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AN EXAMINATION OF THE EFFECTIVENESS RATIOS (ERs) AND LIFE-CYCLE-COSTS (LCCs) OF THE KC-135R AND THE KC-10A (U)

NOV 81

00-038-0

Distribution Statement A
Approved for Public Release

AF Studies and Analyses
1 November 1981

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BACKGROUND:

This study was accomplished in response to the questions raised in the AFALD/CC letter, subject: "KC-10 Acquisition and Life Cycle Costs" 7 August 1981. It contains an expanded and updated analysis of the relative capabilities and LCCs of the KC-10A and the KC-135R in their tanker roles.

SCOPE:

The study examines the tanker role of the KC-10A and KC-135R. The cargo carrying capabilities of the aircraft were not addressed and the aircraft are compared on a sortie-to-sortie basis. A sortie-to-sortie methodology is used so that comparisons can be made between the AF/SA and AFALD analyses. However, sortie-to-sortie comparisons do not tell the entire story and should be modified to account for mission and aircraft differences. Acquisition costs were provided by the respective program offices and the Operating and Support (O&S) costs were provided by AF/ACMC. Acquisition costs plus 20 years of O&S costs were used to estimate LCCs. Annual ten percent fuel cost growth excursions were also analyzed.

FACTORS BEARING ON THE ANALYSIS:

A sortie-to-sortie comparison based on common operating parameters and assumptions can be misleading because it does not account for three main differences in the two aircraft and their missions. First, the KC-10 will support general purpose forces such as TACAIR and airlift deployments while the KC-135R will mainly support SIOP forces. Second, the KC-10 has a large cargo carrying capability which provides flexible employment opportunities. The KC-135R has a limited cargo carrying capability and is not equipped for sustained palletized cargo operations. Third, the KC-10 is programmed for a 3.0 crew ratio and 540 flying hours/year which provides a greater sustained surge capability than the KC-135R force. The KC-135R, tied to the SIOP alert role, is programmed for a 1.27 crew ratio and 350 flying hours per year. Therefore, because of actual mission and aircraft differences, comparing the aircraft on a sortie-to-sortie basis using common parameters can result in misleading results.

To properly compare the aircraft a methodology beyond the scope of this paper and the AFALD 7 August 1981 letter is required. The methodology must account for the KC-10's current inability to stand SIOP alert, its cargo carrying capability, and its greater wartime surge capability. Simultaneously, the KC-135R cargo carrying capability should also be included in the analysis. Therefore, this analysis should not be construed as the final answer to the tanker modernization question, but rather as an analytical exercise in reply to the AFALD letter.

ASSUMPTIONS:

Table 1 contains the major differences in assumptions between the AFALD analysis and previous AF/SA tanker studies. The asterisk marked items were deleted in this analysis. The common set of assumptions, shown in Table 2, were used in all

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TABLE 1
COMPARISON OF ASSUMPTIONS

ITEM	AF/SA PREVIOUS STUDIES KC-10	AF/SA PREVIOUS STUDIES KC-135	AFALD ANALYSIS (7 AUG 81) KC-10	AFALD ANALYSIS (7 AUG 81) KC-135
CREW RATIO	3.0**	1.27	1.27	1.27
FLYING HOURS	540	326	326	326
BACKUP AIRCRAFT INVENTORY	10%*	5%	5%	5%
INFLATION RATE	WEIGHTED* INDICIES (PROGRAM PECULIAR)	OMB WEIGHTED INDICIES	RAW INDICIES (PROGRAM PECULIAR)	OMB WEIGHTED INDICIES
FUEL CONSUMPTION	2506 GAL/HR	1645 GAL/HR*	2381 GAL/HR*	1645 GAL/HR*

*Items deleted to form Table 2.
**Crew ratio is based on 1/2 active and 1/2 reserve.

TABLE 2
SUMMARY OF COMMON ASSUMPTIONS

ITEM	KC-10	KC-135
BACKUP AIRCRAFT INVENTORY	5%	5%
INFLATION RATE	RAW INDICIES (PROGRAM PECULIAR)	OMB WEIGHTED INDICIES
FUEL CONSUMPTION	2506 GAL/HR	1732 GAL/HR

the flying hour/crew ratio combinations. Table 3 contains the peacetime operating tempo parameters and Table 4 contains the LCC data used to prepare the figures. Four different cases were analyzed using common operating parameters. LCCs were based on average acquisition costs of $55.7M for the KC-10A and $16.5M for the KC-135R.

TABLE 3
KC-10 AND KC-135R PEACETIME OPERATING PARAMETERS

CASE	ANNUAL FLYING HOURS	CREW RATIO
1	326	1.27
2	350	1.27
3	400	2.0
4	540	3.0

TABLE 4
LIFE CYCLE COST DATA
(FY 81 $M)

NO FUEL COST GROWTH			10% ANNUAL FUEL COST GROWTH		
CASE	KC-10	KC-135R	CASE	KC-10	KC-135R
1	93.1	48.4	1	128.7	73.0
2	94.9	50.0	2	133.1	76.4
3	100.5	56.1	3	144.2	86.3
4	112.9	70.2	4	171.8	110.9

METHODOLOGY:

Equation (1) was used to calculate the Effectiveness Ratios (ERs) over a broad spectrum of mission ranges for both radius and 1,000nm return missions.* The measure of merit used to compare the aircraft was the Life Cycle Cost per KC-135A Equivalent (LCC/A). The LCC/A was computed for each aircraft by dividing the LCC by the ER as in equation (2).

$$(1)\quad ER = \frac{\text{Maximum fuel transfer at distance "X" nm from a base for a given tanker}}{\text{Maximum fuel transfer at distance "X" nm from a base for a KC-135A}}$$

*A radius mission aircraft flies some distance out to a point, transfers fuel, and flies back a distance equal to its outbound distance. A 1,000nm return mission aircraft flies a distance to a point, transfers fuel, and returns 1,000nm to a recovery base.

(2) $LCC/A = \frac{LCC}{ER}$

where: LCC = Life Cycle Cost
ER = Effectiveness Ratio

Previous tanker studies used average effectiveness ratios of 3.0 for the KC-10 and 1.5 for the KC-135R. However, since the LCC/A is extremely sensitive to ER, which changes rapidly with distance, a range of effectiveness ratios which account for different missions and distances should be examined when comparing LCC/A values. Figures 1 and 2 show the ER as a function of distance for both aircraft flying radius (Figure 1) and 1,000nm return (Figure 2) missions. These figures show the inaccuracy of using an average 3.0 ER for the KC-10 and 1.5 ER for the KC-135R. By using the actual ER for both aircraft for a particular range and mission, LCC/A calculations are not biased by the 1.5 and 3.0 ER figures. Thus, using this methodology eliminates the dependence on average effectiveness ratios.

ANALYSIS:

Figures 3-10 compare the LCC/A for the KC-10 and KC-135R for various mission profiles as a function of distance. The solid curves represent no fuel cost growth and the dashed curves represent an annual 10 percent fuel cost growth over twenty years. The horizontal lines on each figure represent a baseline KC-135A 20 year Life Cycle Cost with and without annual fuel cost growths. Expected tanker mission distances are shown at the bottom of each figure. The radius missions are based on NATO, Persian Gulf, and Korean scenarios; the higher distance missions are based on scenarios without tanker basing rights outside the CONUS. These figures were computed using the data from table 4 and Figures 1 and 2. For comparative purposes, LCC/A vs range curves, for radius and 1,000nm return missions using common operating parameters, are shown on the same page. For equal mission types and distances, without a fuel cost growth, these figures show that the KC-135R is more cost effective than the KC-10 except in Case 4 when each aircraft is flown with a crew ratio of 3.0 and 540 hours per year. When an annual 10 percent fuel cost growth is added to the LCC, the KC-135R is more cost effective in only two out of the four cases.

OBSERVATIONS:

1. Effectiveness ratios vary widely for each aircraft as a function of range.

2. Effectiveness ratios dramatically affect the LCC/A for each aircraft.

3. The KC-10 LCC/A exceeds the KC-135R LCC/A in three out of the four cases without fuel cost growth considerations.

4. Adding a 10 percent annual fuel cost growth to the LCC of each aircraft, the KC-10 LCC/A exceeds the KC-135R LCC/A in two of the four cases.

5. To objectively compare the two aircraft more than a sortie-to-sortie analysis based on common operating parameters is required; the differences in aircraft capabilities must be recognized and accounted for.

TANKER EFFECTIVENESS RATIO (ER)
VS
RANGE
(RADIUS MISSION)

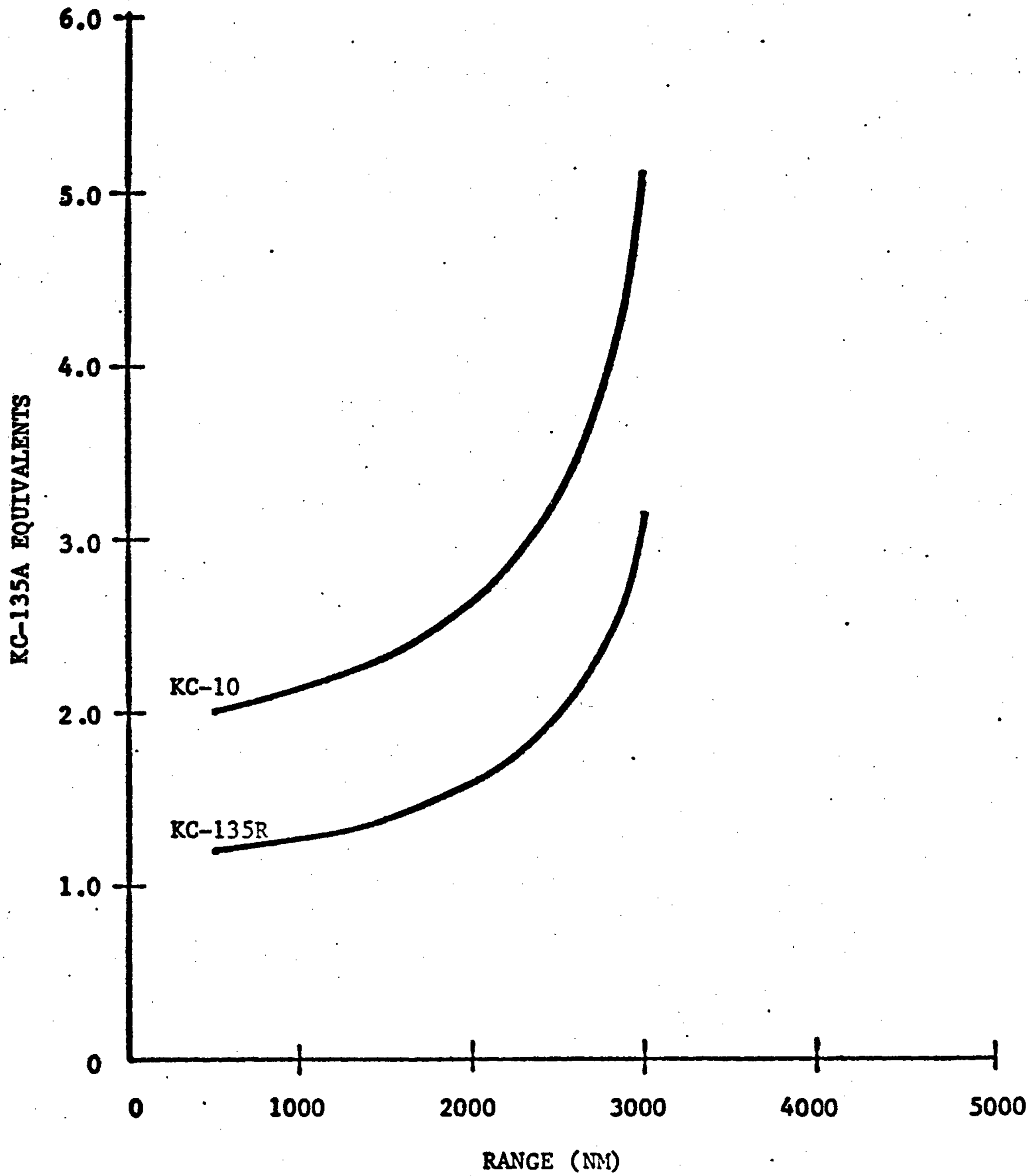

FIGURE 1

TANKER EFFECTIVENESS RATIO (ER)
VS
RANGE
(1000NM RETURN MISSION)

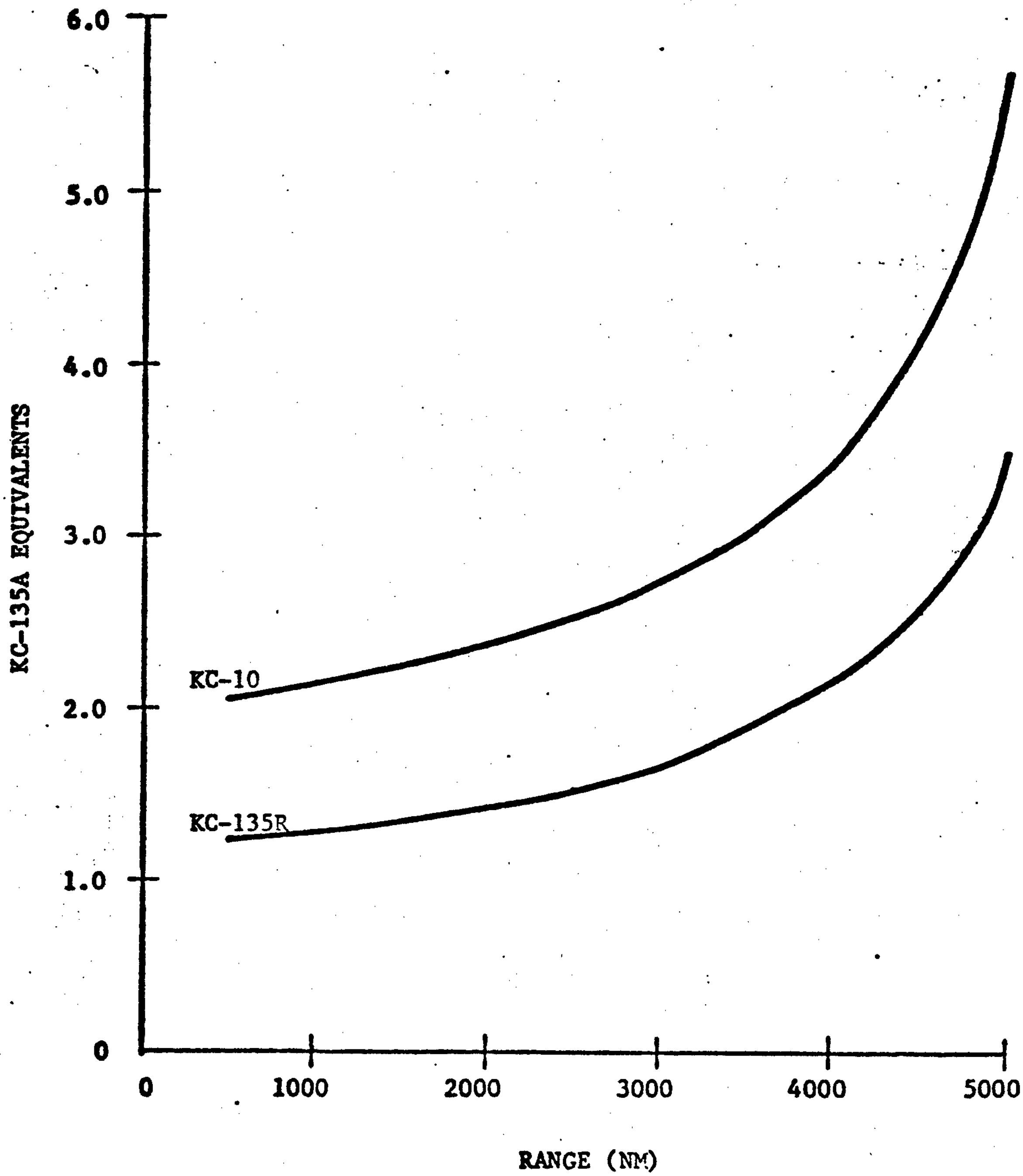

FIGURE 2

20 YR LIFE CYCLE COST PER KC-135A EQUIV VS RANGE

With Annual 10% Fuel Cost Growth ‒ ‒ ‒ ‒ ‒
Without Annual 10% Fuel Cost Growth ———

	CASE 1	
AIRCRAFT:	KC-135R	KC-10
CREW RATIO:	1.27	1.27
FLYING HRS/YR:	326	326
MISSION PROFILE:	RADIUS	RADIUS

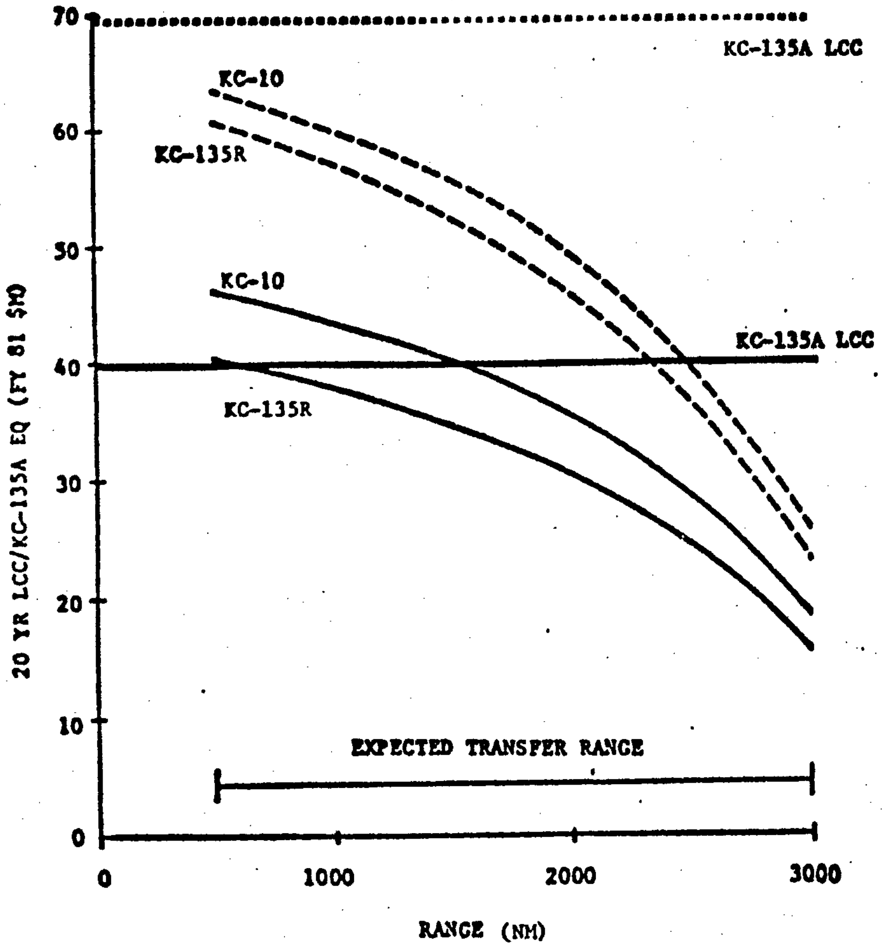

FIGURE 3

	CASE 1	
AIRCRAFT:	KC-135R	KC-10
CREW RATIO:	1.27	1.27
FLYING HRS/YR:	326	326
MISSION PROFILE:	1000NM RETURN	1000NM RETURN

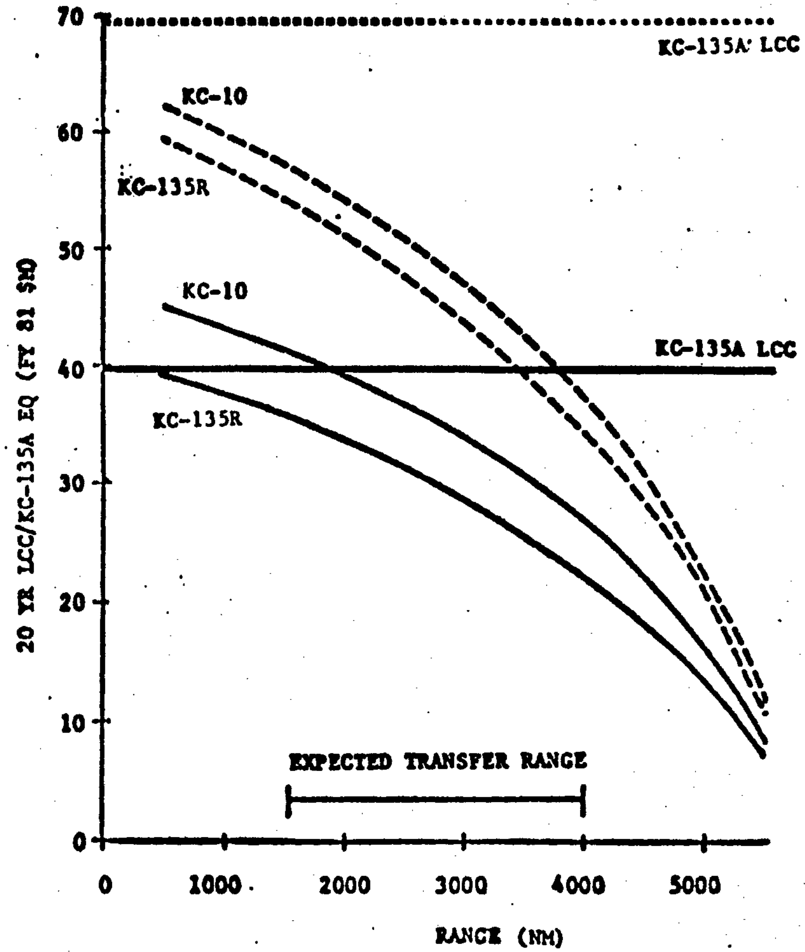

FIGURE 4

20 YR LIFE CYCLE COST PER KC-135A EQUIV VS RANGE

With Annual 10% Fuel Cost Growth - - - - -
Without Annual 10% Fuel Cost Growth ———

	CASE 2	
AIRCRAFT:	KC-135R	KC-10
CREW RATIO:	1.27	1.27
FLYING HRS/YR:	350	350
MISSION PROFILE:	RADIUS	RADIUS

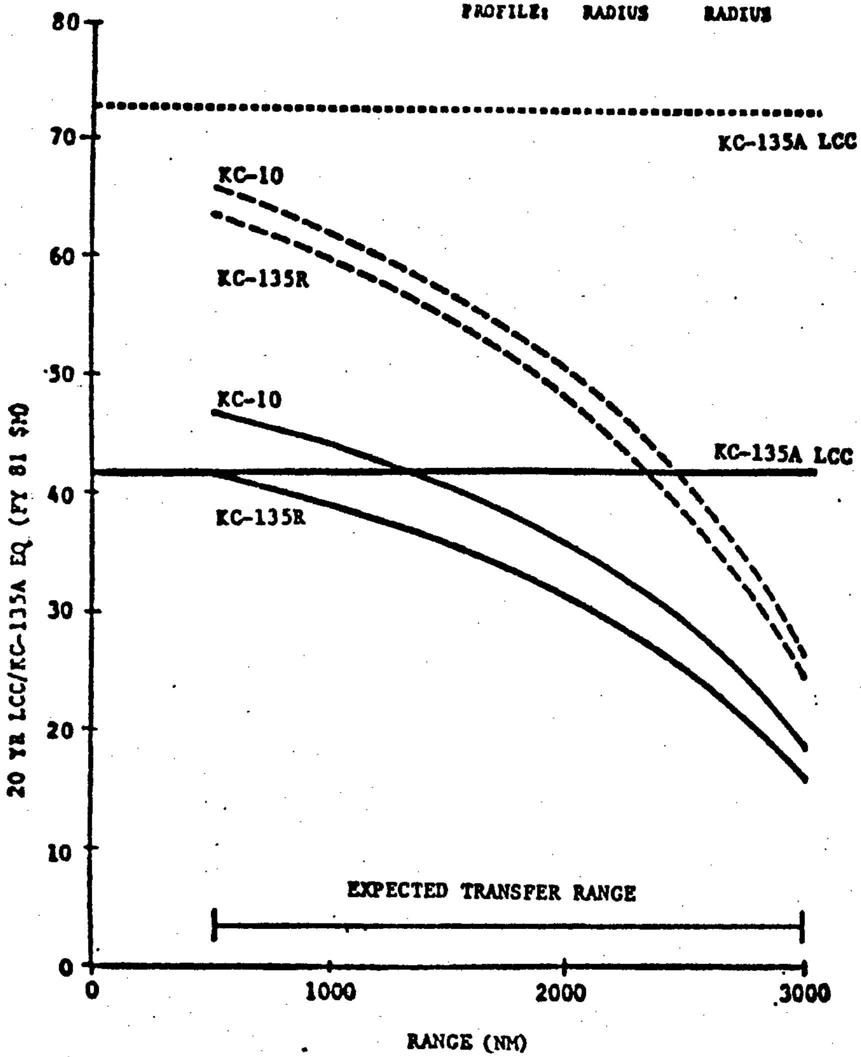

FIGURE 5

	CASE 2	
AIRCRAFT:	KC-135R	KC-10
CREW RATIO:	1.27	1.27
FLYING HRS/YR:	350	350
MISSION PROFILE:	1000NM RETURN	1000NM RETURN

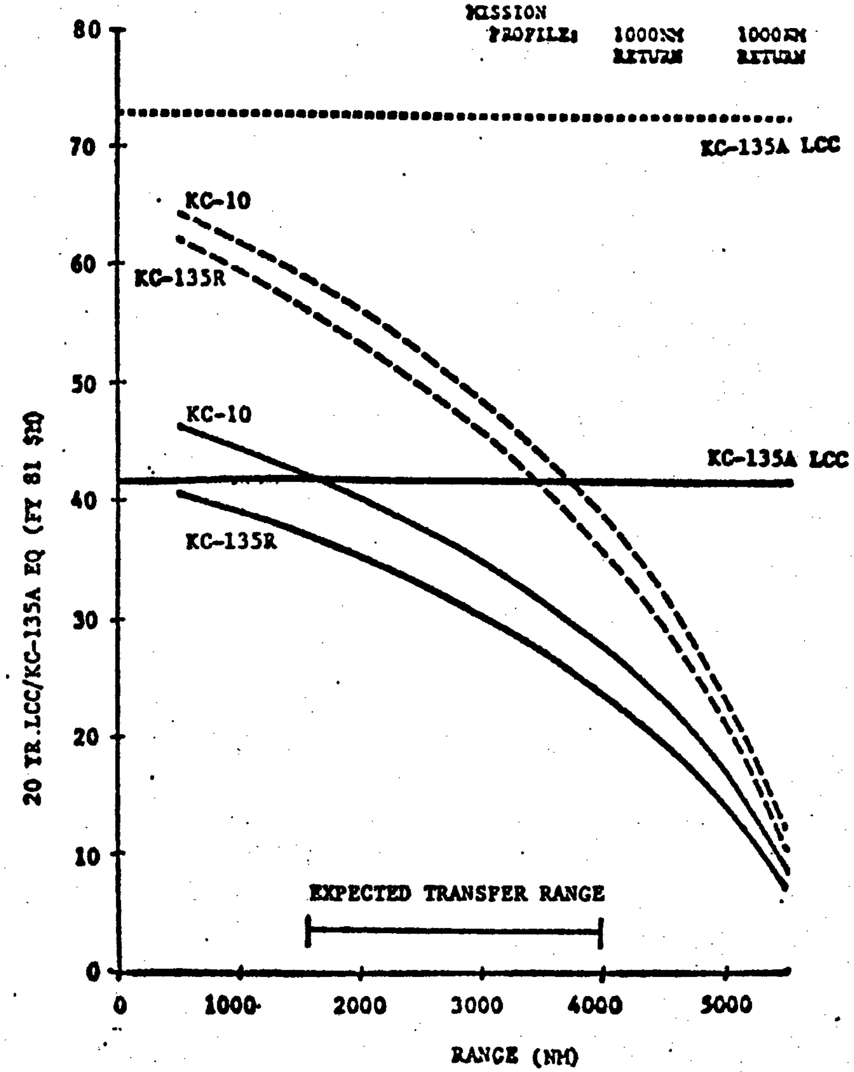

FIGURE 6

20 YR LIFE CYCLE COST PER KC-135A EQUIV VS RANGE

With Annual 10% Fuel Cost Growth - - - - -
Without Annual 10% Fuel Cost Growth ———

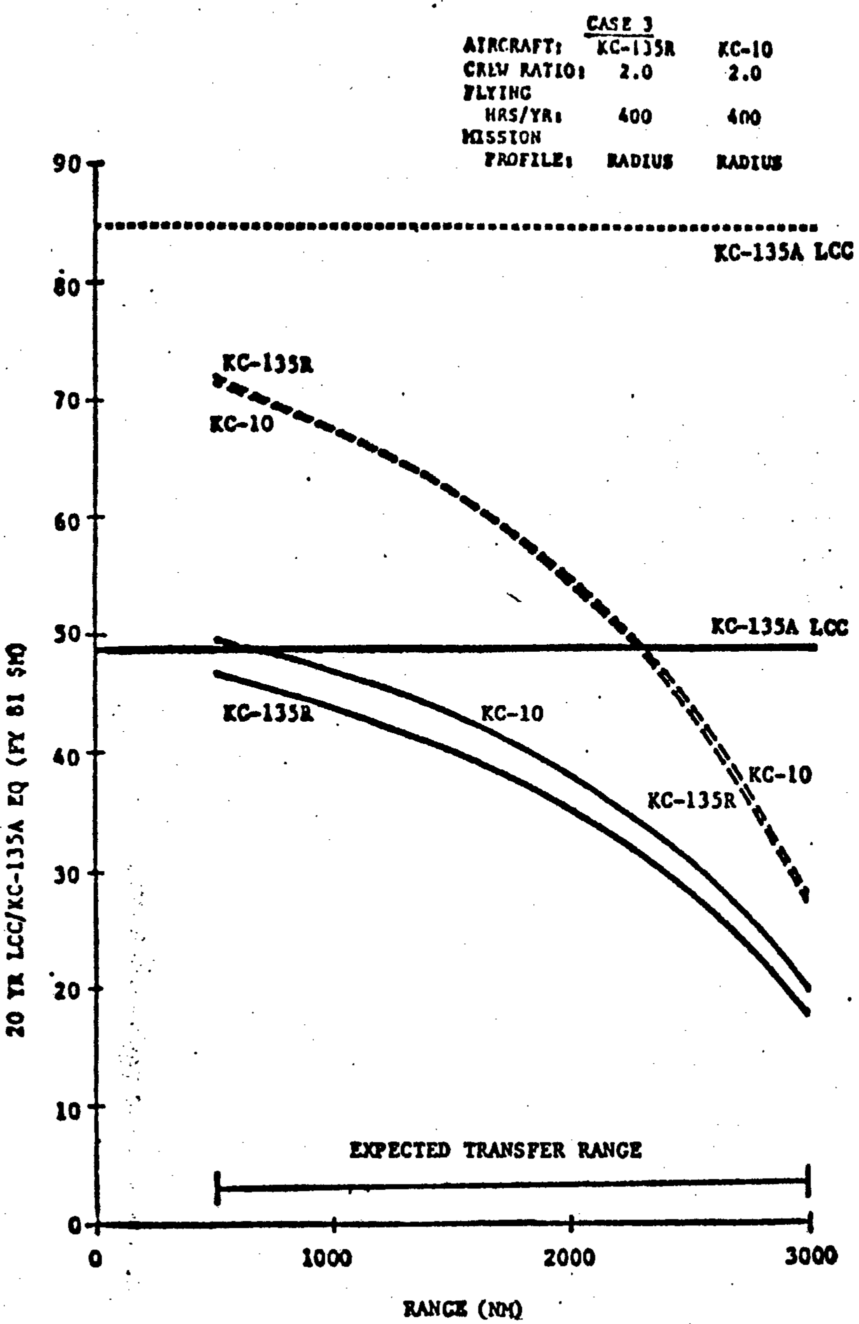

FIGURE 7

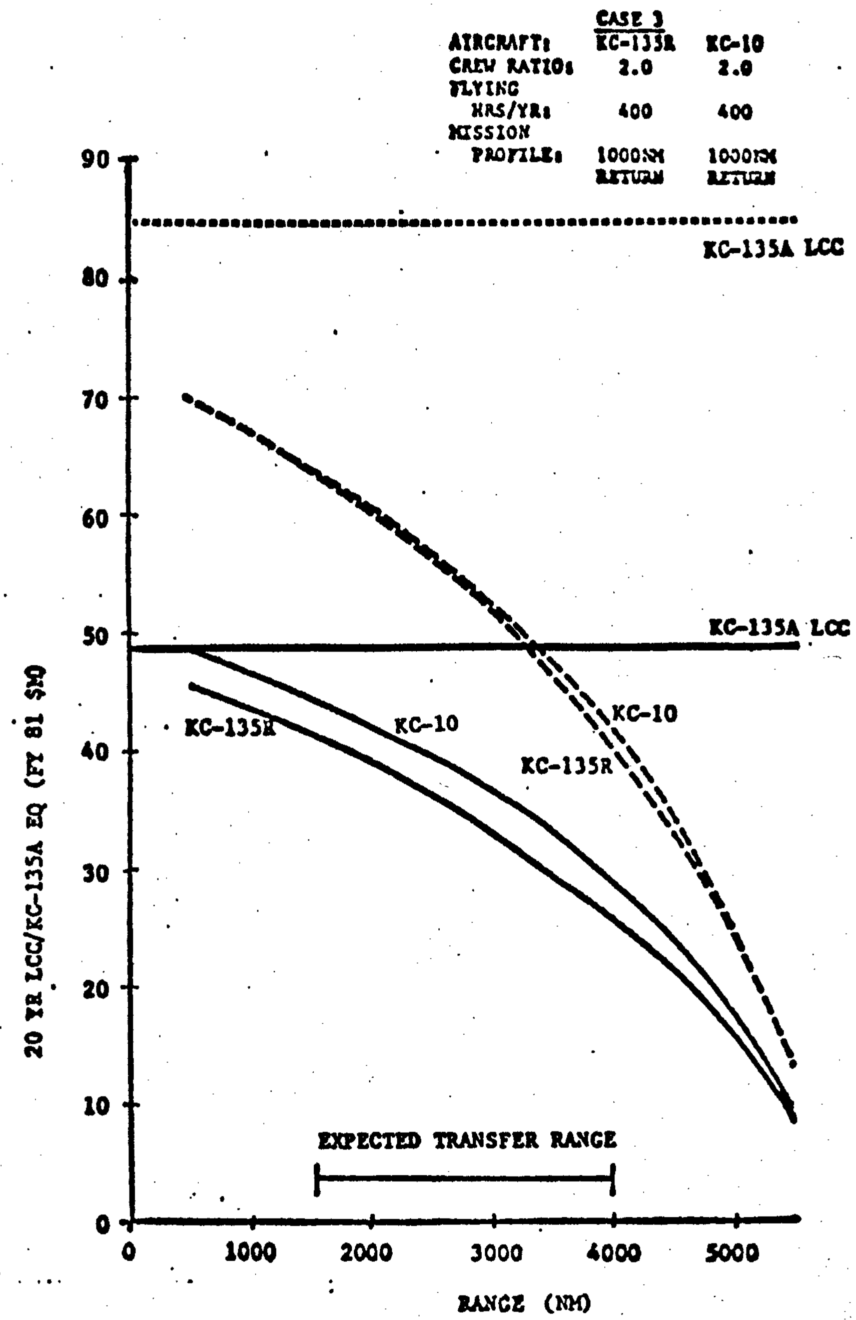

FIGURE 8

20 YR LIFE CYCLE COST PER KC-135A EQUIV VS RANGE

With Annual 10% Fuel Cost Growth - - - - - -
Without Annual 10% Fuel Cost Growth ———————

	CASE 4 KC-135R	KC-10
AIRCRAFT:	KC-135R	KC-10
CREW RATIO:	3.0	3.0
FLYING HRS/YR:	540	540
MISSION PROFILE:	RADIUS	RADIUS

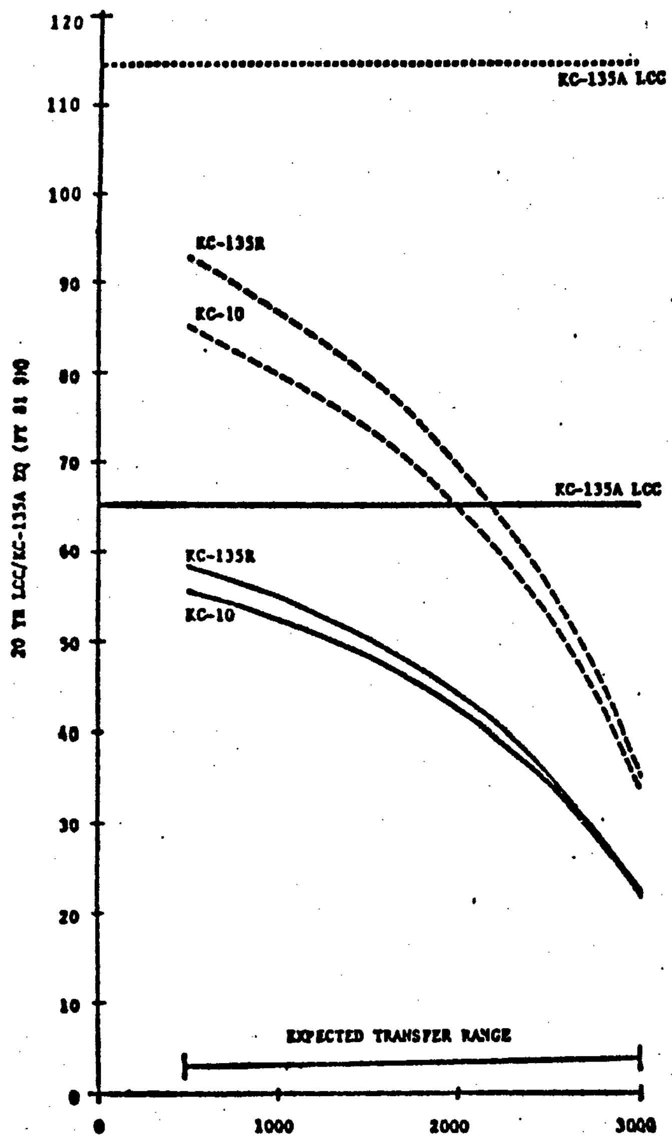

FIGURE 9

	CASE 4 KC-135R	KC-10
AIRCRAFT:	KC-135R	KC-10
CREW RATIO:	3.0	3.0
FLYING HRS/YR:	540	540
MISSION PROFILE:	1000NM RETURN	1000NM RETURN

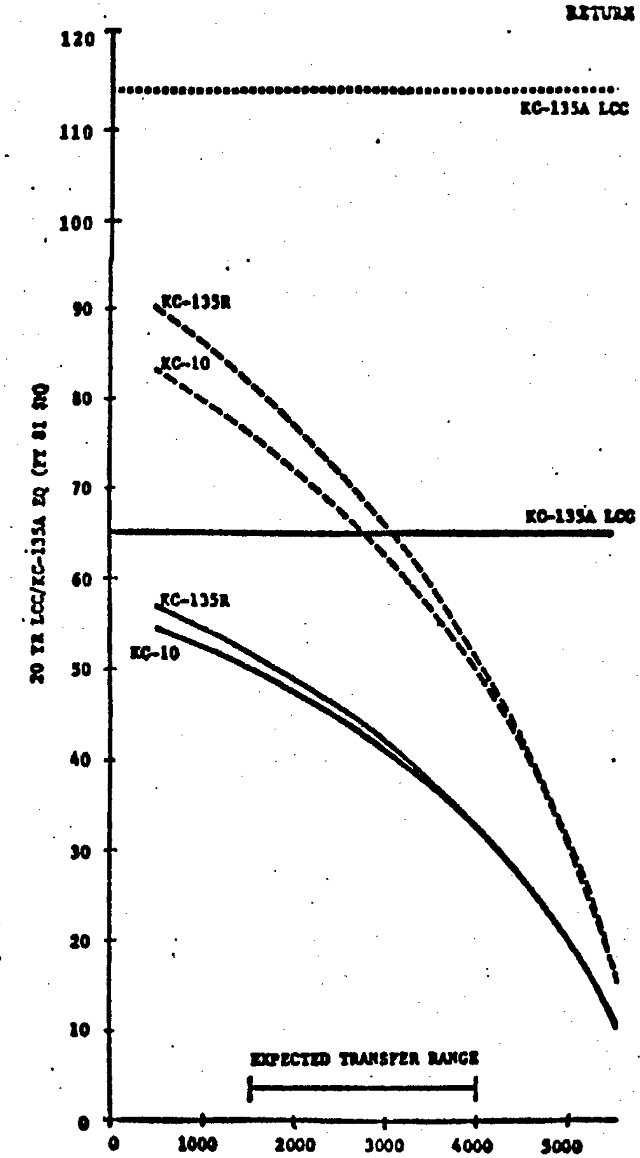

FIGURE 10