fuel at the same flying radius of 2,500 nautical miles.

Refitted instead with a **refurbished JT-3D engine**, the basic tanker becomes the **KC-135E**. The JT-3D, built by Pratt and Whitney and no longer being manufactured, is salvaged from Boeing 707s now being phased out of commercial service. The improved fuel-delivery capacity of the KC-135E is 75,600 pounds at 2,500 nautical miles.

* * * * *

The only altogether new aircraft in the fleet, the **KC-10 tanker/cargo aircraft** is currently being procured from the McDonnell Douglas Corporation. At the same flying distance of 2,500 nautical miles, the KC-10 has a fuel-delivery capacity of 162,000 pounds.

NOTE: Chapter II details other characteristics of these four aircraft.

wings of the entire fleet--to be completed in fiscal year 1987 at a cost of about \$528 million (in current dollars)--guarantees the structural viability of these aircraft well into the next century. ^{1/} But aging technology does create and exacerbate operational problems, most centering on the KC-135's engine.

1. For further background on ongoing modernization efforts, see Congressional Budget Office, *Aerial Tanker Force Modernization* (March 1982).

Today about 150 KC-135s have been modified with new or refurbished engines and other improvements. (These modifications are detailed in Chapter II.) The remainder still have old, first-generation J-57 engines; these are designated KC-135As. The limited thrust from the J-57 engines means dependence on long runways--more than 10,000 feet at maximum gross takeoff weight (297,000 pounds). Even from long runways, KC-135As rely on demineralized water for a mechanically troublesome water-injection system that provides additional thrust for takeoff. Both the runway and water requirements limit geographical access and/or impose fuel-capacity constraints, and thus they hamper the tankers' operational flexibility and fuel-carrying capacity. For instance, the water-injection takeoff system limits operation of KC-135As in places where demineralized water is scarce, such as some parts of the Middle East. In the United States, costly water-processing facilities and tank trucks are located at bases with permanently assigned KC-135As. During the winter, water must often be heated; at air temperatures below 20 degrees Fahrenheit, water must be drained from the aircraft so it will not freeze in the engines before or during takeoff. Moreover, even with water injection, in many places the KC-135A cannot take off with a maximum fuel load for lack of sufficient runway length.

According to the Air Force, the J-57 engine on KC-135As is also becoming more expensive to maintain. Its upkeep requires more man-hours per flight hour than do any of the re-engined aircraft. But its performance statistics are still generally good, because money is being spent to replace the components that have shown the most deterioration. ^{2/} The cost of these repairs for the total fleet is about \$135 million (in fiscal year 1984 dollars), of which roughly half has been spent to date. If these aircraft continue to operate into the 1990s, more complete overhauls may be needed.

Many of these problems will be resolved with the re-engined aircraft described in Chapter II. The Air Force is also beginning to receive 60 new KC-10 tanker/cargo aircraft, which are being bought primarily to correct a shortfall in airlift capacity. Today, however, the tanker fleet still consists mainly of unmodified KC-135As.

Because the requirements planned for use of the tanker fleet will determine the success of ongoing, planned, or proposed efforts to upgrade it,

2. These include improvements to or replacement of the turbine area, fuel manifold, combustion case, and compressor blades.

the remainder of this chapter details the demands placed on the fleet. ^{3/} These demand projections underlie the Congressional Budget Office's (CBO) analysis of possible options for improving aerial refueling resources.

Features Stimulating Tanker Demand

Planning by DoD reflects the fact that any military plane, whether conventional or strategic, combat or support, gains several clear advantages if it can be refueled in midflight. One, of course, is *extended range*. An obvious associated benefit is *promptness*. For example, fighters deploying from Langley Air Force Base in Virginia to Dhahran, Saudi Arabia, can get there in 15 hours non-stop with air-refueling rather than 47 hours by landing en route to refuel. Another benefit is *security*, because basing for combat aircraft can usually be kept to safe areas. ^{4/} Still others are *flexibility* and *autonomy*; aerial refueling obviates the need for combat planes to follow routes with midcourse, land-based refueling stations and avoids reliance on other nations' cooperation. Finally, aircraft fueled in flight are spared the wear and tear associated with extra landings and takeoffs.

Complicating matters, and indicating that pressure on tanker resources will continue to mount, is tanker aircraft *versatility*. Support of the strategic bomber force--today some 300 aircraft--is still the first-priority mission of the entire KC-135 tanker fleet, and the one that consumes by far the most resources. To this end, about 30 percent of the aircraft and their crews "stand alert" around the clock, ready to take off and execute their missions within minutes of notification. The nearly 200 tankers on daily alert are not available for other missions. ^{5/}

In addition to their primary role of supporting strategic bombers, tankers today are also relied on heavily to support most air missions--including conventional bombing, tactical fighter deployment and employment, and airlift operations. Tankers are also used in many day-to-day operations worldwide, including support of training and military exercises and a wide

-
3. The Defense Guidance (DG) scenario guides general-purpose force planning, while the Single Integrated Operational Plan (SIOP) guides strategic nuclear force planning.
 4. Basing is not always limited to safe areas, since other considerations such as peacetime training must also be addressed. With aerial refueling, however, the option exists to disperse aircraft to safe bases in times of heightened tensions.
 5. Normally, about 5 percent of the tanker fleet is in the maintenance "pipeline." Tankers on daily alert represent about 30 percent of the 615 Primary Authorized Aircraft (PAA) -- those not in the pipeline.

variety of other military tasks. For instance, tankers support military cargo aircraft carrying supplies and equipment to remote areas such as in Europe and South America. In Saudi Arabia, U.S. tankers support Airborne Warning and Control System (AWACS) aircraft in their ongoing surveillance effort to stabilize the Persian Gulf region.

PROJECTED DEMAND FOR TANKER RESOURCES

Trends in demand for tankers for both the near and long term can influence the choice of how to improve the fleet and when. The demand projection is a dynamic not a steady one, shifting as a result of changes in force structure and force use, as well as general U.S. defense policies and commitments. Four primary factors are influencing demand for tanker capacity:

- o A growing proportion of conventional military aircraft now equipped and slated for in-flight refueling,
- o A near-term increase in fuel-demanding missions for the strategic bomber force,
- o The Air Force's procurement of newer, more fuel-efficient aircraft, and
- o The United States' commitments to its allies.

Trends indicate that current tanker resources probably fall short of today's demand as determined by Air Force estimates. In the near term, demand is likely to continue to grow. Then, however, it may well decline somewhat, with the shift occurring around 1990. Efforts to address the problem of tanker "shortages" should therefore take into account this early peaking and later tapering of demand.

Pressure from the Strategic Forces--An Increasing and Receding Pattern

Demand for tankers to support strategic forces will likely rise in the next few years, increasing the tanker shortfall. By the end of the decade, however, tanker demand should decline. This pattern primarily reflects changes in anticipated numbers of bombers in Air Force inventories and the missions assigned to them.

As part of the Administration's plans for the strategic forces announced in October 1981, the bomber force is being modernized with two

new aircraft: 100 B-1B bombers are currently being fielded; 132 Advanced Technology Bombers (ATBs) incorporating "stealth" radar-evading technologies are planned to be fielded starting in the early 1990s. ^{6/} The ATB is considered necessary to maintain the ability to penetrate upgraded Soviet air defenses. After the Air Force introduces many of these new bombers, it will gradually retire the aging B-52s. In the interim, however, there will be more bombers than there are today, pushing up tanker demand in the coming few years.

The types of missions planned for strategic bombers will also exert pressure on demand in the near term, but in later years, that pressure is seen to diminish. B-52 bombers are being modified to carry cruise missiles (relatively small missiles able to be released from aircraft at long ranges and to travel to their targets on their own power). All B-52G models have been modified by now, and plans are proceeding to modify the B-52Hs. All B-1Bs are planned to be able to carry cruise missiles, but ATBs are not planned to carry cruise missiles.

The missions designated for B-52s carrying cruise missiles will proceed in two phases. The first--called the "shoot-and-penetrate" mission--involves installation of cruise missiles on pylons under the wings, with the internal bomb bays remaining loaded with short-range weapons. The bomber first launches the cruise missiles before entering enemy airspace and then continues at low altitudes to launch short-range weapons.

The shoot-and-penetrate profile calls for a lot of fuel, because the bomber is to be heavily loaded before releasing its cruise missiles, and then it must be able to fly long distances at low altitudes (at which jet engines are inefficient) to release its short-range weapons. The external cruise missiles also significantly increase the air resistance ("drag") the aircraft faces. According to an earlier CBO study, average tanker requirements increase by 34 percent for each bomber affected. ^{7/} This mission is most prominent through the 1980s, substantially increasing the demands on the supporting tanker force. Figure 1 shows how strategic bomber force missions will evolve over the coming 10 years in light of Administration plans.

The second mission, which B-52 bombers will begin to assume in the late 1980s, will reduce tanker requirements. This mission involves cruise-

6. See remarks of Senator Carl Levin, *Congressional Record*, December 3, 1982, p. S14378.

7. Congressional Budget Office, *Aerial Tanker Force Modernization*, page 14.

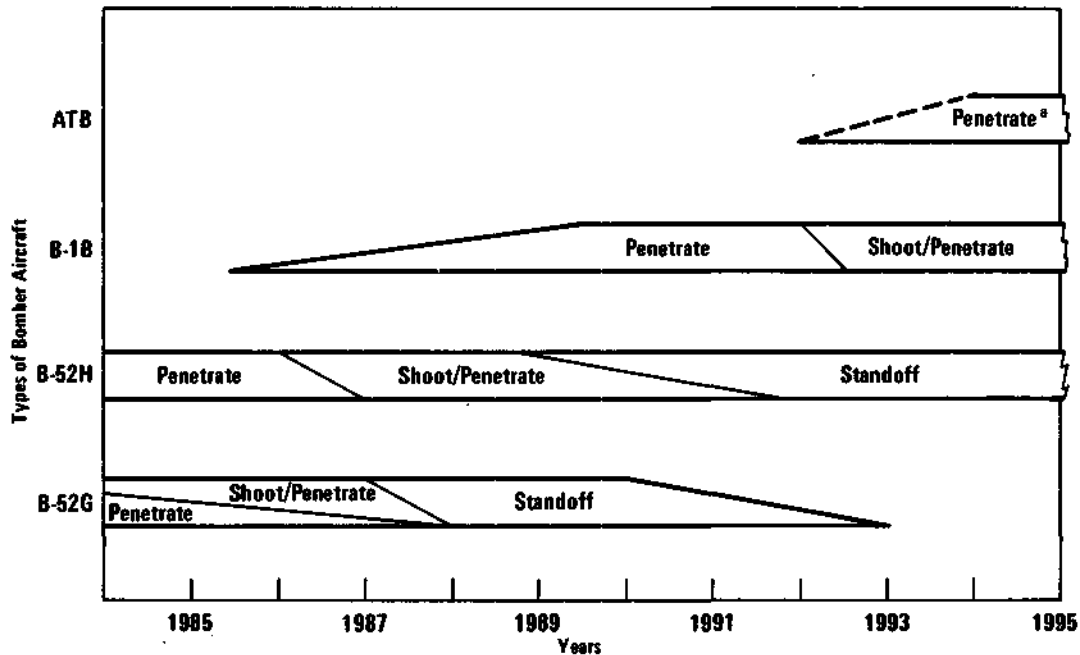
missile carriage only. By then, these bombers would not carry short-range weapons that require flight in enemy airspace, because Soviet air defenses are presumed to be too taxing for B-52 operations. Since these so-called "stand-off" bombers capable of launching long-range missiles could avoid long flight at low altitude, fuel requirements--hence demand for tanker support--would decline substantially.

Strategic force demand for tankers is seen declining in the 1990s for other reasons as well. By then, the bomber force will consist of fewer and more fuel-efficient aircraft because of modernization efforts now under way. According to Air Force estimates, new engines on the B-1 will generally be more fuel efficient than those of the B-52. Fuel efficiency of the ATB should be at least as good as that of the B-1.

Pressure from the Conventional Forces--A Similar but Less Certain Pattern

Demand for tanker support for conventional forces is harder to project. Whereas strategic nuclear missions are based on quite detailed plans de-

Figure 1.
Development of U.S. Strategic Bomber Force Missions
Projected to Fiscal Year 1995



SOURCE: Congressional Budget Office, based on Department of Defense information.

^aInitial introduction of the Advanced Technology Bomber is planned for the early 1990s.

signed to change little once an attack begins, conventional missions are far less prescribed and are subject to spontaneous adaptation to circumstances.

In DoD plans stressing rapid force projection abilities for the conventional forces, the role of aerial refueling has been growing substantially in recent years, figuring prominently in plans for a conventional NATO conflict in Europe as well as for contingencies elsewhere. Current objectives for U.S. support of the NATO allies call for moving six Army divisions and 60 tactical fighter squadrons to Europe within the first ten days of a war. ^{8/} Tanker support would figure heavily in meeting those goals. Tankers would serve not only to support fighters and transports on the way to a theatre of combat, but would also augment operations of tactical fighters. With aerial refueling, fighters running low on fuel but still carrying unexpended weapons could continue their missions. Other aircraft, such as long-range surveillance AWACS and conventional bombers, would also rely on inflight refueling.

Though the effects on tanker demand of conventional forces are less clear than for strategic forces, they tend to reinforce the near-term increase and long-term decline noted above. Tactical fighter forces, which account for most conventional-force demand for tankers, are planned to expand from the current 36 wings to 40 by 1991, an increase of about 300 aircraft. (Plans for this expansion, however, have been delayed each year since 1982.) Moreover, the composition of those forces is slated to change dramatically. The fuel-inefficient F-4 fighters introduced in the 1960s--each requiring one tanker just to cross the Atlantic, rather than one tanker per several new F-15 fighters--currently make up about 30 percent of the tactical air forces. By 1991, however, according to Administration plans, F-4s would account for only about 7 percent. (Figure 2 shows the planned composition of the tactical fighter force over time.) Thus, the conventional forces' demand on aerial tankers could decline, complementing the likely decline in demand from strategic forces.

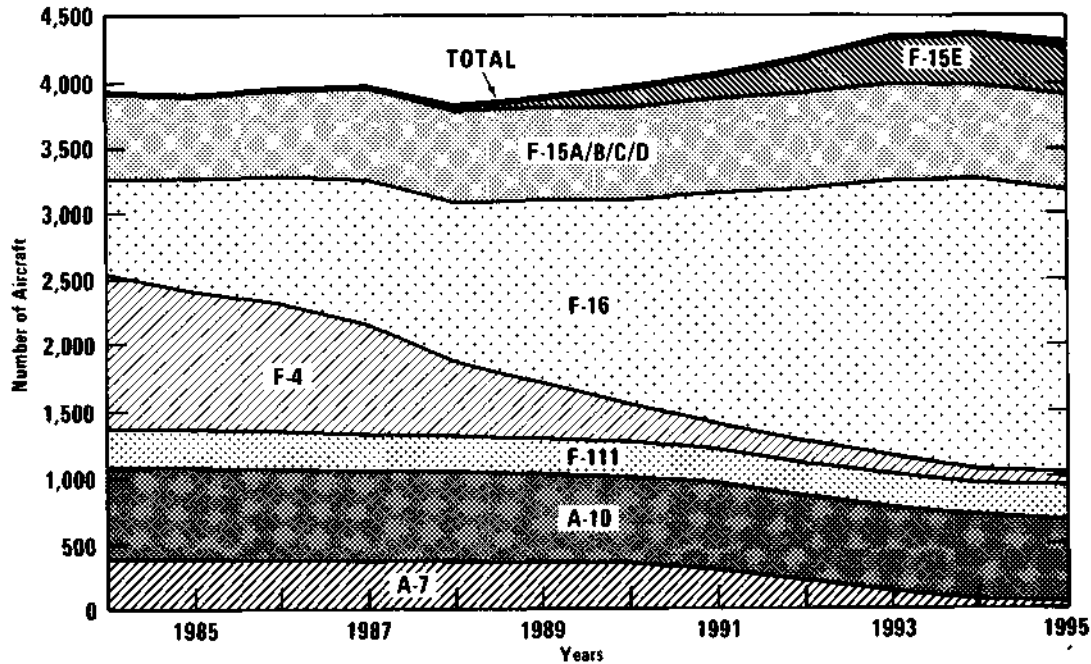
Benchmark for Tanker Demand

Though official tanker requirements are classified, rough estimates are publicly available. Tanker requirements are usually stated in "KC-135A equivalents," using the fuel-delivery capacity of the current tanker as the basis for comparison. ^{9/} Thus, a KC-135A equals one tanker equivalent. A modified

8. Department of Defense, *Annual Report to the Congress, Fiscal Year 1985*, p. 175.

9. Fuel-delivery capacity varies as a function of distance from takeoff base. The capacity of the KC-135A for an average mission -- 63,000 pounds at a 2,500 nautical mile radius -- is used as the analytic baseline for comparing tanker capacity improvements.

Figure 2.
Development of U.S. Tactical Air Forces
Projected to Fiscal Year 1995



SOURCE: Congressional Budget Office, based on data provided by the U.S. Air Force.

KC-135R, with its new engine increasing fuel-delivery capacity by 50 percent, represents 1.5 tanker equivalents. Still another modification with a refurbished engine, the KC-135E, is valued as 1.2 tanker equivalents. The new KC-10 aircraft capability is expressed as three tanker equivalents. (Table 1 in Chapter II gives further details on the tanker modifications.)

A Department of Defense response of March 1984 to a study by the General Accounting Office (GAO) states that "... the DoD knows that at least 1,000 tanker equivalents are required, and depending on events and future weapon system needs, significantly more may be required." ¹⁰ Thus, in this analysis the CBO has used 1,000 as a lower bound for what DoD believes is currently required, although peak tanker requirements may rise

10. DoD response of March 16, 1984, to GAO report, "Potential for Reducing Costs by Using More JT3D Engines in the KC-135 Reengining Program (GAO/NSIAD-83-47)," September 23, 1983, p. 7.

well above this level. Below that level, the risk would be highest of having to divert tanker resources dedicated to the strategic mission to meet conventional demand.

Using the above capacity ratios, *current tanker fleet capacity is now about 800 KC-135A equivalents--about 200 short of the lower bound.*

CHAPTER II

APPROACHES TO

MEETING TANKER NEEDS

Efforts to modernize and expand U.S. aerial refueling capacity are under way. To date, the Air Force has taken three general approaches. Two involve re-engining and otherwise improving the performance of existing KC-135A tankers. The third involves procurement of a new tanker/cargo aircraft, the KC-10. (Table 1 gives comparative details on all aircraft.) The relative costs of these methods differ considerably, as do the improvements they can yield, and the speed with which they can be accomplished.

APPROACHES TO MODERNIZATION

Between 1977 and 1985, \$2.7 billion was budgeted for re-engining the tanker fleet's KC-135As and \$3.3 billion (in current dollars) for procurement of KC-10s. Under contracts initiated through 1985, the Air Force will have funded 230 re-engined tanker aircraft and will have procured 40 KC-10s.

Re-Engining with the CFM-56--the KC-135R Tanker

According to the Air Force's preferred course, the old J-57 engines on unmodified KC-135As are being replaced with a new, higher-thrust turbofan engine designated the CFM-56. Both the current J-57 engines and the constraining water-injection system described in Chapter I are being replaced with this modification. The program also includes modernization of a number of systems and subsystems, including strengthened main landing gear, auxiliary power units and some new instrument and control systems. Most of these other modifications were required to accommodate the aircraft's more powerful CFM-56 engines, which also increase its fuel-carrying capacity. The result, according to the Department of Defense, will be a KC-135R able to deliver, on average, 50 percent more fuel than can its predecessor. Part of this increased delivery capacity can be attributed to a 27 percent improvement in the engine's fuel efficiency. ^{1/}

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1. Estimates here and elsewhere are based on average fuel-delivery capacities of the aircraft at specified distances, and are quite sensitive to the ranges and diversity of missions.

TABLE 1. OPERATIONAL AND SUPPORT CHARACTERISTICS OF FOUR TANKER AIRCRAFT

	KC-135A	KC-135R	KC-135E	KC-10
Operational				
Maximum Gross Weight (in pounds)	297,000	322,500	299,000	590,000
Fuel Load at Maximum Gross Weight (in pounds)	189,700	202,800	189,700	359,000
Takeoff Distance at Maximum Gross Weight (in feet, at 90 degrees Fahrenheit)	11,200	8,100	9,600	8,800
Fuel Delivery Capacity at 2,500-Nautical-Mile Radius (in pounds)	63,000	94,500	75,600	162,000 <u>a/</u>
Fuel-Efficiency Improvement Relative to KC-135A (in percents)	--	27	14	<u>b/</u>
Smoke Pollution Reduction Relative to KC-135A (in percents)	--	92	74	<u>b/</u>
Compliance with Commercial Noise Standards	No	Yes	No	Yes
Support				
Maintenance Man-Hours per Flight Hour (engine only)	3.20	0.70	1.00	<u>c/</u>
Engine Removal Rate (per 1,000 Flight Hours)	0.83	0.28	0.41	<u>c/</u>

SOURCE: Congressional Budget Office from data provided by U.S. Air Force.

- a. At longer mission distances, the ratio of fuel delivered by the KC-10 relative to the KC-135A's increases significantly.
- b. Not directly comparable to the KC-135A.
- c. Logistic support for the KC-10 is being managed by McDonnell Douglas and does not have comparable statistics. However, the aircraft is exceeding all contractual requirements regarding reliability and maintainability.

In addition, even with its greater fuel-delivery capacity, the KC-135R requires a much shorter runway for takeoff. This, along with ended reliance on water-injected thrust, improves the basing and flight flexibility of the aircraft. According to the DoD, the KC-135R can, for instance, operate from 130 more airfields in the United States than can the KC-135A. 2/

The KC-135R program does have an important initial drawback. The "lead time" for the KC-135R--the span from funding approval to delivery of the re-engined aircraft--is about two and a half years. As of September 1985, only some 28 KC-135Rs have been delivered to the fleet. Budgetary restrictions account for the lag. When new aircraft are procured, long-lead-time items, such as engines and landing gear, are bought in advance of funding approval for the full aircraft; the aim is to minimize the time from full funding approval to delivery. Modification programs, however, are not subject to advance procurement. 3/ Because of its lengthy lead time, reliance on the CFM-56 re-engining program significantly affects the near-term prospect for modernizing and adding capacity to the fleet.

The Air Force program currently calls for funds for re-engining 287 aircraft through the five-year plan (1986-1990), at a total cost of about \$5.7 billion. 4/ The average cost for the re-engined KC-135R (not including research and development) is \$20.8 million per aircraft. Annual operating and support costs are \$2.3 million per aircraft. (Operating costs include fuel, maintenance, and pay for crew and other direct and support personnel. Obviously, this figure can fluctuate widely with fuel costs and annual numbers of flying hours.) 5/

Re-engining with the JT-3D--the KC-135E Tanker

Another re-engining approach--a quicker and cheaper one--has also been undertaken, namely to salvage and refurbish JT-3D engines and related equip-

2. The DoD response of 16 March 1984 to General Accounting Office final letter report: "Potential for Reducing Costs by Using More JT-3D Engines in the KC-135 Reengining Program," dated September 23, 1983, p. 2. The Air Force explained in more detail that, while most of these airfields could not support peacetime tanker operations, they could be used for emergency situations requiring force dispersal for safety.
3. One exception can apply in the case of multi-year funding, which requires a commitment for given quantities over several years. The Air Force requested approval for multi-year funding for the KC-135R in fiscal year 1984, but the request was not approved by the Congress.
4. This total includes obligations occurring beyond 1990 for installation of the kits.
5. Numbers here and elsewhere in the study assume 305 hours of flying per year per active force tanker and \$0.94 per gallon fuel prices, based on Air Force data.

ment from Boeing 707s retired from commercial service. Commercial operators are retiring these planes because they fail to meet the Federal Aviation Administration's (FAA) noise and emissions standards effective in U.S. airspace as of January 1985. ^{7/}

Because it exploits existing aircraft of little economic value in civilian markets, this modification is substantially less expensive for the military than procuring new engines. At the same time, the JT-3D modification is far narrower in scope than CFM-56 re-engining. It does not include new auxiliary power units, for example, or new generators. (Other points of comparison between the two re-engining programs are detailed opposite.)

The average cost for the JT-3D re-engined aircraft, designated the KC-135E, is \$4.1 million--about one-fifth the cost of the KC-135R. Annual operating and support costs for the KC-135E are about \$2.3 million per aircraft, the same as for the KC-135R, but in times of rising fuel prices they could be higher. ^{7/} The JT-3D engine may also incur the added expense of a major overhaul after 15 years, adding another \$250,000 per aircraft (in fiscal year 1985 dollars). ^{8/} In contrast, the CFM-56 engine is not expected to need a major overhaul over the system's life.

According to DoD estimates, the JT-3D modification will yield a KC-135E tanker with fuel-delivery capacity improved by an average of 20 percent over its predecessor, attributable in part to an increase of about 14 percent in its own fuel efficiency. Like the KC-135R, the refurbished E version will require a shorter takeoff distance and so will have access to more airfields. The incorporation of thrust reversers will also give the KC-135E some landing ability that the costlier KC-135R lacks. (Thrust reversers redirect engine output to help stop an aircraft during landing. With them, a KC-135E on an icy runway could land with more fuel remain-

6. Federal Aviation Regulations, Part 36.

7. Operating and support costs for the KC-135E are estimated to be about \$0.04 million more than for the KC-135R. KC-135E operating costs include more for fuel than the KC-135R; thus, rising fuel prices would make operating and support of the KC-135E more expensive relative to the KC-135R.

8. The refurbished engine is expected to operate about 6,000 hours before requiring a major overhaul. That translates to about 15-20 years of operation, depending on whether the aircraft is being flown in the active force or Reserve forces--which fly more hours.

KC-135R	KC-135E
Adds new engine instruments	Adds used engine instruments
Has no thrust reversers	Has thrust reversers
Adds fire detection/extinguishing system	--
Adds turbine engine monitor	--
Adds new generators	Adds used 707 generators
Adds new airbleed system	--
Adds dual auxiliary power unit for quick start	Adds cartridge start system
Adds new series yaw damper	Adds 707 yaw damper
Adds flight control augmentation system	--
Adds new rudder actuator	--
Adds strengthened main landing gear	--
Adds rudder pedal controlled nose steering	--
Adds new air data computer	--
Reduces smoke pollution below KC-135A by 92 percent	Reduces smoke pollution below KC-135A by 74 percent

IMPROVEMENTS COMMON TO BOTH AIRCRAFT

Removal of water injection system
 Enlarged horizontal stabilizer
 Addition of 5-rotor brakes
 Addition of Mark III antiskid system

ing--which makes the aircraft heavier and harder to stop--than could a KC-135R, which lacks thrust reversers.) 9/

9. The commercial version of the CFM-56 engine has thrust reversers, but owing to cost and weight considerations, coupled with the lack of a stated requirement, the Air Force chose to have them removed in the military version of the engine. On an icy runway, with 10,000 pounds of fuel remaining, thrust reversers enable the KC-135E to land on a 5,565-foot runway, while the KC-135R requires 6,450 feet. The runway length requirements for takeoff (at mission effective weight), however, greatly exceed those for landing for both aircraft, and the KC-135R can take off from a somewhat shorter runway than the E version. Thus it would be difficult to quantify any operational advantage provided by thrust reversers; however, they do provide an added margin of safety and for that reason, they are found on all commercial aircraft. According to the Air Force, the cost of incorporating thrust reversers on future modifications would be \$2.5 million to \$3.7 million (in fiscal year 1984 dollars) per aircraft.

Both re-engining modifications allow removal of the troublesome water-injection system, significantly improving geographical flexibility. Unlike the CFM-56 engine, however, the JT-3D does not meet the new U.S. noise and emissions standards. Although the military is exempt from these regulations, the KC-135R with its new engine will comply with them.

Ultimately, KC-135E re-engining may be limited by the supply of "donor" Boeing 707 aircraft, the source of components for the modification. Interestingly, though, there is no constraint on the supply of engines, since a surplus of engines is now available. But other parts, such as some cockpit instruments, must come from the donor 707s. The remaining supply of donor aircraft now totals about 500 worldwide, and most are owned by non-U.S. airlines. How many of these 500 aircraft are or will be available remains uncertain. In 1987, the International Civil Aviation Organization will adopt the environmental regulations now in effect in the United States, which may greatly increase the availability of donor aircraft.

Several companies, however, have begun manufacturing "hush kits," to bring 707s into compliance with the new noise abatement regulations; this may dampen the prospects of a substantial future supply of donor aircraft. Hush kits reportedly sell for between \$2 million and \$3 million.^{10/} Although demand for the kits has not been very strong to date (fewer than 100 kits have been sold so far), it is not clear how many of the 500 potential donor aircraft may become unavailable to the military by using hush kits to remain in commercial service. The kits may also raise the cost of donor aircraft, since the sellers would now have an alternative use for them. Nonetheless, it seems likely that a substantial number of aircraft would be available at costs well below those of the CFM-56, if the Administration and the Congress chose to act quickly and pre-empt private-sector competition.

Moreover, because the KC-135E modification uses existing parts and is less comprehensive than the KC-135R modification, lead time is also significantly shorter--less than six months, compared to two and one-half years. Thus, the E model is available to the fleet much sooner, which may be important in addressing near-term demand.

The active-duty Air Force has expressed concern about the condition of foreign-owned 707 aircraft engines and instruments. According to an unofficial spokesman for the FAA, however, all Boeing aircraft available worldwide were built to meet U.S. aviation standards, and all but a few have

10. For details, see *Aviation Week and Space Technology* (November 12, 1984), pp. 157-160.

probably received continued care and maintenance in accordance with international civil aviation standards. Furthermore, any lapses in maintenance are far more likely to have had a deleterious effect on the engines than on the airframes themselves. Since there is a surplus of engines, if an aircraft were found to have unsuitable engines, other engines could be substituted, with the airframe components still coming from donors.

The active-duty force has raised other concerns, namely potential maintenance and support problems. Since the JT-3D engines come from many sources, there is more variation among the parts than if they had all been operated and maintained by the same user. This potentially makes them more difficult than new engines to maintain and support. The JT-3D, however, is basically the same TF-33 engine currently in the active-duty force on B-52H bombers, as well as on other Air Force aircraft; 80 percent of the JT-3D engine parts are common with these engines and are listed in federal stock. Spokesmen at the Air Force Logistics Center which manages KC-135 depot maintenance say that remaining nonconforming parts can be replaced in the course of regular maintenance and attrition. ^{11/} Furthermore, about \$8.0 million has been allocated so far to improving conformity among the engines. Perhaps most important, the Air National Guard has said that the aircraft have so far posed no maintenance problems. ^{12/} Guard mechanics are generally much more experienced than their active-force counterparts; they also tend to work on the same plane and so become familiar with its individual quirks. Nonetheless, the Guard's experience should moderate concern about the Air Force's ability to maintain KC-135E aircraft.

The KC-135E and the Reserve Forces

In sum, the refurbished E version of re-engining is available earlier at about 20 percent of the cost of the R version, and with 40 percent of the increase in capacity. Yet the Administration has never requested the refurbished E version, perhaps because the E has been viewed as diluting support for the more capable R program. Since 1982, JT-3D re-engining has been undertaken only at the direction of the Congress and has been designated only for tankers in the Air National Guard and Air Force Reserve. These are the oldest tankers in the fleet, and they were scheduled to receive CFM-56 re-engining last. Funds have been approved to provide all 128 Guard and Re-

11. Conversation at Oklahoma City Air Logistics Center, December 6, 1984.

12. Meeting with Air National Guard representative, February 7, 1985.

serve aircraft with JT-3D re-engining, with the last modifications to be completed in calendar year 1986. In addition, about 20 special mission aircraft have been modified with JT-3Ds, including the aircraft used by the Commander-in-Chief of the Strategic Air Command.

The Reserve Forces play an important role in the tanker mission, representing about 23 percent of the Air Force's aerial refueling capacity. ^{13/} They are more experienced, since most of their people have served on active duty. This is reflected in a higher "mission-capable" rate than for the active-duty force: 76 percent, in comparison with 65 percent. A disadvantage follows from their part-time status, however. Most Reserve personnel have other careers, hence less flexibility, than their active-duty counterparts--particularly with respect to "alert" commitments and overseas task forces. Heavier reliance on the Reserves also increases the chances that they would be needed in lesser crises than a major war; calling up the Reserves during such crises, though legally permissible, can be politically difficult.

Despite the differences in the active-duty and Reserve forces' abilities, the Congress has shown interest in substituting Reserve for active-duty personnel. The Reserves have also shown enthusiasm for the less expensive, JT-3D re-engining program. This suggests one option treated in Chapter III.

New Aircraft--the KC-10 Advanced Tanker/Cargo Aircraft

In the early 1980s, the DoD sought to expand tanker resources by taking advantage of the added capacity of new-generation wide-body commercial transports. The KC-10, a military version of McDonnell Douglas's DC-10, was the winner of a competition. Besides improved range and payload, the KC-10 offered the special attraction of being able to serve two functions--as tanker and cargo carrier. To date, however, the KC-10 has been procured mainly to augment the cargo fleet. ^{14/} At present, 36 KC-10s are in the Air Force's inventory, and delivery of another 24 is planned to be completed by 1987.

Nonetheless, the large KC-10--with a maximum gross takeoff weight of 590,000 pounds, compared to 297,000 pounds for a KC-135A--offers sub-

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13. Bennie J. Wilson, ed., *The Guard and Reserve in the Total Force* (Washington, D.C.: National Defense University Press, 1985).
 14. Although less efficient as a cargo carrier than other cargo carrier aircraft, such as the C-5, 60 KC-10s would be capable of augmenting the airlift fleet by as much as 9 percent.

stantial capacity as a tanker as well as an airlifter. It is also an entirely new plane, rather than a refurbished existing one, which may mean a longer period before the Congress would have to invest in a still newer tanker.

Not surprisingly, the KC-10 costs substantially more than either re-engining program. The average purchase price per plane (not including military construction) is \$74.1 million, over three times the investment cost of modification with the CFM-56 engine, the costlier of the two re-engining choices. Current operating and support costs are also significantly higher than for any KC-135, but only because the KC-10 is now operated largely as though for the airlift mission. The demands of airlift call for three crews per aircraft, compared to 1.27 crews for the tanker mission. With additional crews, the KC-10 is flown upwards of 400 hours a year, compared to around 305 for the KC-135. If further KC-10s were procured as dedicated tankers, they could be operated with the tanker crew ratio of 1.27 crews per aircraft, as with the KC-135s and operated the same number of hours per year. This would yield only somewhat higher operating and support costs than for the re-engined tankers--about \$2.9 million per year, or \$600,000 more than the CFM-56 re-engined tanker.

The KC-10 can carry more than 355,000 pounds of fuel, or almost twice as much as the KC-135A. Its fuel delivery capacity averages about three times that of the unmodified KC-135, depending on the range and mission assigned to it. It is equipped with both a boom (the long tube that most aircraft use to accept fuel in the air) and a hose and drogue (used mostly to refuel fighter aircraft), so that it can refuel several types of aircraft on one mission. 15/

When used as a tanker, the KC-10 is particularly effective in deploying fighter planes overseas, since it can carry much of a fighter squadron's personnel and equipment while also conveying fuel. The KC-10 could also be very effective in support of strategic bomber missions--especially the more fuel-intensive ones--because its large fuel-carrying capacity gives it greater relative efficiency at longer ranges. On the other hand, since the current KC-10s were purchased primarily for conventional airlift operations, they were procured without certain features that the Strategic Air Command insists are requirements for the strategic mission. An example is a quick start ability that allows rapid engine start and takeoff. Future procurement could include these features at no additional cost. 16/

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15. The KC-135 can also refuel fighter aircraft that require a hose and drogue, such as those in the Navy and with NATO allies, but an adapter kit must be installed on the ground beforehand. The KC-10's capability is built in.
 16. McDonnell-Douglas has offered to add these features provided it has a minimum commitment for 24 additional aircraft.

TABLE 2. RELATING TANKER COSTS AND CAPACITY--INVESTMENT AND ANNUAL OPERATING AND SUPPORT COSTS (Costs in millions of dollars, capacity in tanker equivalents)

Modernization Approach	Capacity Improvement per Unit Added	Units Needed to Add One Tanker Equivalent to Fleet	Investment Costs		Tanker Equivalents Per Unit Operated	Operation and Support Costs	
			Per Unit Procured	Per Tanker Equivalent Procured		Per Unit	Per Tanker Equivalent
KC-135A (Baseline)	--	--	a/	a/	1.0	2.5	2.5
KC-135R	0.5	2.00	20.8	41.6	1.5	2.3	1.5
KC-135E	0.2	5.00	4.1	20.5	1.2	2.3	1.9
KC-10	3.0	0.33	74.1	24.5	3.0	2.9	1.0
KC-10 if Replacing KC-135A in Fleet	2.0	0.5	74.1	37.1	--	--	--

SOURCE: Congressional Budget Office.

a. Procurement of the basic KC-135A was completed in the early 1960s.

Should the Congress plan to buy more than the full complement of 60 now planned for purchase through 1987, it must act soon. Although final assembly will still be in the works through 1987, without long-lead money in 1986 for additional aircraft orders, the production line will soon close for new orders; subcontractors will have completed their work on long-lead items for the current order. Thus, the opportunity to buy a new tanker, for which research and development costs have been largely amortized, may soon disappear.

HOW THE APPROACHES MEASURE UP IN COST EFFECTIVENESS

How much improved aerial refueling capacity can investment dollars buy? The answer to this question--essential in assessing the relative merits of the approaches--lies in what it costs to add a given unit of capacity (a tanker equivalent) to the fleet. By investing \$20.8 million in a KC-135R, for example, the Air Force can add one-half of a tanker equivalent to the fleet (see Table 2). To increase capacity by a full tanker equivalent, the Air Force would have to spend \$41.6 million on two KC-135Rs. By this measure, the KC-135E, costing a modest \$4.1 million per unit purchased, is the most economical approach. Though five KC-135Es would have to be purchased (because one E modification adds only 0.2 tanker equivalents), the investment cost for a full additional tanker equivalent would come to only \$20.5 million, or \$21.1 million less than for the R version. Again by this measure, the expensive KC-10, surprisingly, can be more cost effective than the KC-135R, despite its \$74.1 million purchase price per aircraft. For that sum, the Air Force can add three tanker equivalents. If a KC-10 is merely added to the fleet, its investment cost per single added tanker equivalent is just \$24.5 million; if instead it replaces a KC-135A, its unit price per tanker equivalent rises to \$37.1 million, closer to but still less than the investment cost of the KC-135R.

In comparing operating and support costs, this ranking changes--although the differences among them are significantly smaller, less than \$1 million a year. In these terms, the KC-10 emerges as the most economical choice and the KC-135E as the least. The KC-135R falls midway between. Compared to the annual \$2.5 million the Air Force now spends on upkeep for its KC-135As, any of these tanker improvements offer cheaper operation and support.

CHAPTER III

OPTIONS FOR IMPROVING TANKER RESOURCES

Consideration of how to proceed with upgrading the tanker fleet must focus primarily on three issues:

- o **Modernization** -- How soon would modernization efforts allow the Air Force to phase out its operationally hampered KC-135As?
- o **Timing and Capacity** -- How would the pace toward the tanker fleet's minimal needed improvement mesh with projected demand?
- o **Cost** -- How much money can realistically be committed to tanker modernization--especially in light of recent efforts to curb growth in defense spending?

In deliberating about how to continue improving the fleet, the Congress will inevitably face some tradeoffs. Maximum capacity and optimal timing, for example, may be achievable only at high cost. More moderate expenditures might still purchase the capacity needed, but perhaps too late. And better pacing might be managed for still less money, but at appreciable sacrifice in aerial refueling capacity. Narrowing the debate to any one of the modernization approaches now under way can worsen the effects of such tradeoffs. The Congressional Budget Office has therefore studied options that entail combinations of these approaches.

WHY MIX THE MODERNIZATION APPROACHES?

No one of the approaches described in Chapter II can fully satisfy the concerns noted above. Depending on the KC-135R alone would mean high costs and likely slow progress. In contrast, depending only on the KC-135E could be quite economical and timely, but would not produce so much long-run improvement in tanker capacity. Turning exclusively to the KC-10, while achieving appropriate capacity and promptness, might be so costly as to invite a backlash effect further delaying and/or scaling down modernization efforts.

Each of the alternatives to the Administration's program that the Congressional Budget Office has examined, therefore, features combinations

of the approaches. The options are distinguished by the emphases they place on each modernization approach; none relies solely on one approach. (Table 3 displays the procurement profiles for each option.) One alternative mix--emphasizing JT-3D re-engined KC-135Es--provides modestly greater capability in the near term and significantly faster modernization at a lower cost than does the Administration's program. A variation of that option, and really a first step toward it, Option IIA looks at some additional transfer of KC-135Es to the Reserve forces, with whom the KC-135E has been very popular. Another alternative mix, emphasizing additional procurement of KC-10s, offers substantially more capability than the Administration's program for similar costs.

Basis for the Analysis

To depict the overall capacity achievable by enacting each option (see Table 4), the CBO has used the Air Force's procurement commitments through 1985 as the status quo of the aerial refueling improvement effort. That is, analytic assumptions for all options include prior authorizations for re-engining 102 KC-135R tankers, 128 KC-135E tankers in the Reserve forces, and continued multi-year procurement of 60 KC-10 tanker/cargo aircraft to be completed in 1987. The CBO has also applied Air Force estimates for comparing the aircrafts' capability, which is based on their average fuel-delivery capacity relative to that of the unmodified KC-135A over an average mission distance. By this method (as noted in Chapter II), the Air Force estimates the KC-135R to be a 50 percent improvement over the unre-engined KC-135A, or the equivalent of 1.5 KC-135As. The KC-135E is considered the equivalent of 1.2 KC-135As. And the KC-10 is considered the equivalent of three KC-135As.

These estimates have certain significant limitations. As averages, they are fairly sensitive to the diverse ranges of missions assigned to the fleet. In analysis, the large KC-10 tanker/airlifter, for example, shows a relative improvement of less than 200 percent for missions of shorter distance and greater than 200 percent for longer missions, on which its sizable fuel-carrying capacity can be fully exploited. Also, as the number of re-engined tankers increases, or as overall demand declines, the marginal contribution of each improved tanker declines.

OPTION I. THE ADMINISTRATION'S PLAN EMPHASIZING THE KC-135R TANKER

Initiated in 1977, the Administration's plan for 1986 through 1990 emphasizes the KC-135R tanker featuring the powerful new CFM-56

TABLE 3. PROCUREMENT UNDER THE OPTIONS, FISCAL YEARS 1986-1993

Options and Items Procured	1986	1987	1988	1989	1990	Subtotal 1986- 1990	1991	1992	1993	Total 1986 to Completion
Option I										
CFM-56 Re-engining Kits	43	50	50	72	72	287	72	53	--	412
KC-10 Aircraft	12	8	--	--	--	20	--	--	--	20
Option II										
CFM-56 Re-engining Kits	36	36	36	36	36	180	7	--	--	187
JT-3D Re-engining Kits	33	48	48	48	48	225	--	--	--	225
KC-10 Aircraft	12	8	--	--	--	20	--	--	--	20
Option III										
CFM-56 Re-engining Kits	30	30	30	30	30	150	--	--	--	150
JT-3D Re-engining Kits	30	48	48	48	26	200	--	--	--	200
KC-10 Aircraft	12	8	8	8	8	44	8	8	8	68

SOURCE: Congressional Budget Office.

NOTES: Actions up to 1986 include approved purchases of 102 KC-135R re-enginings, 128 JT-3D re-enginings, and 40 of the total planned purchase of 60 KC-10 tanker/cargo aircraft.

TABLE 4. COMPARISON OF THE OPTIONS: CAPACITY, PERCENT MODERNIZED, AND INVESTMENT COSTS, FISCAL YEARS 1986-1995 (Capacity in tanker equivalents, costs in billions of 1986 dollars)

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Option I. The Administration's Plan Emphasizing the KC-135R Tanker										
Tanker Capacity	843	895	912	934	958	989	1,025	1,043	1,097	1,105
Percent Modernized	35	40	45	51	58	67	77	87	98	100
Investment Costs	1.27	1.13	1.02	1.42	1.45	1.39	0.99	0.03	0.03	0.00
Option II. Emphasizing the KC-135E Tanker										
Tanker Capacity	846	908	934	962	989	1,011	1,029	1,038	1,038	1,038
Percent Modernized	37	49	61	73	85	92	97	100	100	100
Investment Costs	1.29	1.04	0.93	0.92	0.95	0.18	0.02	0.00	0.00	0.00
Option III. Emphasizing the KC-10 Tanker/Cargo Aircraft										
Tanker Capacity	836	908	958	1,006	1,039	1,063	1,082	1,096	1,096	1,096
Percent Modernized	37	49	61	72	85	91	96	100	100	100
Investment Costs	1.18	1.30	1.24	1.29	1.24	0.46	0.38	0.22	0.00	0.00

SOURCE: Congressional Budget Office.

NOTES: Actions up to 1986 include purchase of 102 KC-135R re-enginings, 128 KC-135E re-enginings, and 40 of the planned total purchase of 60 KC-10 tanker/cargo aircraft. Numbers in bold type indicate capacity at or above the benchmark demand estimate of 1,000 tanker equivalents, and completed fleet modernization.

engine. As of its February 1985 budget, the Administration planned to have funded re-engining for 287 KC-135Rs in 1986-1990 (see Table 3). Testimony suggests that, in later years, the Administration has plans for continued conversion until the entire fleet consists of KC-135Rs, plus the 60 KC-10s now being introduced. ^{1/} This study assumes that, in the years beyond 1990, re-engining of KC-135As with the CFM-56 would continue to completion at the maximum planned pace of 72 aircraft a year, for a total purchase of 412 KC-135R tankers in 1986 and beyond. The active-force tanker fleet would consist of 514 KC-135Rs, including 102 that were authorized before 1986.

Under this plan, total tanker force capacity would grow gradually, surpassing the benchmark of 1,000 KC-135A equivalents in 1992--after the likely peak of tanker demand has passed. Modernization would also proceed, though slowly. By 1990, 58 percent of the fleet would have been modernized with some form of re-engining. Modernization would be completed only as late as the mid-1990s.

The Administration's option has the advantage that it calls for purchase of a new engine that can furnish the greatest added refueling capability per re-engined aircraft. The CFM-56 modification also meets commercial noise limits and provides the greatest air pollution abatement.

At the same time, the Administration's option is expensive. Over the next five years, it would cost \$6.3 billion, requiring substantial real growth in spending on tankers. Costs to complete all re-engining and KC-10 procurement under the likely Administration's plan would come to \$8.7 billion. Yet, despite growth in the defense budget over the last several years, and despite emphasis on modernizing strategic forces, fiscal constraints and competing priorities in weapons systems have caused the CFM-56 tanker re-engining program to be cut back both by the Congress and the Department of Defense. ^{2/} The re-engining program of fiscal year 1983, for example, was designed to have funded 334 re-engined aircraft by the end of 1988, but the current program will have bought just 245 by that date (Table 5 compares the two programs). Whereas the original program planned to build

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1. In testimony before the Senate Armed Services Committee, February 1982, Secretary of the Air Force Verne Orr stated, "Over the long-term, the Air Force plans to re-engine all KC-135As with the CFM-56 engine."
 2. In fiscal year 1985, the Congress cut back the request for 31 re-engining kits to "at least" 24. With the funds available, the Air Force procured 30 kits. In fiscal year 1985, after the "Rose Garden" budget compromise, the DoD cut back the original re-engining request from 65 kits to 36. Expressing concern both about fiscal constraints and the tanker shortfall, the Congress, in turn, directed that 43 kits be procured.

TABLE 5. COMPARISON OF ORIGINAL AND CURRENT ADMINISTRATION PROGRAMS FOR KC-135R RE-ENGINEING (In numbers of units procured)

Fiscal Year	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total 1982-1990
1983 Plan	10	19	31	65	65	72	72	--	--	334
1986 Plan	10	19	30	43	43	50	50	72	72	389

SOURCE: Congressional Budget Office.

up to a maximum re-engineing rate of six aircraft a month (72 a year) by 1987, current plans--assuming no further cutbacks--will not achieve this rate until 1989. High costs could continue to impede the program if, as in recent years, the Congress seeks to curb growth in defense spending.

Continued slowdowns in the Administration's option would exacerbate its major fault: lack of timeliness. Already out of synchrony, the peak of demand and completion of the buildup in tanker capacity would be separated still further. Furthermore, the fleet would have to operate with unmodified KC-135As beyond the mid-1990s. As important, the basic KC-135 airframe now being re-engined is continuing to age, and by the mid-1990s, it will be about 35 years old, making continued investment in expensive KC-135R modifications increasingly less economical.

OPTION II. EMPHASIZING THE KC-135E TANKER

Stressing the KC-135E instead could avoid some of these problems of high cost and mistiming. As noted in Chapter II, because the KC-135E modification relies on aircraft that have, at least for now, lost their commercial economic value, it is both inexpensive and quick. The average \$4.1 million cost of JT-3D re-engineing is about one-fifth that of CFM-56 re-engineing, and the six-month turnaround period from funding to delivery is also one-fifth the time. This option would take advantage of emphasizing both re-engineing programs to yield cost-savings, faster modernization of the fleet, and somewhat greater near-term tanker capacity.

Under Option II, CFM-56 re-engining in most years would continue at the rate of three per month, close to its recent rate, for a total of 187 KC-135Rs over the period 1986-1991--225 fewer than envisioned in the Administration's likely plan (see Table 4). At the same time, 225 JT-3D re-enginings would proceed at a rate of four per month. This would complete re-engining of the 412 remaining KC-135As.

In the near term, overall tanker capacity under Option II would be modestly higher than under Option I, and the 1,000-tanker-equivalents benchmark would be passed a year sooner. The rate of modernization would be markedly improved over the Administration's program, with 85 percent of the fleet modernized by 1990 and all of it by 1993.

Moreover, costs would be lower. Five-year investment costs would be reduced by about \$1.2 billion, and total program savings would amount to about \$3.4 billion. This would help hold down growth in defense spending. (Table 6 compares investment costs of the alternatives relative to the Ad-

TABLE 6. ANNUAL INVESTMENT COSTS OF THE ALTERNATIVES RELATIVE TO THE ADMINISTRATION'S PLAN, 1986 TO COMPLETION (In billions of 1986 dollars)

	1986	1987	1988	1989	1990	Subtotal 1986- 1990	Total to Completion ^{a/}
Option I							
Administration Plan	1.27	1.13	1.02	1.42	1.45	6.29	8.73
Incremental Costs or Savings (-) Compared to Option I ^{b/}							
Option II	0.02	-0.09	-0.09	-0.50	-0.50	-1.16	-3.40
Option III	-0.09	0.17	0.22	-0.13	-0.21	-0.04	-1.43

SOURCE: Congressional Budget Office.

- a. Procurement completion dates: Option I, 1992; Option II, 1991; Option III, 1993.
 b. Five-year discounted investment costs (at 4 percent discount rate) for the Administration's plan are \$5.79 billion; discounted savings for Option II equal \$1.0 billion; and for Option III, \$0.0 billion.

ministration's plan.) A possible requirement for a technologically advanced tanker, suited to accompany ever more advanced bombers or to serve in increasingly taxing missions, might also argue for holding down current investment. 3/

The success of Option II would depend on the availability of suitable "donor" aircraft--the retired commercial 707s that furnish parts for KC-135Es. As the option is envisioned, less than half of the remaining worldwide supply (see Chapter II) would be needed. This should make the option feasible, even though some airlines might decide to keep these aircraft in commercial use by buying hush kits for them. Furthermore, U.S. aircraft manufacturers now have economic incentives to clear some foreign commercial markets of 707s to make way for new aircraft sales. They might be helpful in acquiring donor aircraft for the Air Force.

But the option has drawbacks, too. Aircraft re-engined with the JT-3D engine cannot meet the current noise and air pollution abatement standards regulating commercial domestic flight, while those refitted with the CFM-56 engine can. This would certainly be a detriment at air bases near large civilian centers. There is also concern that the age and nonuniformity of the recycled JT-3D engines would make them difficult to maintain. But to date, the Air National Guard has reported no problems of this kind.

Over the long run, this option would provide somewhat less capability than the Administration's program because the JT-3D does not offer the full performance improvement of the CFM-56. As reported in Chapter I, however, analysis indicates that demand will decline in the latter years of the projection period after peaking around 1990. If this picture were to change significantly, a fallback would still be available--namely, that the CFM-56 production line would still be open.

Implementing this option would mean putting JT-3D re-engined aircraft in the active-duty forces for the first time, and some Air Force officials have expressed concern that this would complicate logistics by requiring new training and new stocks of spare parts. The latter might not be a problem, in that the basic JT-3D engine now powers the B-52H bombers, AWACS surveillance planes, and other aircraft already in the active-duty force. Furthermore, two active-duty bases are already collocated with Air

3. Possible technological upgrades include reduced "radar signatures" (detectable elements) and/or defensive avionics. Although some of these modifications could be made to current tankers, it is more likely that such extensive investment would be made in new aircraft.

National Guard JT-3D aircraft, and three more are collocated with JT-3D equipped Air Force Reserve units. ⁴/ Thus, basing KC-135Es together with these aircraft might actually exploit economies of scale for spare parts and technical support. Having KC-135Es in the active-duty force would also allow for backup aircraft for the Guard and Reserve, which will soon have all KC-135Es; if the Reserve forces were to lose a KC-135E in a peacetime accident, a replacement would be readily available from the active fleet, as was the case when both active and Reserve forces had KC-135As.

Though having KC-135Es in the active-duty force might complicate training for different versions of tankers, how much is difficult to say, especially in comparison with training complications called for by the Administration's plan. By 1990, under this option, the active fleet would consist of a mix of KC-135E and KC-135R aircraft. Under the Administration's plan, though, a mixed fleet of KC-135As and KC-135Rs would persist well into the 1990s.

While re-engining some aircraft with the JT-3D has many advantages and seems to have few insurmountable drawbacks, JT-3D re-engining has never been formally supported by the active Air Force. It has, however, been supported by the Air National Guard, all of whose aircraft will--when purchases made in 1985 are delivered--have JT-3D engines. The Congress could take the first step toward Option II by placing more of the tanker capability in the Reserves and re-engining those added Reserve aircraft with the JT-3D.

Option IIA. Redistributing Tanker Capacity Using the KC-135E

The Guard currently has 13 KC-135 tanker units, and the Reserve has three. Each unit has eight tankers of which one is on alert for the strategic mission at all times. As cited in Chapter II, Major General Conaway of the Air National Guard has testified that "robusting" Guard units from eight to a minimum of ten aircraft each would allow a unit to maintain two tankers on alert at all times. With ten aircraft, the ratio of Reserve force support tankers to mission-available tankers would improve from 8 to 1 to 5 to 1, a more efficient use of existing assets.

4. The current Air Force basing plan has B-52H aircraft stationed at the following bases: K.I. Sawyer, Minn., Dyess, Tex., Carswell, Tex., Ellsworth, S. Dak., and Minot, N. Dak. Colocated bases in the Guard are Pease, N.H., and Fairchild, Wash.; in the Reserves, Grissom, Ind., Mather, Cal., and March, Cal.

One approach to building up the reserves would be to eliminate two of the 32 active-duty tanker squadrons. The 32 aircraft thus withdrawn from active duty would be re-engined with JT-3D engines and distributed among most of the Guard and Reserve units, so that each had ten tanker aircraft.

Two units, at Pittsburgh and Milwaukee, currently cannot accommodate ten tankers without increasing ramp space and other infrastructure. But 14 units could be augmented with two tanker aircraft each. The remaining four tankers could be used either as backup for the Reserve forces or to establish a permanent tanker unit in Alaska to support air defense and reconnaissance missions. At present, active-duty force tankers rotate to Alaska on a temporary basis, increasing the burden on their squadrons' remaining personnel and tankers. A permanent Reserve mission there could partly alleviate the drain on active-duty personnel to support the Alaskan tanker task force.

Permitting a first step toward Option II, total savings compared to the Administration's plan from re-engining the 32 aircraft with the JT-3D would be about \$370 million. But, savings in any year compared to Option I would depend on the rate of concurrent KC-135R re-engining. With these aircraft in the Reserve forces, operating and support costs would increase by \$20-30 million a year, eventually offsetting the investment savings--in 10-20 years. ^{5/} But there are also some additional advantages. One might be improved readiness. On the basis of the two-year average of 1983-1984, the Guard's "mission-capable" rate is about 76 percent, compared to 65 for the active-duty force. (Mission-capable rates measure the time that aircraft are not "mission-limited" by requirements for either supplies or maintenance.) In general, the Guard benefits from having more experienced personnel to fly and maintain its aircraft; hence the improved readiness. More important, there would be a net addition of four to six aircraft to the total force able to stand constant alert for the strategic mission, because the Reserve forces could make more efficient use of their aircraft. ^{6/}

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5. Although military personnel costs decrease, they are more than offset by increased operating and maintenance costs from additional flying hours--392 versus 305--and civilian technicians required by the Reserve forces.
 6. Another approach would achieve the benefits of robusting--namely, more alert aircraft--though it would provide no new candidates for JT-3D re-engining. Under this approach, the mission of two Guard and Reserve units now using JT-3D aircraft would be changed and their aircraft would be used to robust the remaining units. Although this would provide no advantages from a re-engining perspective, neither would it offer any of the drawbacks associated with impacting active force missions.

This option is not, however, without drawbacks. The availability of fewer active-duty aircraft would make it harder to carry out some types of commitments. For instance, the active-duty forces assume proportionately more of the peacetime support and training missions than do the part-time Reserve and Guard. In some cases such as overseas missions, which regularly have unavoidable delays, it might be difficult to substitute Guard or Reserve personnel, who must be back at their civilian jobs, for active-duty forces. At a minimum, scheduling would become more difficult. Furthermore, as reliance on the Reserves increases, presidential authority to respond to a military conflict diminishes because of the fixed limit on Reserve forces a president may call upon.

These drawbacks might not be quantitatively important, however. Under this option, only about 25 percent of all KC-135 tankers would be in the Reserve or Guard, compared to about 20 percent under the Administration approach. This modest increase might not greatly complicate planning, though a farther-reaching reassignment of aircraft to the Reserves might.

OPTION III. EMPHASIZING THE KC-10 TANKER/CARGO AIRCRAFT

With increased reliance on the new KC-10 aircraft, the Air Force could satisfy the competing demands of expanded aerial refueling capacity and timeliness. Neither Option I nor II meets the benchmark of 1,000 KC-135A equivalents until the 1990s, by which time tanker demand is forecast to slacken. By economizing on a mixed re-engining program and applying most of the savings toward an enlarged KC-10 purchase, Option III would go far toward addressing the near-term problems of tanker shortages.

Specifically, rather than buying 412 KC-135Rs, this option would have 150 tankers in the active-force fleet re-engined with the new CFM-56 and 200 with the refurbished JT-3D engines over the 1986-1990 period. With the savings relative to the Administration's plan, 48 additional new KC-10 tankers would be purchased between 1988 and 1993 (see Table 2). At the same time, because of the capability afforded by the KC-10, as well as the higher operating and support costs of these additional tankers, 62 KC-135As would be retired without being re-engined as KC-10s came into the force. As noted in Chapter II, the KC-10's large fuel-carrying capacity makes it particularly efficient as a tanker for very long missions, such as those supporting some strategic bombers--especially bombers carrying external cruise missiles for "shoot-and-penetrate" missions (see also Chapter I). Thus, the 48 KC-10s would be procured and operated as dedicated tankers

equipped for the strategic mission. This, along with retirement of the KC-135As, would obviate the need for additional crews. More important, each KC-10 put into the strategic role could free up about three KC-135 tankers for conventional missions, for which an increase in sheer numbers of tankers--or "booms"--can be as important as a particular tanker's capacity. Here, greater numbers of tankers allows for more flexibility and efficiency in scheduling and operations.

This option would provide the most capability in the near term, and about the same capability as the Administration's plan over the long term. The tanker fleet would reach the benchmark figure of 1,000 tanker equivalents by 1989, three years sooner than would the Administration's plan, and 85 percent of the force would be modernized by 1990, compared to 58 percent under the Administration's plan. Also, this option would incorporate a new, modern tanker, which might postpone for more years the need to buy a still newer tanker.

Finally, adopting Option III would keep a tanker production line open into the 1990s, which would be critical if security requirements dictated a rapid increase in the size of the tanker fleet. As a tanker/cargo aircraft, an open production line for the KC-10 also offers opportunities for increased airlift capacity, a constant concern to all of the services.

This option would not, however, reduce costs below the Administration's five-year plan--a clear drawback. In fact, costs would actually rise in years 1987 and 1988, which might be a problem in light of near-term limits on funding (see Table 6). However, over the long run, this option would save about \$1.4 billion compared with likely Administration plans.

REDUCING TANKER DEMAND-- APPROACHES TO IMPROVE EFFICIENCY

As the Congress assesses various ways to add to aerial refueling capacity, the Air Force could also consider ways to economize by reducing demand for tanker support. Though any such course would entail some sacrifice of military capability, a few are outlined here to highlight the flexibility possible at the policy and planning level.

Rising tanker demand could be offset considerably by forgoing the taxing "shoot-and-penetrate" mission and having only "stand-off" missions for B-52s. This would, of course, reduce the target coverage from successful penetration missions.

Demand could be reduced further by retiring some of the B-52s sooner than the Air Force now plans to do. Such a course would probably be considered seriously only if an arms control agreement were secured.

The Air Force could be more selective in its planned use of aerial refueling, and could revert to ground refueling at en route bases for some combat aircraft. Among the likeliest candidates would be fuel-intensive fighter aircraft (notably F-4s) designated for conventional combat in Europe. One result would be greater tanker capacity available for use elsewhere. Another, however, would be sacrifice of autonomy and promptness for those combat aircraft forced to depend on midcourse land refueling. In a major war with many participants, U.S. aircraft would most readily find other nations prepared to offer midcourse land refueling. But at the same time, it is in such a major war that the need for airborne refueling might also be most acute.

Increasing planned wartime "utilization rates" would allow each tanker to fly a few more hours per day during combat, thus expanding the effective capacity of the fleet. Some Air Force officials believe that, even with monthly and quarterly restrictions on crew flying time, there is some flexibility to increase these wartime rates, especially since re-engined tankers should require less maintenance and support. This conclusion, however, is not uniformly agreed on, and some peacetime investment in stocks of spare parts and support might be needed to allow for more wartime flying.

In sum, while alternatives to reduce tanker demand exist, all involve military or political risks--or indeed, added costs--that DoD apparently believes do not outweigh the benefits.

