

DTIC FILE COPY

②

AD-A217 368



AIR WAR COLLEGE

RESEARCH REPORT

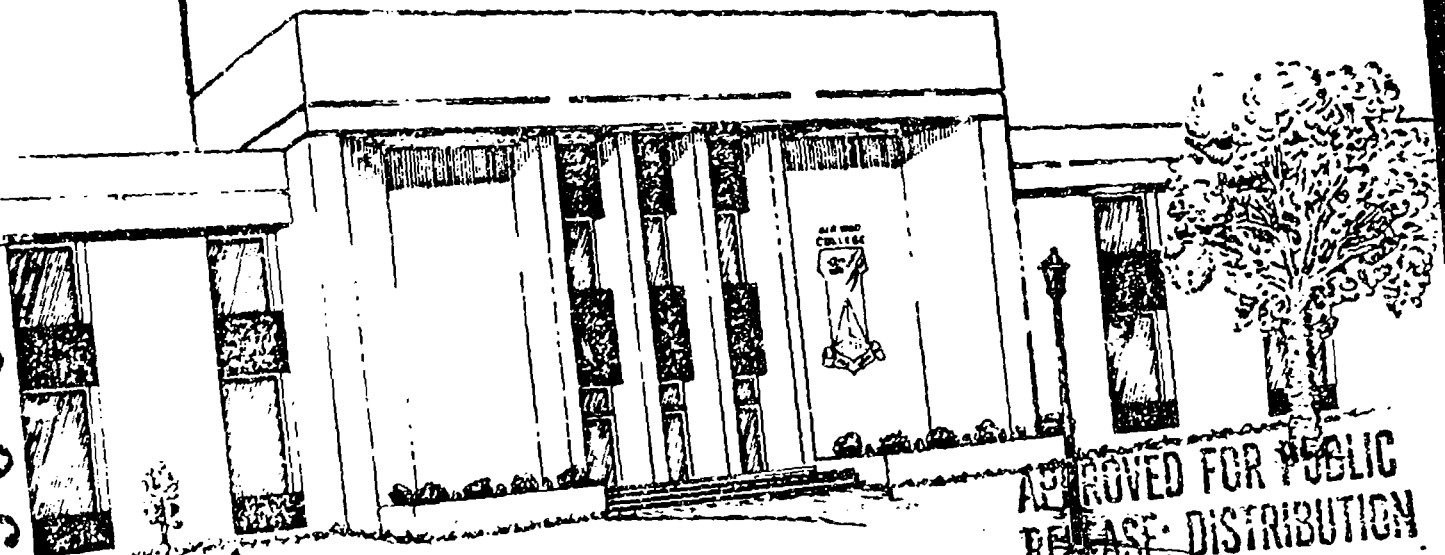
KC-135 SURVIVABILITY IN A WAR IN EUROPE

LT COL JOHN EKWALL

1989

DTIC
ELECTE
FEB 01 1990
S E D
CD

90 02 01 055



AIR UNIVERSITY
UNITED STATES AIR FORCE
MAXWELL AIR FORCE BASE, ALABAMA

APPROVED FOR PUBLIC
RELEASE; DISTRIBUTION
UNLIMITED

AIR WAR COLLEGE
AIR UNIVERSITY

KC-135 SURVIVABILITY IN A WAR IN EUROPE

by

John Ekwall
Lieutenant Colonel, USAF

A DEFENSE ANALYTICAL STUDY SUBMITTED TO THE FACULTY
IN
FULLFILLMENT OF THE CURRICULUM
REQUIREMENT

Advisor: Colonel Frank W. Anderson, Jr.

MAXWELL AIR FORCE BASE, ALABAMA

May 1989

DISCLAIMER

This study represents the views of the author and does not necessarily reflect the official opinion of the Air War College or the Department of the Air Force. In accordance with Air Force Regulation 110-8, it is not copyrighted but is the property of the United States government.

Loan copies of this document may be obtained through the interlibrary loan desk of Air University Library, Maxwell Air Force Base, Alabama 36112-5564 (Telephone: [205] 293-7223 or AUTOVON 875-7223).

Accession For	
NTIS GRA&I	☒
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	



EXECUTIVE SUMMARY

TITLE: KC-135 Survivability in a War in Europe

AUTHOR: John Ekwall, Lieutenant Colonel, USAF

Two important issues come to mind when one thinks of deploying KC-135 assets to the next battlefield -- tanker survivability, and tactics to best support our fighter aircraft in their close air support (CAS) and battlefield air interdiction (BAI) roles in and near the Forward Line of Own (friendly) Troops (FLOT). Gone are the days of Vietnam where air superiority and geography allowed air refueling operations to go unimpeded without the threat of enemy aircraft and sophisticated ground fire. In the next European war scenario, we can expect a significant air-to-air threat for the first several weeks assuming we can gain air superiority early; if we don't, then the air-to-air threat will remain throughout the conflict. We can also fully expect a significant surface-to-air (SAM) threat with the proliferation of state-of-the-art SAMs and precision antiaircraft artillery (AAA) now held by the Warsaw Pact.

This paper will analyze the current threat to the KC-135 in a NATO/Warsaw Pact war, and develop air refueling tactics and procedures to increase the survivability of our limited tanker force. By definition, the KC-135 is a high value asset since it provides the required range for our fighters to deliver ordnance on target; is limited in numbers; and is no longer in production. (Note: KC-10s will not be factored into this analysis because of their extremely high price tag. They will more than likely be assigned an aircraft ferry/cargo role early in any major conflict.) This analysis will develop tactics which will not only increase survivability of both tanker and fighter aircraft; but will also bring the fighters to the FLOT fully fueled and in prime position to begin their CAS and BAI missions.

BIOGRAPHICAL SKETCH

Lieutenant Colonel John Ekwall (M.B.A., Embry Riddle Aeronautical University) is a KC-135 command pilot who commanded the "Best Air Refueling Squadron in the Strategic Air Command for 1986." As Commander, he was selected as lead pilot in the Strategic Air Command's operational development of the 'Thunderhawks' aerial demonstration team. This test involved a KC-135 Stratotanker and a B-52H Stratofortress flying in tandem formation at low altitude. The maneuvers consisted of close wingtip and trail formation, steep turns in excess of 60 degrees of bank, and high speed air refueling -- all at 200 feet above the ground. A veteran of Southeast Asia, he served with the 361st Tactical Electronic Warfare Squadron at Phu Cat Air Base, Vietnam as an aircraft commander in 1970-71; and again in 1972-74 in support of KC-135 Young Tiger operations flying out of U-Tapao AB Thailand, Andersen AFB Guam, and Kadena AB Okinawa. While in Vietnam, he flew 147 combat missions totalling 1040 combat hours -- he was awarded the Distinguished Flying Cross and six Air Medals. His most recent operational assignment was Deputy Combat Support Group Commander at Fairchild Air Force Base, Washington. He is graduate of the Naval War College, Newport, RI. Colonel Ekwall is a recent graduate of the Air War College, class of 1989.

TABLE OF CONTENTS

CHAPTER		PAGE
	DISCLAIMER.	ii
	EXECUTIVE SUMMARY	iii
	BIOGRAPHICAL SKETCH	iv
I	INTRODUCTION.	1
	Background.	1
	Assumptions	5
	Limitations	8
II	THE THREAT.	10
	Air-to-air.	10
	Surface-to-air.	11
III	CURRENT TACTICS AND PROCEDURES.	14
	Initial Studies of Low Altitude Air Refueling	14
IV	TANKER DEFENSE.	21
	Self-Defense Force Package.	22
	Electronic Countermeasures.	24
	Low Altitude Refueling.	25
V	TANKER TACTICS AND FIGHTER DELIVERY	29
	Air Refueling Route Profiles.	29
	Fighter Delivery Near the FLOT.	32
	CONCLUSIONS	34
	ATTACHMENTS	36
	BIBLIOGRAPHY.	40

CHAPTER 1

INTRODUCTION

BACKGROUND

The KC-135 Stratotanker was designed as an air refueling platform to provide its receiver aircraft with fuel for added range and endurance. It is similar to the commercial Boeing 707 and was built throughout a nine year production period from 1955 through the end of 1964. A total of 730 aircraft were ordered for the Strategic Air Command (SAC) replacing the aging KC-97.(10:319) The primary mission of the KC-135 is to air refuel the B-52 Stratofortress, the FB-111, and the newly acquired B1-B by providing these bombers with the necessary range to successfully deliver nuclear weapons on selected strategic targets deep in Soviet territory. Since 1964, however, the massive increase in requirements for air refueling support throughout the Department of Defense (DoD) has gone well beyond the number of KC-135 airframes to provide it.(10:321) Almost every aircraft in the Air Force inventory, and nearly all fixed-wing Navy and Marine Corps aircraft, are air refueling capable. Reflecting the changing mission of the KC-135, according to SAC officials (HQ SAC/DONA), fifty-five percent of all KC-135 training sorties goes to support other than SAC's bomber force training requirements. Today the KC-135 is the backbone of SAC's air refueling inventory and

is complimented by an additional 60 McDonnell Douglas KC-10 Extenders. Given their limited numbers, the KC-135s and the KC-10s provide invaluable air refueling support to our conventional air assets worldwide.

The KC-135A was first introduced into combat in actual air operations on 9 June 1964 in Southeast Asia.

Four KC-135s operating out of Clark Air Base in the Philippines, and nicknamed Yankee Team Tanker Task Force, refueled eight F-100 fighters on their way to strike Communist-backed Pathet Lao anti-aircraft emplacements on the Plain of Jars in northern Laos. The tankers loitered over southern Laos until the strike was over then refueled two of the fighters before returning to Clark. (14:126,127)

During the nine years and two months of the war in Southeast Asia (SEA), the KC-135s had provided 813,878 refuelings and had transferred 1.4 billion gallons (8.96 billion pounds) of fuel. (12:iii) Throughout the conflict, KC-135s staged from non-hostile airfields such as U-Tapao Thailand, Andersen AFB Guam and Kadena Air Base, Okinawa. Except for special missions such as Linebacker I and II, where tankers flew near North Vietnam's Haiphong Harbor area, their refueling tracks were permanent refueling "anchors" (see atch 1) which were situated far from known surface-to-air (SAM) batteries and anti-aircraft emplacements. The airspace to and from these anchors was virtually free from enemy aircraft so the air-to-air threat was almost non-existent. (12:105) Official records indicate

that we lost five KC-135s in the entire war in Southeast Asia, none of which were attributed to enemy action.(12:106) Normal air refueling sorties lasted 4 to 5 hours and were flown at altitudes above 20,000 feet (some sorties were flown at 15,000 feet since fully loaded F-105s could not afford the extra expenditure of fuel needed to climb above this altitude).(12:21)

The type of air refueling operations experienced in support of SEA are gone! The next war, whether it be in Europe, the Middle East or possibly in Latin America, will require a whole new set of tactics and procedures to deal with the near certain air-to-air and surface-to-air threats of the 1990s and beyond. Tanker survivability has been discussed in the past, but has not evolved into command-wide tactics. As mentioned, we were fortunate in SEA to have gained air superiority in the early stages of the war, we were also fortunate that radar guided SAMs were confined mostly within North Vietnam, particularly the Hanoi/Haiphong areas. With the rapid increase in technology and the proliferation of an entire family of Soviet SAMs, now owned and operated by our potential adversaries, the airspace over and near the next battlefield will be extremely lethal to the unarmed KC-135.

The KC-135 is a high value asset, not because of its price tag; but because of its limited numbers and its unique

role of providing the necessary range and endurance to its receiver aircraft. As Lt. Gen Harley Hughes, Air Force ex-Deputy Chief of Staff for Plans and Operations once said, "...the tankers really are the lifeblood of our fighting force...a national asset...irreplaceable."(10:319) Since the KC-135 is no longer in production, any significant losses in the next war will have a noticeable affect on sustained air refueling support of conventional combat air operations; not to mention the liability inflicted upon the nation's nuclear bomber force without sufficient refueling assets to strike deep targets. Granted, the KC-10 can still be manufactured; however, their price tag limits their expendability. Besides, with their huge cargo carrying and air refueling offload capability, the KC-10's mission will more than likely be limited to fighter aircraft ferry and cargo support missions from the U.S. in the early stages of hostilities.

Today our tanker crews train using the same tactics and procedures used in the Vietnam war. In our most realistic war-like scenarios, flown over the Nevada desert at Red Flag, we still see KC-135 aircrews flying high-altitude, three-ship trail formation. The way we operate at Red Flag is not realistic! If we don't change our parochial thinking about tanker air refueling procedures and tactics, and focus sharply on tanker survivability, we will lose tankers in the next war!

The purpose of this paper is twofold. First, to show how truly vulnerable the KC-135 is in today's Soviet threat environment given a war in Europe. Second, to suggest and analyze different tactics and procedures which might improve the survivability of these vital refueling assets. This paper will also develop air refueling tactics to enhance fighter aircraft close air support (CAS) and battlefield air interdiction (BAI) commitments in a future hostile environment.

There are certain assumptions and limitations that must be stated so as to define and narrow the scope of this analysis, they are:

ASSUMPTIONS

(1) At the outbreak of hostilities in Europe, it can be assumed that Soviet air and ground forces will make a concerted effort to neutralize or destroy allied airfields in NATO that pose an immediate threat to their offensive drive westward. Soviet Backfire and Bear bombers, as well as heavy artillery and Soviet "Spetsnaz" forces will more than likely target airfields in Central Europe. A January 1989 Washington Times article reinforces this assertion.

...The United States and NATO will have to dramatically rethink the entire concept of fixed, forward-based air operations...new Soviet tactics (airfield interdiction and destruction) would mean runway-based planes may not have a home to come

back to.

...According to Don Kerr, air power specialist with the International Institute of Strategic Studies in London....(the Soviets) will come after our airfields with everything they've got in the first few hours of the war...they know the exact location of every airfield in NATO. It's actually very difficult to destroy one (an airfield), but it is not difficult to give us a very bad 36 hours....The Soviets conclude 50 percent of NATO's firepower is in its aircraft. Success to them depends on destroying our airpower on the ground in the first hours. They can put down Scud B missiles with fuel-air explosives or chemicals, scatter anti-personnel mines, and keep NATO aircraft holed up long enough to get their own aircraft overhead to put iron bombs in the runways.(1:1)

Given this assumption, we can further assume that those surviving fighter and tanker assets, plus those aircraft deploying from the CONUS, will most likely be forced to be based in Western Europe, i.e. United Kingdom, Norway, Iceland, Spain, and Portugal. (1:1) The Soviets have now forced Allied tactical aircraft to traverse greater distances to the FLOT (Forward Line of Own Troops *) located along the NATO/Warsaw Pact borders, which increases their exposure to the enemy's air and ground threat. This will also radically increase enroute air refueling requirements

Note: The battlefield can be broken down into two integral parts: the FLOT and the FSCL. The FLOT is "a line that indicates the most forward position of friendly forces in any kind of military operation at a specific time." Whereas the FSCL is "a line established by the appropriate ground commander to insure coordination of fire that is not under his control, but may affect current tactical operationsthe FSCL should be placed as close to the FLOT as operational and safety considerations permit...at least 25 kilometers...when operating with U.S. ground forces."(9:247)

so as to deliver our combat air forces to the battlefield with enough fuel to successfully conduct CAS and BAI operations in support of the ground commander.

(2) Our air assets commonly employed for CAS/BAI are normally those with a relatively short combat radius. Attachment 3 lists the combat radius without air refueling for the following aircraft: F-4 at 425 Kilometers(KM), A-10 at 460KM, and the A-7 at 800KM. Given these ranges, and assuming they will have to operate from bases in Western Europe; these attack aircraft must refuel in order to transit to and from the FLOT, while at the same time have enough fuel endurance to loiter over the FLOT to conduct their missions.

(3) It is commonly held that fighter aircraft survivability in the combat zone depends upon a combination of speed, electronic deception, maneuverability, sustainability, and "nap of the earth" (below treetop level) flight to avoid enemy radar detection.

(4) Given the unrelenting Soviet conventional arms buildup and force modernization, there is no guarantee of NATO air superiority over the next battlefield in Europe. Our forces are significant, however, the first week to ten days of the war will be such that anything that flies on either side will most likely be extremely vulnerable to

air-to-air as well as SAM attack.

LIMITATIONS

(1) This analysis will focus on the KC-135's support of short range attack aircraft such as the A-10, F-4, and A-7 in their CAS and BAI roles. The battlefield is Europe in a NATO/Warsaw Pact confrontation. The conflict is a full-scale conventional war with U.S. air assets supporting the Army's AirLand Battle doctrine. There is no defined forward edge of the battle area (FEBA), and enemy concentrations are scattered either side of the traditional NATO/Warsaw Pact border, with enemy special forces deep in NATO territory.(3:254)

(2) Low intensity conflict and special operations will not be addressed since they lend themselves more to the parochial SEA style of air refueling. In these operations, the enemy is most likely isolated to a specific geographical area and in many cases surrounded or bounded by large bodies of water. With our naval superiority, air refueling over international waters is relatively safe.

(3) KC-10 assets will not factor into support of fighters operating in or near the FLOT. KC-10 operations are envisioned to be solely limited to ferrying aircraft (along with their logistics support) to and from the European theater. The KC-10 will also play a major role in refueling

C-141s and C-5s bringing troops, equipment and supplies to various in-theater staging areas.

(4) Fighter tactics will not be addressed once they have departed the tanker. This analysis is limited to delivering the fighters near their target area fully fueled, at low altitude and at high speed.

CHAPTER II

THE THREAT

If the enemy wanted to halt our highly competent air arm "dead in its tracks" in a war in Europe, all they would have to do is knock out our tanker aircraft. In a high threat environment, the unarmed KC-135 is currently a "sitting duck" since the obvious in-theater threats to the tanker are many: enemy air-to-air weapons, ground launched heat-seeking missiles, and radar guided antiaircraft ground fire. Tankers which fly preset, common routes to and from predetermined air refueling areas, and who fly within preestablished air refueling orbits at or above 5000 feet above ground level (AGL) are extremely vulnerable to the aforementioned threats. It is highly conceivable that by destroying only the Allies' air refueling assets, that the enemy could virtually eliminate NATO's tactical air participation in the AirLand Battle. Let's take a close look at each of these threats as they pertain to an East-West war in Europe.

Air-to-air

In this situation, let's visualize three KC-135s from Mildenhall AB, United Kingdom have just refueled 12 F-16s at 20,000 feet (FL200) at a location 120 miles west of

East Berlin. The fighters are in a enroute descent down to 200 feet AGL to get under enemy radar coverage scattered throughout the area. Twenty minutes have elapsed when number three tanker in trail formation sees his lead aircraft and number two tanker explode in two brilliant fireballs while at the same time sees two yellow/white streaks of smoke pass his left wing. Soviet fighters! The next set of rockets launched find their target on the remaining tanker. Three KC-135s disappear in one of the easiest turkey shoots of the war. This graphic visualization shows just how vulnerable our tankers are to the increasing numbers of Soviet/Warsaw Pact MiG-31 Foxhounds, MiG-29 Fulcrums, and other air interceptors with their highly sophisticated air-to-air look down/shoot down capabilities.(8:135)

The unrefueled range of the MiG 31 (approximately 2100 nautical miles) poses a threat to all of NATO. The MiG 29, on the other hand, with a lesser unrefueled range, can, however, be quite effective in air-to-air operations in the Central Region (see attachments 2 and 3). These Soviet air interceptors each carry 6 to 8 air-to-air missiles.

(13:58,75)

Surface-to-Air

As previously noted, when hostilities break out in a NATO/Warsaw Pact war in Europe many Allied airfields will most likely be neutralized driving Allied air forces to

operate from bases in Western Europe. By doing so, enroute distances to the target areas in Eastern Europe will increase; and therefore, require increased air refueling support to Allied fighters. These enroute distances would also prolong both tanker and fighter exposure times to the air-to-air and SAM threats.

Unlike Vietnam where it was relatively clear where the enemy was located, and even clearer boundaries of "threat free" airspace, the war in Europe will be quite different.

...With improved communications and more mobile forces on both sides, there may not be much in the way of 'front lines'....the U.S. Army would employ 'offensive defensive' tactics, perhaps falling back in front of the enemy advances and counter-attacking in a different place. The end result is a checkerboard battlefield, with 'good' and 'bad' squares interspersed. The enemy may be in some of our rear areas....The Air Force must be able to provide close air support to the Army units no matter how unfriendly the skies (or territory) are. The battlefields of the future will be far more lethal than the those of Vietnam. The threat to aircraft is more formidable...there will be few areas of low lethality. Wherever the enemy is, he will have a full range of modern, capable, air defense weapons -- everything from shoulder-fired weapons right on up to the latest mobile SAMs.(3:254)

...Soviet/Warsaw Pact industries produce 28,000 SAMs each year...three times as many as NATO....the Soviet/Warsaw Pact will have one tactical SAM system for each NATO aircraft. These are strengthened by larger numbers of highly effective, mobile antiaircraft artillery (AAA), such as the ZSU-23-4.(11:137)

...the ZSU 23-4 self-propelled antiaircraft gun...is radar controlled and can fire up to 800 rounds per minute. Soviet tank and motorized rifle

divisions also have the S-60 57mm self-propelled antiaircraft gun, which is radar-controlled. These are accompanied by the deadly SA-6 SAM missile system....each company is equipped with the SA-7 missile, a shoulder-fired heatseeker similar to the U.S. Redeye. A newer, longer-range SAM is the SA-8, which is deadly up to 8 miles (48,000 feet) or more from its launcher. Backing up these highly mobile systems are large numbers of acquisition and early-warning radars, most of them redundant, which makes these systems very hard to counter.(3:254)

It would be extremely advantageous, in keeping with Soviet warfighting doctrine, to send these special motorized rifle and tank units (at the beginning of the conflict) deep into NATO territory. These units would employ their mobile, radar guided surface-to-air missiles to effectively counter the incoming Allied air threat.

The skies over Europe will be extremely hazardous to any aircraft flying during times of hostilities. The KC-135 will be no exception. Being a high value asset, the tanker will be a "special prize" for the Soviet interceptor pilot or the SAM/AAA operator.

CHAPTER III

CURRENT TACTICS AND PROCEDURES

Today KC-135 aircrews refuel fighter aircraft exactly like they did in Southeast Asia in the late 1960s and early '70s -- nothing has changed. On a daily basis, SAC crews takeoff from locations around the world to refuel fighters at high altitude, normally in established air refueling "anchors" or "tracks", and do so in either single ship or formations of 2 or 3 tankers flying trail formation, stacked up in 500 foot intervals. Anyone who could get their hands on a tanker air refueling manual, and who had read any number of unclassified articles on air refueling in SEA, could easily build a simple plan to attack these assets. At present, we are very predictable on how we employ the KC-135.

Initial Studies of Low Altitude Refueling (LAAR)

The Chief, SAC Tactics Division, 1st Combat Evaluation Group (1CEVG), Barksdale AFB LA, confirmed that current high altitude air refueling procedures left the KC-135 extremely vulnerable since there are no means of active self-defense, nor are there currently any realistic inflight tactics to increase the tankers survivability in the next war. This issue of survivability is a valid one and

is shared by the SAC staff and aircrews alike.(6:--)

Given the fact that high altitude refueling leaves the tanker more susceptible to enemy attack, several SAC KC-135 squadrons that have experimented with the effects, not tactics, of low altitude air refueling -- that is, at or below 5000 feet AGL. There are two Air University, Air Command and Staff College studies (one printed in 1985 and the other in 1988) which deal with KC-135 low altitude air refueling (LAAR). The first report deals primarily with the effects low altitude flight has on the KC-135 airframe; and the other is a synopsis of four low altitude test sorties flown by the 305th Air Refueling Wing, Grissom AFB IN in the Spring of 1987.

The first study was based upon a computer simulation test and KC-135 technical order data. The study concluded that low altitude flight is feasible; however, peacetime safety of flight may be in jeopardy because of undue stress placed upon the airframe.(7:41) In early 1985, the Boeing Military Airplane Company (BMAC), makers of the KC-135, recognized the effects of turbulence on the tanker's airframe resulting from low altitude flight; and using their computer model, determined that certain modifications were required to eliminate/repair structural cracking. These modifications were Engineering Change Proposals (ECPs) in the form of Time Compliance Technical Orders (TCTOs). Two of

these required modifications were:

- (1) TCTO 989/ECP 405, "Lower Wing Surface Reskin Program," and
- (2) TCTO 1200/ECP 484, "Outboard Wing Lower Surface Life Extension Modification."(7:17,18)

According to authorities at the KC-135 Material Management Branch (OC-ALC/MMSRA) Tinker AFB OK, all KC-135s completed TCTO 989 in 1987; and approximately one-third have undergone TCTO 1200 with a final completion date in CY1991. Each TCTO requires certain detailed inspection criteria that is normally done at Programmed Depot Maintenance (PDM), Wichita KS. There are times (especially in a prolonged conventional war scenario) when required inspections would come due and the airframes would be unable to return to depot. In such cases, these Non-Destructive Inspections (NDI) could be performed by local base personnel once trained on the NDI test equipment.(7:21)

The findings of this report clearly state:

...The KC-135 should not fly low level without the modifications incorporated in TCTO 989 and TCTO 1200....and that inspection requirements increase significantly when the airplane is flown low level for long periods. Inspection requirements also increase as gross weight and/or airspeed increases. The concept of KC-135 low level refueling is a viable option for planners.(7:41,43).

The second study discusses a test conducted by the

305th Air Refueling Wing (ARW) which dealt with the handling characteristics of the KC-135 during LAAR. This test consisted of four flights by a KC-135 at altitudes between 3000 and 5000 feet AGL and a speed range of 240-310 knots, indicated airspeed (KIAS), refueling A-10s and F-4s.(4:2)

This study concluded the following:

- (1) Aircraft control is safe and the pilots felt comfortable at all test altitudes and airspeeds.(4:37)
- (2) LAAR is a safe procedure for the average tanker pilot; however, an experienced boom operator is preferred for operations in light to moderate air turbulence.(4:37) Other crew factors and limitations were explored, but it was determined that they could be overcome with LAAR familiarity and training.(4:44,45)

These two studies have also been analyzed by the KC-135 Tactics Division, 1CEVG, which is the center for establishing LAAR procedures and tactics. To date, they have researched the aforementioned studies, and analyzed several of their own test missions. They have been in direct contact with the KC-135 Program Manager at BMAC. The most recent guidance published by 1CEVG dated 28 April 1988, established the following LAAR limitations:

- (1) LAAR should not be attempted precipitously command-wide, but should await adequate airframe stress analysis by aircraft vendor and a proper training facility (low level restricted flying

areas) with core instructors prior to implementation.

(2) LAAR at 3000 feet AGL requires no special training program other than a routine familiarization sortie and then continuation training.

(3) Use aircraft that have been modified with TCTOs 989 and 1200.

(4) At this time it is not recommended to train for refueling/navigation below 1000 feet AGL.

(5) Navigation:

(A) Students attending Undergraduate Navigation training in the T-43 aircraft trainer at Mather AFB CA receive 48 hours of low altitude navigation academics, four low altitude T-45 simulator missions and two low altitude T-43 missions. Because of the similarities in navigation equipment between the T-43 and the KC-135, the low altitude training at Mather is well suited to the tanker mission.

(B) Flying between 2000 and 3000 feet AGL, the onboard navigation radar (APN-69) is a useful aid. Flying between 1000 and 2000 feet AGL the radar becomes less reliable; therefore, map reading and dead reckoning (DR) techniques should be used. Below 1000 feet, radar is virtually eliminated, relying solely on map reading and DR.(5:--)*

The bottom line is that LAAR procedures (as well as Low Altitude Navigation) are still in their infancy stages. Very few aircrews have actual hands-on low altitude air refueling flying. In summary, the factors which currently delay implementation of this valuable wartime tactic are:

NOTE: Crews should be able to use the on-board Inertial Navigation System (INS) which provides longitude/latitude information of their present position, and also gives heading information corrected for winds to their next ground navigation point. This aid, plus terrain/map reading, should be adequate in clear weather.

(1) Lack of conclusive tests of the KC-135 airframe to see if it can truly withstand peacetime training sorties at altitudes below 1000 feet AGL even with TCT0989/1200 modifications accomplished.

(2) Formation of several low altitude training areas which would be long and straight enough for crews to practice which would be free from ground obstructions and other low flying aircraft.

(3) An inexpensive, technologically-advanced, aid to navigation while flying at altitudes below 1000 feet AGL in other than clear weather conditions.

Yet the KC-135 is capable of superb maneuverability especially at low altitude. In January 1987, when low altitude air refueling was just a glimmer in the SAC planners' eyes, this author was selected to develop and flight test maneuvers for SAC's B-52/KC-135 Aerial Demonstration team called "The Thunderhawks". The purpose of this demonstration team was to show the versatility and maneuverability of SAC's large warfighting airplanes. The demonstration profile included formation flight of a single B-52 and a single KC-135 in close trail formation, in wing-tip formation, steep bank turns, and air refueling. Each of these maneuvers was performed at 200 feet AGL. It

was my experience that refueling, DR navigation, and aircraft control were not much different than at higher altitudes. It was determined that power and flight controls were very responsive and that the KC-135 handled like a 'fighter' at these low altitudes. One maneuver called the "break", was a quick separation between bomber and tanker which occurred at the end of the air refueling portion of the demonstration -- the tanker turning left and the bomber turning right. At 310 KIAS, and at 200 feet AGL, the KC-135 would go from straight and level flight to a 70 degree left bank turn in under two seconds with very little effort at all. The tanker's climb capability while still in this steep bank turn was also very remarkable.

Low level refueling in the KC-135 is not much different than conducting the same operations at FL250. Flying at lower altitudes does take more concentration and effort to see and avoid other low flying aircraft or ground obstacles. This is a valid tradeoff when one considers the benefits of flying low in an effort to avoid enemy radar/SAM threat.

CHAPTER IV

TANKER DEFENSE

So far, we have determined that the air-to-air and surface-to-air threats are formidable to the survivability of our KC-135s in a war in Europe. We have also determined that Soviet doctrine dictates a concerted plan to neutralize or destroy NATO airbases in Central Europe at the outbreak of hostilities. Since the remaining Allied air bases would then be situated in the far reaches of Western Europe, the need for inflight refueling of our fighter aircraft is a paramount necessity in order to bring our air power to bear upon the enemy.

As discussed earlier, a means of eliminating the Allies' airborne force projection would be to destroy NATO's tanker assets; thereby significantly reducing the necessary range and endurance of our short-legged attack fighters launching from Western Europe. Therefore, the question remains: in order to wage a successful air campaign against selected, high threat targets in support of the Airland Battle in Europe, how do we defend our tankers so as to survive these threats posed by our competent adversary? In today's era of burgeoning budget deficits and tight fiscal constraints on defense spending, any multimillion dollar

"star wars" tanker self-defense scheme would be unrealistic. Therefore, the following list of low cost alternatives will be analyzed:

- (1) Self-defense force package
- (2) Electronic Countermeasures
- (3) Low Altitude Air Refueling

Self-Defense Force Package

In support of the AirLand Battle in Europe, the KC-135 will most likely be refueling the following aircraft designed for CAS/BAI: F-4C/E, A-10A, F-16A and A-7A/D. It is proposed here that a force projection package be created that centers around the KC-135. By building such a package, comprised of any combination of the aforementioned aircraft depending upon the mission (plus an EF-111, F-15s and an AWACS), the survivability of the KC-135 would be greatly enhanced. Consider the example of an Army ground commander requesting close air support in an extremely high threat zone. After analysis, the Theater Air Component Commander determines that four A-10s and two F-16s are required to neutralize the enemy ground targets. What type of package should be put together for the CAS mission as well as for tanker/force package defense against any number of air-to-air or SAM threats in this hostile zone. Here is a sample of a proposed force package:

-- Two KC-135s

---One tanker for enroute refueling and for final

prestrike fuel top-off for the fighters. At a predetermined 'safe' distance from the FLOT, this tanker returns to home station.

---Second tanker continues with fighters in tow to the target area.

-- Four A-10s and two F-16s (CAS/BAI dedicated assets)

-- One F-4E (SAM and radar controlled antiaircraft weapons suppression.)

-- One AWACS (this aircraft is not an integral part of our force package, but is in radio and radar contact while our force package is enroute to and over the FLOT.)

---The AWACS will provide real time air threat information, current data and updates on CAS/BAI targets, and navigation assistance by providing radar vectors for the least hostile route to the target area.

-- Four F-15s (these aircraft will provide MiG defense to suppress the air threat. This number can be reduced if the AWACS in the area has sufficient air cover.)

-- One EF-111 or EA-6B (used to determine the electronic threat, defeat enemy radar with electronic countermeasures, and warn the force package to take defensive action.)

After the first tanker departs, and assuming there is an AWACS in the area with F-15 escort for the air-to-air threat, our force package will look like this: one KC-135, one EF-111 on the tanker's left wing along with the two

F-16s and the F-4E. On the tankers right wing is the flight of four A-10s. After the A-10s and F-16s complete their CAS/BAI missions, the EF-111 and F-4E can either stay with the force package or can depart on a secondary mission after receiving fuel from the tanker. This will be at the discretion of the Theater Air Component Commander after careful real-time threat analysis.

To the planner, these additional aircraft required to defend the "high value" tanker, as well as the transiting CAS/BAI aircraft, is a small price to pay to survive these assets in a hostile environment thereby reducing attrition rates that today are in the Soviet's favor.

Electronic Countermeasures (ECM)

One trade-off that could be made in the structure of this force package would be to outfit the KC-135 with its own ECM equipment replacing the need for the EF-111 or the EA-6B. "ECM pods (either procured or surplus from tactical forces) as well as chaff and flare dispensers...would provide a formidable electronic (defense) detection platform."(4:21) The alternative of least cost would be to use ECM packages salvaged from retiring B-52s and install them as a palletized unit [similar to the Palletized Inertial Navigation System (PINS) temporarily installed on KC-135s which deployed to Europe in the 1970s and early 80s]. Ideally, each KC-135 squadron would have 2 or 3 of

these portable ECM packages at their disposal to train their crews; then deploy with these packages to be used on selected, high threat air refueling missions in the war in Europe.

Low Altitude Refueling

In an attempt to avoid enemy electronic detection, the majority of U.S. combat strike aircraft have adopted high speed, low altitude, "nap of the earth" tactics to either remain below enemy ground radar; or to blend into the radar ground clutter of the "look down/shoot down" air threat. The KC-135 should do the same to enhance its survivability. As an integral component of the aforementioned force package, the tanker should maneuver with the fighters so as to traverse hostile territory enroute to a specified geographical target location on time. (Fighter delivery tactics will be discussed in Chapter V.) In the fog and friction of war, and in the interest of self-defense, low altitude flight and air refueling could become a necessity -- even if the distance is 50, 100 or 200 miles. What is the advantage of low level flight against the surface-to-air threat? Low level flight significantly reduces the time of exposure to line-of-sight targeting, and the enemy's reaction time to lock-on and fire his missiles.

Figure 1 graphically illustrates the advantages of low level flight in a hostile environment. Consider, for

example, a Soviet Spetznaz team located well behind the Allied front lines in Central Europe near the French/West German border. This team is mobile and is equipped with an arsenal of handheld, heatseeking SA-7 missiles together with the newer, longer range SA-8 carried on mobile launchers. Assume also that the team is dug in and camouflaged in the center of an open meadow situated beneath a well-known air refueling corridor used by Allied fighters enroute to the front. For simplicity, assume the length (diameter) of the meadow is 640 feet and surrounding the meadow are trees averaging 100 feet in height somewhat restricting visual line-of-sight with the horizon.

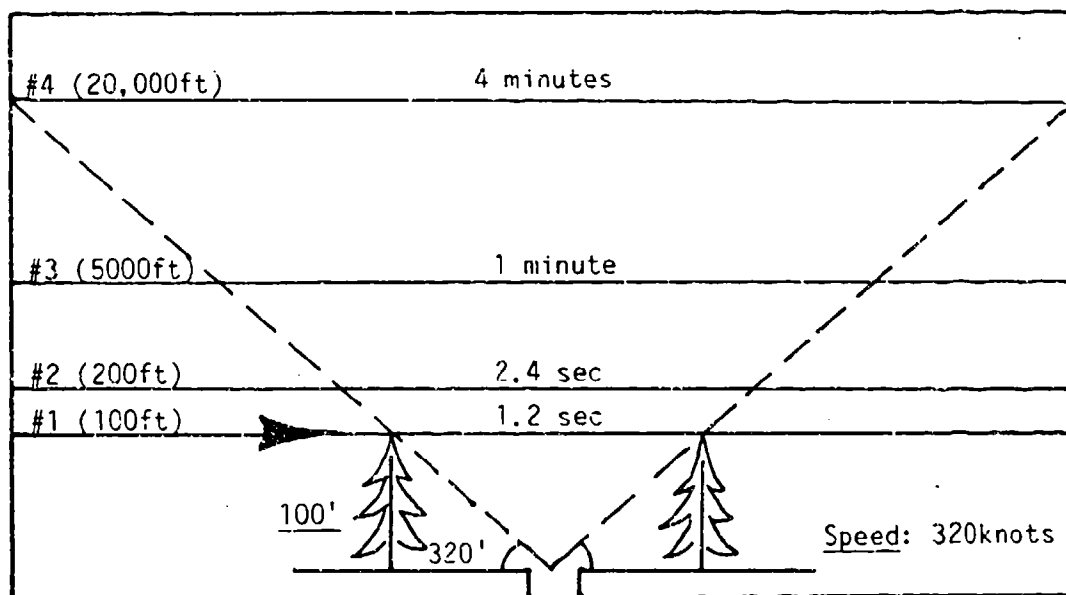


Figure 1.

Using simple mathematical relationships, the line-of-sight exposure time for a tanker overflying this meadow at different altitudes can be computed. Assume the tanker is flying at a constant ground speed of 320 knots (this speed

is compatible with fighter air refueling limitations). Aircraft #1, flying at tree top level (100') will be in visual contact for enemy recognition and missile execution reaction time for only 1.2 seconds. Not Bad! For aircraft #2 at 200 feet, the time is 2.4 seconds -- still not bad. But now look at the aircraft at 5000 and 20,000 feet, the time increase to one minute and four minutes, respectively. Plenty of time for the enemy to launch more than one missile at the unsuspecting tanker and receivers.

Suffice it to say that flying low level has distinct advantages in avoiding the surface-to-air threat since it significantly reduces exposure times. It also reduces exposure time to ground-based radar. "Aircraft remaining outside the horizon-induced limit of radar could remain undetected. Radar horizon distances can be computed...by factoring the aircraft altitude, height of the radar antenna and 'K', a constant."(4:11,12) For example, given no obstructions to line-of-sight with the horizon, an aircraft flying at 10,000 feet MSL can be acquired by a radar facility having a 20 foot antenna as far away as 129 miles.(4:12) Detection distances are directly proportional to aircraft/antenna height and an unobstructed line-of-sight. In other words, the lower the aircraft, the shorter the antenna, and the rougher the terrain, the shorter the detection distance.

We have looked at three low-cost methods to defend the KC-135. There may be times when tanker defense would not be as critical and the tanker could easily complete its mission using any combination of the above alternatives. However, it is on those selective missions when known or suspected enemy ground and/or air defenses are heavily concentrated that would require the combination of all three defense alternatives so as to better insure we get the "ordnance over the target" in support of the ground commander. In Chapter V, we will develop tactics for this proposed force package, as well as, low altitude flight/air refueling for tanker defense.

CHAPTER V

TANKER TACTICS AND FIGHTER DELIVERY

Now that we have analyzed the feasibility and benefits of low altitude air refueling, and have also determined the need for force package self defense; let's turn to the employment of these two concepts in the form of theater tactics for the KC-135 and its receiver aircraft. There are two primary objectives in developing tanker tactics for a conventional war in Europe: (1) tanker and receiver aircraft survivability; and (2) refueling strike aircraft so that they arrive over the FLOT with sufficient fuel to successfully conduct CAS/BAI operations and return to home station. In pursuit of these objectives, tactics need to be developed for the following areas:

- (a) Air Refueling Route Profiles, and
- (b) Fighter Delivery Near the FLOT.

Air Refueling Route Profiles

As described earlier, a proposed force package would consist of the following: 2KC-135s, 4A-10s, 2F-16s, 1F-4E, 1EF-111, 4F-15s, and 1AWACS. Remember, the AWACS must be in the vicinity of the FLOT; and if the AWACS has sufficient protection, then the additional F-15s are not a necessary part of the force package. This analysis will not address

any particular air-to-air nor air-to-ground weapons for defense, but instead will deal with airborne flight profiles which will inhibit the enemies ability to readily locate and shoot down the KC-135.

Upon mission execution, the elements of the force package will depart their respective bases in Western Europe and rendezvous at a predetermined point over friendly soil at a single altitude between FL240-280. Once joined-up, the force package will cruise at the rendezvous altitude towards the target area. Depending on the threat analysis provided by real time intelligence, the fighter aircraft will receive a fuel top-off from tanker #1 prior to entering the known hostile zone. At a predetermined distance from the zone, tanker #1 returns to home station. At this time, the remaining force package descends to 5000 feet AGL. Approximately 10 miles prior to entering the threat area, depending upon the weather and terrain, the force package will descend to 300-500 feet AGL. It is important to emphasize here that the route from the rendezvous location to the point entering the hostile zone should be random. In other words, there should be no daily common route going from West to East since this type of flight profile becomes predictable, and therefore, easily targeted. Once in the hostile zone, low level navigation is based upon the threat analysis and the least hostile route is flown to the end air refueling(EAR)/fighter drop off point. Thirty minutes prior

to EAR, the fighters once again begin air refueling for final fuel top-off.

Let's look at this route profile in segments so as to analyze defense tactics. To better understand this, assume a hypothetical battlefield scenario (see atch 4). In this scenario, the FLOT is located along a north-south line along the NATO/Warsaw Pact boundary, it is indeed not a straight line; and we see enemy forces scattered well inside NATO's rear areas -- a typical "checkerboard" environment as alluded to earlier. The objective is to drop the fighters off at point "X" so they can conduct CAS/BAI operations at points "Y" and "Z" in support of the ground commander.

From the time the aircraft departed home station (points "A", "B" and "C"), until arriving at the rendezvous point "D", we'll assume minimal threat since this occurs in Western Europe hundreds of miles from the front. The route segment from the rendezvous point to the end of the first tanker's high altitude refueling (point "E"), however, may be considered medium threat since airbases have been destroyed in this zone.. From this point, including descent to 5000 feet AGL (point "F"), and later down to 300-500 feet AGL (point "G"), the threat continues to increase. It is now the responsibility of the AWACS, F-15s, F-4E, and EF-111, coupled with low altitude cruise, to provide defense against the Soviet air-to-air and SAM/AAA threat, to detect and

neutralize enemy ground radar, and provide electronic countermeasures and deception.

Fighter Delivery Near the FLOT

The next segment begins at point "F", approximately thirty minutes prior to the final EAR point, and ends with the strike aircraft departing the tanker near the FLOT (point "X"). This route segment is used to maneuver the flight so as to drop the A-10s and the F-16s off in the best possible position to successfully complete their missions. Point "X" (fighter EAR and drop off point) is located on a line which is parallel to the farthest westward advances made by enemy forces along the FLOT, and for purposes here is termed the "base line". The distance from the baseline to the FLOT is determined by the theater Air Component Commander, and is basically predicated upon the threat analysis within the area. Point "X", on the other hand, is jointly determined by the crews of the strike aircraft, the ground commander, various forward air controllers, and again based on the threat analysis.

The arrival route (defined by points "F", "G", and "X") is based on current intelligence, and is crucial to arriving at point "X" safely. The angle that is formed by the arrival route and the base line is the variable which enhances random arrival and reduces predictability. These two factors, coupled with low altitude maneuvering, will

help confuse enemy forces. The same is true when the tanker departs point "X" and proceeds to the post-refueling holding area. Depending upon the threat, the flight could arrive at point "X" using a 30 degree arrival and leave point "X" using a 45 degree departure angle. To coin a phrase, this could be termed a "30-45 refueling sortie." One could visualize any combination of similar variations used to confuse the enemy and limit exposure time, thereby enhancing survivability -- the options are numerous.

CONCLUSION

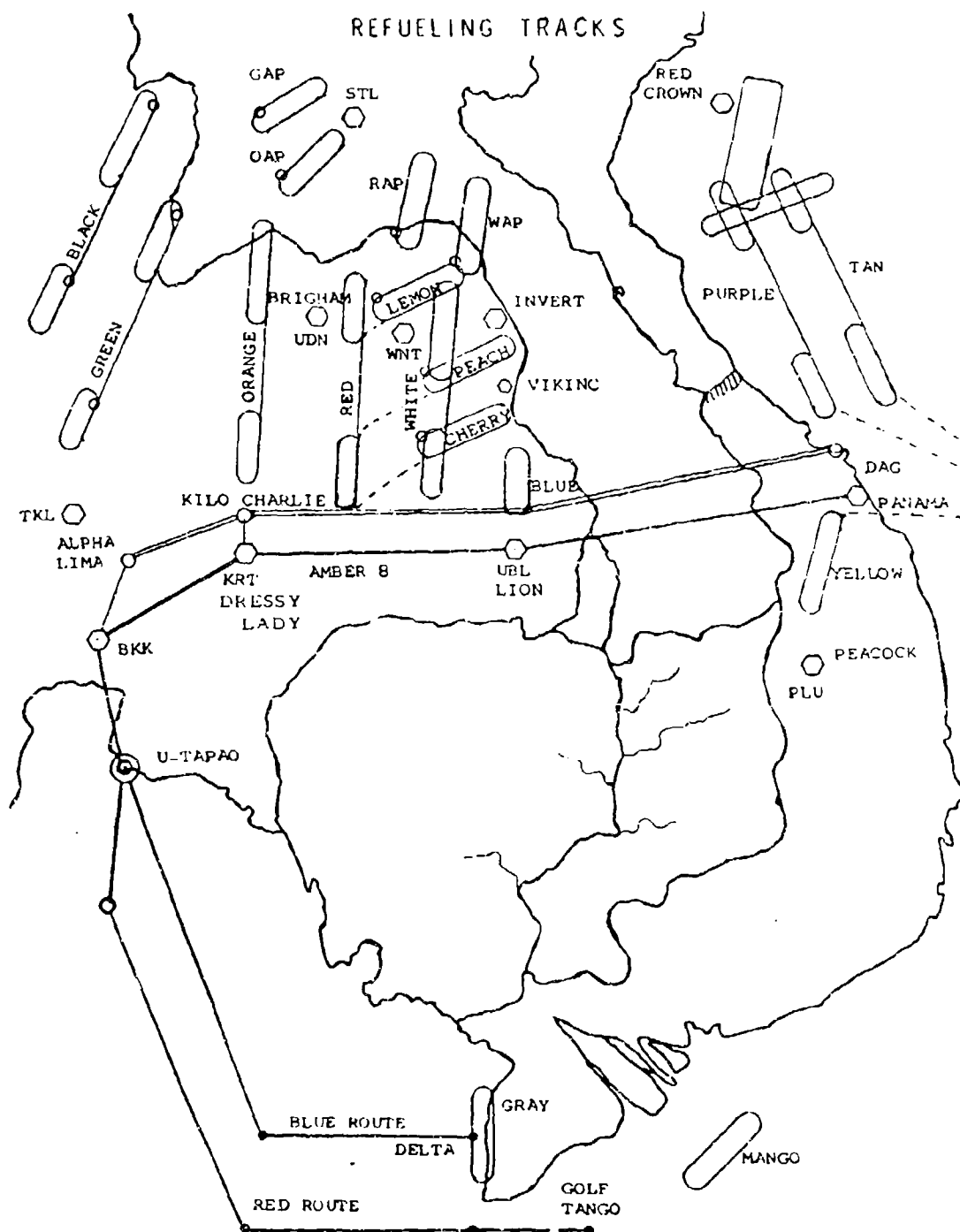
Developing SAC command-wide tactics to enhance the survivability of the KC-135 in a war in Europe has been long overdue. The parochial method of flying high-altitude air refueling formation along established tracks or anchors leaves the tanker and its receivers extremely vulnerable to our adversaries' sophisticated air-to-air and surface-to-air threats.

The tactics developed in this analytical study were designed to give the tanker a means of self-defense in the form of an airborne force protection package; plus low level maneuvers to help evade radar identification and/or visual acquisition. One might argue that the use of fighter escort as described herein is not cost effective; the fact remains, however, that any significant loss in KC-135 assets will have a substantial effect on the Air Force's means to prosecute sustained CAS/BAI roles from their bases in Western Europe. The costs, therefore, are well worth the return when one considers the cost-benefits of providing sufficient and timely air support to the ground commander.

The feasibility of low altitude cruise and air refueling have been documented in recent flight and

computer-generated studies. The many safety factors considered in performing such maneuvers rests upon airframe integrity problems which have been rectified in TCTOs 989 and 1200.

KC-135 survivability has not received adequate attention mainly because we have not been a war or conflict which placed the tanker at moderate or greater risk. In the past, we have not been faced with traversing a hostile environment and losing tankers as a result. The planner must recognize and deal with this eventuality if we are to adequately support our ground forces in a NATO/Warsaw Pact engagement in Eastern Europe. The time to develop tanker tactics is not after we have already lost one or two dozen tankers on day one of the war -- the time for tactics is now!



Legend: CAP, OAP, RAP, WAP: Green, Orange, etc. Anchor Points, i.e. extensions of same named refueling areas.
 Hexagonal Symbols: Communication Sites, with their call signs, which vectored tankers to rendezvous with receivers.
 Kilo Charlie, Amber 8: Flight routes across SEA.

STL: Luang Prabang	TKL: Takhli	UBL: Ubon
UDN: Udon	KRT: Korat	BKK: Bangkok
WNT: Sakhon Nakhon	DAG: DaNang	PLU: Pleiku

Europe

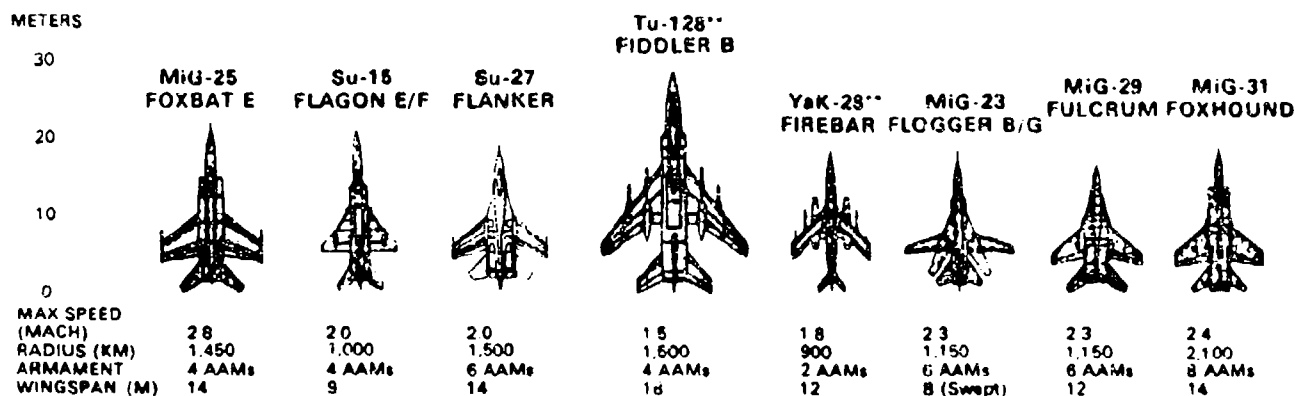
MIG 31 Foxhound (2100km)

MIG 29 Fulcrum (1150km)

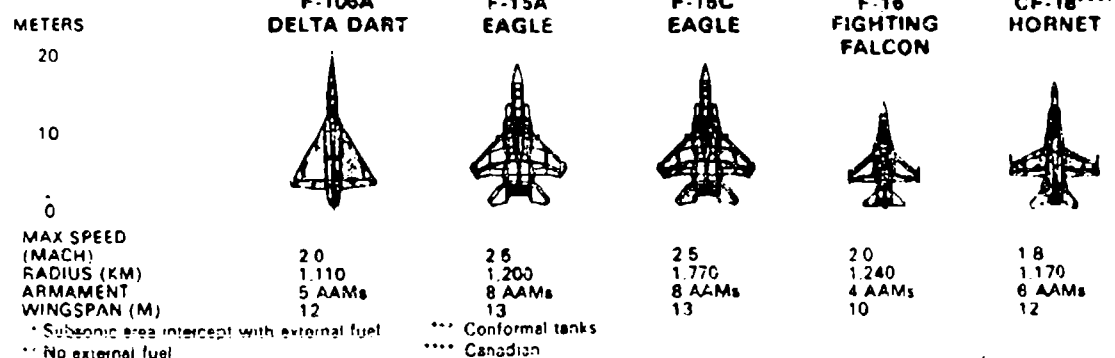


The United States Government has not recognized the incorporation of Estonia, Latvia, and Lithuania into the Soviet Union. Other boundary representation is not necessarily authoritative.

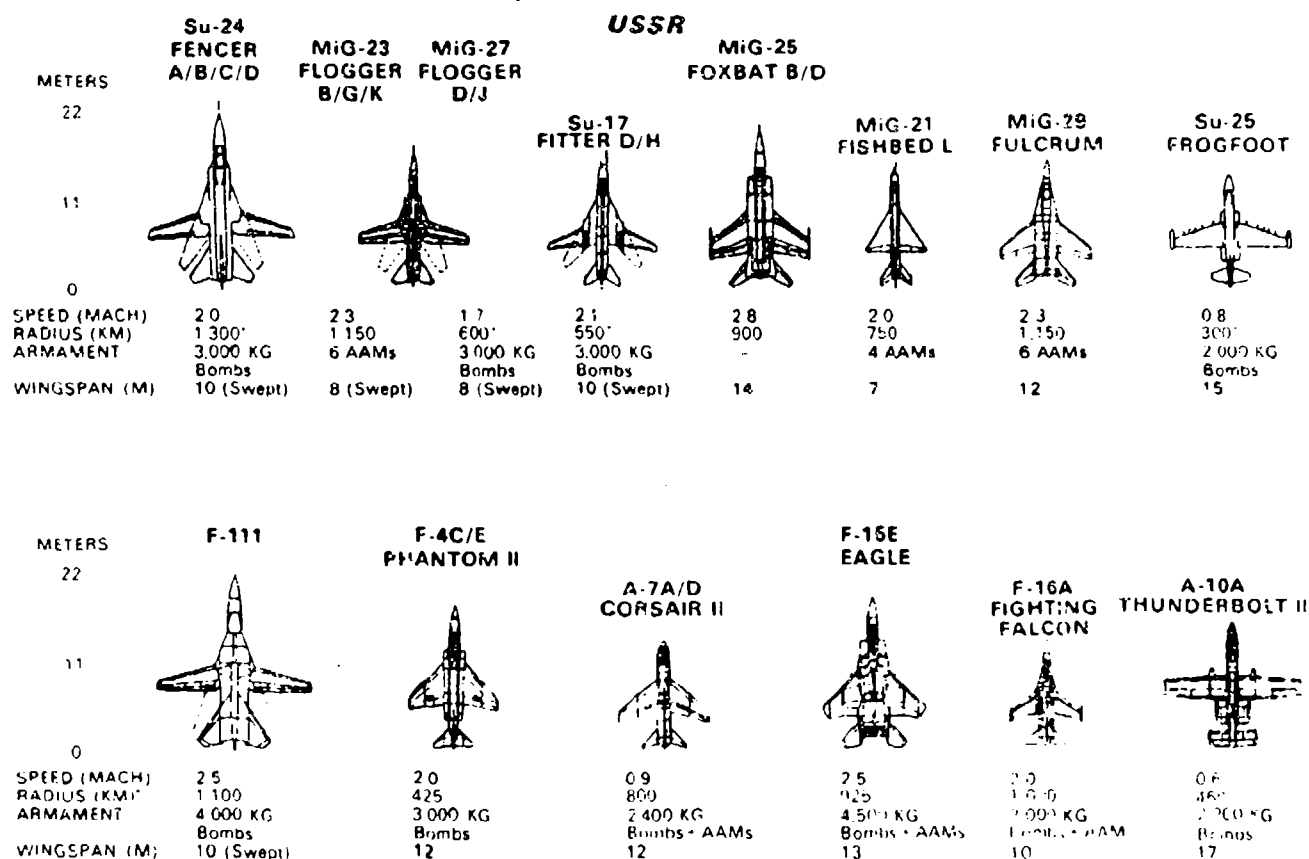
USSR Air Defense Interceptor Aircraft*

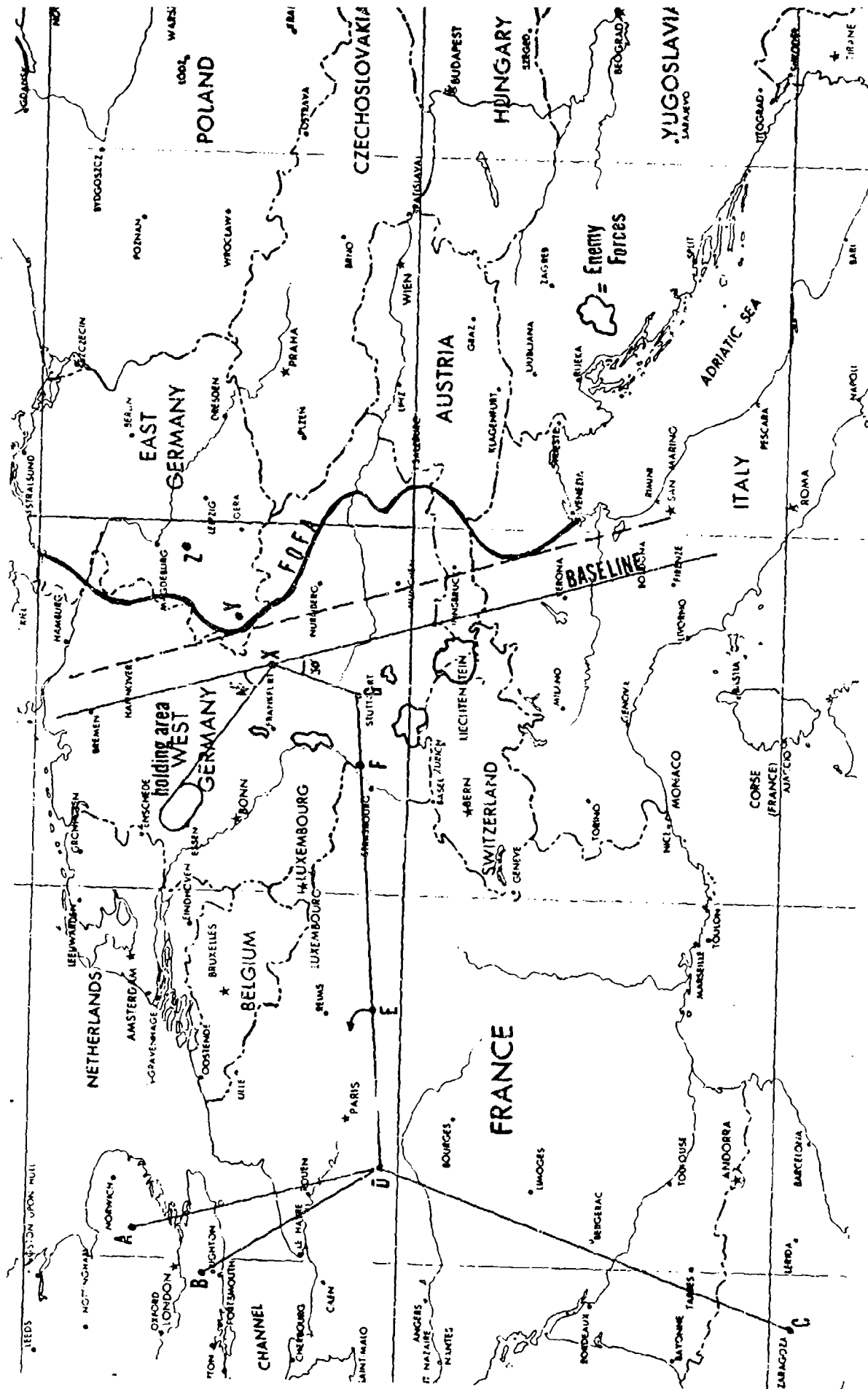


North American Air Defense Interceptor Aircraft*



Comparable Tactical Aircraft





BIBLIOGRAPHY

1. Almond, Peter, "In 1991, Air Force will learn whether it still has a home", Washington Times, 12 January 1989, pp. 1.
2. Boeing Military Airplane Company Report, "Evaluation of KC-135 Low Altitude Refueling Final Report", 15 Sept 87. BMAC, Wichita Kansas.
3. Coyne, James P., "Coordinating the Air-Ground Battle", Air Force Magazine, Oct 1985, pp. 64-70, in AWC Military Strategy and Force Employment Text, General Purpose Forces - Book 1, AY 1988-89, pp. 253-257.
4. Day, Major James L. USAF, "KC-135 Low Altitude Tactics", Air Command and Staff College Student Report No. 88-0680, Air University, ATC, Maxwell AFB AL, April 1988.
5. 1st Combat Evaluation Group, Barksdale AFB LA, "Low Altitude Air Refueling", 28 April 1988.
6. HQ SAC/DO/LG msg dated 192204Z Nov 87, "KC-135 Low Altitude Air Refueling Operations", Offutt AFB NE.
7. Krull, Major Timothy R., USAF, and Major Donald C. Siegel, USAF, "KC-135 Low Level In-Flight Refueling Operations", Air Command and Staff College Student Report No. 85-1500, Air University, ATC, Maxwell AFB AL, April 1985.
8. Lee, William T., and Richard Staar, "Soviet Strategic Force Prospects for the 1980s", Soviet Military Policy Since WWII, 1986, pp. 118-178, in AWC Department of National Security Affairs Text, Soviet Studies Text -- NS622, AY 1988-89, pp. 131-138.
9. McPeak, LtGen Merrill A., "TACAIR Missions and the Fire Support Coordination Line", Air University Review, Sep-Oct 1985, pp. 65-71, in AWC Military Strategy and Force Employment Text, General Purpose Forces -- Book 1, AY 1988-89, pp. 247-252.
10. Morger, Major Randal E., USAF, "Tankers for a Thirsty Fleet", Air Force Magazine, June 1986, pp. 74-80, in AWC Military Strategy and Force Employment Text, General Purpose Forces -- Book 1, AY 1988-89, pp. 319-323.
11. Powell, Major Jan S., "AirLand Battle: The Wrong Doctrine for the Wrong Reason", Air University Review, May-June 1985, pp. 15-22, in AWC Military Strategy and Force Employment Text, General Purpose Forces - Book 1, AY 1988-89, pp. 135-139.

12. "SAC Tanker Operations in the Southeast Asia War", Office of the Historian, Headquarters Strategic Air Command, Offutt AFB NE, 1979.

13. "Soviet Military Power - 1987", Government Printing Office, Washington DC.

14. "The Development of the Strategic Air Command, 1946 - 1986", Office of the Historian, Headquarters Strategic Air Command, Offutt AFB NE, 1 September 1986.