# TACTICAL AIR REFUELING: UNDOCUMENTED PAST, FUTURE REQUIREMENT

GRADUATE RESEARCH PAPER

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Keith W. Moncrief

## Table of Contents

Page

## List of Tables

Table

Page

## List of Figures

## Abstract

Largely the result of military restructuring away from overseas basing to a strategy of forward presence, the Air Force has adopted a concept of **Global Power - Global Reach**. Air Mobility Command has been charged to provide the **Global Reach** needed to project power abroad. The venerable KC-135 is a key component of the mobility half of this national warfighting strategy. Since its creation in the mid-to-late 1950s, the KC-135 Strato-Tanker has been involved in every United States war, regional conflict, special, contingency, peacekeeping, relief and peacemaking operation. The training requirements levied upon tanker crew members are not based upon projected--or past--theater employment experience. This paper seeks to chronicle the wartime experiences of tanker crews. This paper concludes with two findings:

1. A 100% bottom-up review of current training requirements is needed.
2. Innovative modeling techniques should be used to select tactical air refueling training events for use in the simulator and during KC-135 flights.

The adoption of these strategies will more closely link day-to-day tanker training activity to tanker wartime taskings.

# KC-135 TACTICAL AIR REFUELING: UNDOCUMENTED PAST, FUTURE REQUIREMENT

## I. Introduction

Since its development in the mid-to-late 1950s, the KC-135 Stratotanker has been involved in every United States war, regional conflict, contingency, peacekeeping, peacemaking, humanitarian relief, and special operation mission. To date no KC-135 loss can be directly attributed combat action; however, untold thousands of men and women who have flown the KC-135, nicknamed the "tanker," have, because the mission required it, encountered the same threat environment as aircraft they were refueling. The Air Mobility Command's "core tanker" (1996 Air Mobility Master Plan, 1995:vii) was produced during an era when America faced the imminent threat of nuclear annihilation and was expressly designed to support the United States' bomber fleet in the execution of one nuclear strategy or another. The Air Force's recent shift--some say evolution--from the classic Strategic Bombing Doctrine of the 1950s and 1960s to the newer DESERT STORM-types of tactical employment will bring refueling aircraft closer to large numbers of increasingly sophisticated threats. During future conflicts, the ever-supportive tanker fleet can expect to face weapons designed to knock fast-flying, fighter-sized aircraft out of the sky (Boeing, 1991).

Contrary to what might otherwise be believed, fighter-sized aircraft refueling requirements are more fuel-intensive than those of bombers. In fact, the Air Force's force structure movement away from the big, strategic bombers (B-36, B-47, B-52, B-1) to more fighter-sized bombers like the F-117, F-16, and F-15E has caused the wartime refueling demand to spiral upward. To illustrate, "The 14-hour...[F-15]...flight from Langley (Air Force Base, Virginia) to Saudi Arabia required each pilot to execute up to 8 mid-air refuelings. A fitting start to a war in which tankers played a crucial role. Over the six weeks of combat, tankers would pump 110 million gallons of fuel to 46 thousand planes" (Sayenga, 1991).

Background

Bases close to the area of conflict can help avoid dependency on air refueling. These bases are termed forward bases. The US has seen its number of forward bases greatly reduced in recent years. That fact, when combined with a desire to secure a strike force of growing complexity and cost, makes air refueling a resource of increasing value to the Department of Defense.

> As American "shooters" become more expensive and complex, it is readily apparent to even the most casual observer that these resources will never be exposed to the perils of front line basing. The absolute star of the Gulf War was the Stealth Fighter, a misnomer if there ever was one in that this exotic craft carries only bombs--not a single round or missile for the fighter role. Yet the typical mission of this 'silver bullet' required two air refuelings on its nightly excursions to downtown Baghdad. It was inconceivable that this aircraft would be based close to the fighting where it might become vulnerable to Scud attack or overrun by enemy forces early in the conflict. In fact, some 60 percent of all DESERT STORM attack sorties required air refueling. (German, 1994: 4)

Some sources indicate that the doctrinal shift from traditional bomber support to fighter refueling brings with it a corresponding need to refuel closer to the front--possibly over the threats themselves (Boeing, 1991). This increased need for tactical--that is to say, within reach of target area threats--air refueling was proven in DESERT STORM. Even in a limited theater such as the Kuwaiti Theater of Operations (KTO), the distances between coalition main operating bases and their targets routinely required at least two air refuelings. As cataloged in the Gulf War Air Power Survey Summary Report, a list of representative aircraft and target areas shows the extent of this dependence:

Table 1. Strike Aircraft, Representative Distances To Target (Kearney, 1994: 190)

| Aircraft | Combat Radius* | Target Distance |
|---|---|---|
| F-117 | 550 nautical miles (nm) | to Baghdad - 905 nm |
| F-15E | 475 nm | to Western Scud areas - 680 nm |
| F/A-18 | 434 nm | Red Sea Carrier to Kuwait City - 695 nm |
| B-52G | 2177 nm | Diego Garcia to Kuwait - 2500 nm |

* Figures account for a single pre/post-strike refueling per aircraft

Modern warfare's ravenous thirst for airborne gas brings with it an increased threat to tanker crews. In what is today commonly called "the DESERT SHIELD gloom and doom" briefing, Lt. General Charles A. Horner, then Joint Forces Air Component Commander for the United States Central Command (CENTCOM), announced projected tanker aircraft losses during his visits to Saudi Arabian-based US Air Force units. The general cited aircraft attrition models as his information source. Though the exact figures listed during the general's discussion remain classified to this day, the information he passed had a devastating impact on attending tanker crewmembers. "I just couldn't believe that that many tankers were going to be lost.... For the first time in our lives, we tanker crewmembers felt like targets over the battlefield," said one crewmember (Scolarici, 1994). Fortunately for the Department of Defense (DoD), those attrition model-derived statistics proved to be greatly overstated. Given an enemy willing to fight, DoD's luck might run out.

## Problem Statement

Published tanker combat crew flight training requirements have kept pace with neither the changing threat environment nor the shift in Air Force doctrine. In keeping with today's **Global Reach-Global Power** (United States Air Force, 1990) warfighting concept, the KC-135 crew training regulations--and day-to-day flight scheduling--should aspire to cultivate tanker crew warfighting skills. DoD's combatant commanders in European Command (EUCOM), Space Command (SPACECOM), Strategic Command (STRATCOM), Atlantic Command (ACOM), Central Command (CENTCOM), Pacific Command (PACOM), and Southern Command (SOCOM) expect KC-135 crews to effectively execute theater warplans. With little or no notice, a crew is expected to skillfully fight a war. Wartime is a poor time for crews to conduct on-the-job training in preparation for the unforgiving challenges posed by KC-135 tactical air refueling.

Operational needs, evolving Air Force doctrine, and current KC-135 continuation training are in disharmony. The relentless onslaught of day-to-day air refueling requests has occasionally resulted in Air Mobility Command (AMC) treating training events for combat tanker crews as squares to be filled. Crew training should be performed for the express purpose of establishing, maintaining, or increasing combat skills. Today's military budgetary constraints make it more important than ever to make every training dollar count.

Simply put, the problem is that there is currently no clearly-defined process to keep tanker crew training requirements linked to emerging wartime taskings. There is no established administrative mechanism to ensure that tanker crews train the way they will fight in future conflicts. Theater commanders currently have no input to AMC tanker training requirements. The possibility exists that command tanker crews will be caught unprepared to perform specialized warfighting tasks vital to mission success.

<u>Impact on Mission</u>

Although "air refueling is highlighted as one of the five technologies that worked best in the Gulf War," during the years following the Gulf War, the KC-135 has been tasked to perform missions outside its natural, historic core competency (Kearney and Eliot, 1994:223). Today the tanker is used to carry cargo more frequently than ever before; however, the KC-135's wartime tasking continues to be air refueling. In fact, there may not be enough tankers to fulfill the wartime requirement for air refueling. "By its own numbers, AMC documents a shortfall in air refueling requirements versus capability in its notional Defense Planing Guidance war fighting scenario through 2015. In this context alone, one can only question the wisdom of levying an additional 'outside' mission against a weapons system that is always a major participant early in a wartime contingency" (German, 1994:12). Does Air Mobility Command find the use of tankers for cargo transport an acceptable use of the resource? Wouldn't it be more optimal for KC-135 flying hours to be used primarily in preparation for combat support?

Combat commanders and their theater warplanners should have their strike plans supported by tanker crews prepared for the task. To cite one example, DESERT STORM tanker crews were tasked to perform Low Altitude (between 10000 and 3000 feet above ground level) Air Refueling (LAAR) with only a handful of tanker crews who had prior formal training (Scolarici, 1994). Luckily for all concerned, the airmanship of professional tanker crews allowed no DESERT STORM mishaps during these high-risk sorties.

Another example of DESERT STORM-unique tasking of tanker crews was F-117 air refueling. Most crews who supported this bomber had no exposure to the aircraft prior to the war. It was fortuitous that the Iraqis allowed the DoD five months to train its F-117 strike and KC-135 tanker crews in air refueling while in the Kuwaiti Theater of Operations.

Often overlooked for system and training improvements during the budget process, tankers are, according to some, taken for granted by decision makers. Maj. General Donald L. Marks, Chief of Staff for Strategic Air Command in 1990, commented that "The Strategic Air Command's refueling operations often take second place in the public eye to the more glamorous aspects of air power. In conjunction with this mistaken view, tanker aircraft crews and support personnel at times feel they are taken for granted." The general then characterized the tanker as a vital "force multiplier" (Seventy Years of Strategic Air Refueling, 1990:iii).

Lt Col German characterizes the tanker differently:

> What it has really been is a *time machine*. It has flown far beyond its expected life span, enabling this nation to prosecute its wars and other operations on its own terms. It has provided fighters with more time on target, test aircraft with more time pushing the envelope, and everyone in the world the legs to get there...in half the time. In return it has demanded very little other than meticulous care in the maintenance of its place in the launch stream. (German, 1994:2)

Being so reliable an asset has made it easy for the KC-135 to be ignored by both planning staffs and commanders.

The tanker, a key component of the DoD's **GLOBAL POWER, GLOBAL REACH** strategy, has never been at the forefront of strategic thought on the conduct of war; nor has the KC-135 benefited from serious consideration in areas such as the aircraft's replacement or modification. "Given the cavalier attitude this leadership has in regard to operating this resource as the core tanker beyond 2030, it is currently setting the stage for the proverbial 'train wreck' in the future. An aircraft that has lived at the bottom of the priority list for so long is a catastrophic event waiting to happen." This neglect is not seen in other Air Forces owning KC-135 aircraft. "After all, this is the same aircraft the French Air Force sent to Operation Daguet (designation for US's Operation Shield/Storm) with threat warning capability" (German, 1994:4).

Threat warning equipment is designed to warn a crew of threats in a tactical environment. This gear was not deployed with USAF tankers. In fact, US tankers were well behind those deployed to the Kuwaiti Theater of Operations by the French Air Force. In contrast with their French counterparts, USAF KC-135 aircraft had to undergo an emergency modification program just to install the radios necessary to talk to ground controllers (German, 1994:14). Fortunately for the Air Force in DESERT STORM, this radio equipment was procured in record time.

Flying skills needed to fulfill theater-unique air refueling mission requirements cannot become available through emergency modification. With strike aircraft needing air refueling support closer to lethal threat environments, tanker crews require more advanced preparation today than ever before. No process exists at AMC to effectively link tanker crew training requirements to today's challenging wartime taskings.

## Investigative Questions

What can AMC do to effectively link tanker crew training requirements to today's 21st Century battlefield? Keeping this basic research question in focus, this paper will attempt to answer the following investigative questions:

1. With the many combat successes of the venerable KC-135 in mind, is the tactical use of tankers a documented fact?

2. In this era of changing Air Force doctrine, how have tanker taskings changed?

3. How have Air Force doctrinally-derived tanker wartime task changes been factored into the process of tanker training development?

4. How can wartime taskings be more accurately reflected in tanker combat crew continuation training?

In summary, the KC-135 has been a major factor in the successes of US combat operations since the aircraft's development in the 1950s. The convening years have seen a dramatic elevation in the capability of enemy threats to curtail tanker operations. The bombing strategy of the United States has moved from the employment of mainly large bombers such as the B-52 to fighter-sized bombers such as the F-117. With this change in strategy the need for gas is more obvious than ever before. Tanker training requirements are based on factors not related to the changing tanker operating environment. These requirements are not based upon documented lessons learned from tanker crew combat experience, nor are the training requirements based on current wartime taskings. This certainly cannot be what General Merrill A. McPeak, Air Force Chief of Staff had in mind when he described the Air Force's **Global Reach** concept:

> Our unmatched mobility combined with air refueling means we can get anywhere very quickly, take off anywhere, attack anywhere and return anywhere, with landing en route. No spot on the globe is more than 20 hours flying from combat aircraft stationed in the United States. (McPeak, 1990:4E)

## II. Tactical Air Refueling History

### Air Refueling History

Perhaps the best place to begin this investigation would be to examine the history of air refueling itself. Just when did air refueling become a key element of US military strategy?

Major James F. Sunderman in his 1961 book entitled Early Air Pioneers describes the first recorded air refueling: "High above the ground, but still within sight of a small crowd of curious spectators a lone man, with a five gallon can of gasoline strapped to his back, hesitantly gets out of the open cockpit of a Lincoln Standard biplane. He cautiously walks to the end of the wing and then quickly grabs the overlapping wing skid of a 'Jenny.' Oblivious to the 60 to 70 mile-per-hour wind he makes his way to the engine and pours the gasoline in the JN-4's tank. The first inflight refueling has been accomplished!" (Sunderman, 1961:176-178). This refueling became documented history when, "In his log book, on 12 November 1921, Wesley May records the transfer of five gallons of gasoline to a JN-4 receiver flown by a pilot named Dougherty" (Callens, 1985:4).

According to Lt. Col Dennis K. Ryan, in Significant Events in the Evolution of Air Refueling, "Major Henry H. ("Hap") Arnold was one of the first individuals to recognize that air refueling could solve early aviation problems with flight endurance and payload. In 1924 he wrote an article formulated from the collective opinion of several officers after they had witnessed an unrefueled flight of 35 hours and 18 minutes. Major Arnold stated:

> The limit for sustained flight with airplanes had been reached unless some means could be developed whereby gas and oil, and possibly other supplies, could be furnished to a plane in the air from other sources. It was believed that if refueling was demonstrated feasible, new records could be created and a new field opened up in aviation which might prove of value to the science in general. (Ryan, 1992)

Lt. Col Ryan chronicles the first-ever air refueling conducted by the US military:

> The first actual air refueling was performed on 25 June 1923 near San Diego, California, by Lieutenants Virgil Hines and Frank Seifert as they flew their tanker within 35 feet of the wing tip of Captain Lowell Smith and Lieutenant John P. Richter's receiver aircraft. This flight marked the first time a tanker transferred fuel to a receiver. To accomplish this in-flight refueling, Hines and Seifert lowered a 40-foot hose to the receiver, and Smith and Richter fastened it into the fuel tank. It is interesting that this experiment was conducted primarily in preparation to break existing flight-endurance records and not to prove the advantages of air refueling. (Ryan, 1992)

Needless to say, the 1920s was apparently a time of great innovation for the field of aerial refueling--military and civilian.

Arguably the biggest development in the history of air refueling was the roughly six-day flight of the *Question Mark* in January of 1929. According to the book <u>Seventy Years of Strategic Air Refueling: 1918-1988, A Chronology</u>,

> In a test of both the practical value of inflight refueling and crew and aircraft endurance, a modified Atlantic (Fokker) C-2A, the 'Question Mark,' established a world duration record of 150 hours and 40 minutes. The Army Air Corps (the Army Air Service had renamed the Air Corps on 2 July 1926) high-wing, trimotor monoplane had been specially outfitted with a large capacity fuel tank in the cabin, a large hopper in the cabin for receiving fuel, and lines and hand-operated pumps for transferring the fuel to the wing tanks. The tankers, two modified Douglas C-1 biplanes, were each equipped with two 150-gallon cabin tanks and a 40 foot refueling

> hose. Shuttling in the airspace between Santa Monica and San Diego, California, a distance of approximately 110 miles, the tankers made 43 contacts with the 'Question Mark,' allowing it to remain airborne until engine problems forced it to land at its starting point near Burbank. Tanker-receiver contacts averaged seven and one-half minutes and a total of 5,700 gallons of fuel was transferred through the one-and-three-fourths-inch diameter hose. Oil, food, water and other items were also passed during the refueling contacts. (Seventy Years of Strategic Air Refueling, 1990:2-3)

In what was perhaps the first recorded slight for tanker crews, at the completion of this widely celebrated accomplishment, the crew of the *Question Mark* was awarded the highly coveted Distinguished Flying Cross for the mission. The supporting tanker crews received only letters of commendation (Seventy Years of Air Refueling, 1990:3).

Also significant in this record-setting event, several events happened during this flight. According to Lt. Col Ryan, the list includes the following:

- Having only 100 gallons of fuel in tanks at time of takeoff, thereby creating the requirement for air refueling.
- Flying nonstop for 11,000 miles, thus demonstrating the increase in the radius of operation for military aircraft.
- Making a total of 37 air refueling contacts, totaling about four hours of "hookup" time, thus proving the reliability and feasibility of air refueling.
- Accomplishing several night air refuelings, thus demonstrating that air refueling was not limited to daytime operations.

- Transferring over 5,000 gallons of fuel and 250 gallons of oil to the receiver from several tanker sorties, pointing toward the future utility of tanker-specific aircraft. (Ryan, 1992)

On the *Question Mark* were some of the great pioneers of aviation: Major Carl Spaatz, Captain Ira Eaker, Lt. Elwood Quesada, and Lt. Harry Halverson (Ryan, 1992). The US Army Air Corps did not conduct air refueling again until 1941. In 1941 the modification of B-24s into tankers for B-17 Pacific strike missions was studied (Seventy Years of Air Refueling, 1990:9).

The success of the *Question Mark* became the logic behind British experimentation with air refueling. In October 1934, "Sir Alan Cobham, who had begun inflight refueling experiments two years earlier, formed the British firm of Flight Refuelling Limited. A pioneer in military applications of aerial refueling, Flight Refuelling Limited was originally sponsored by a commercial enterprise, Imperial Airways" (Seventy Years of Air Refueling, 1990:7).

The years following World War II saw a succession of converted bomber aircraft perform the air refueling mission. Beginning with the B-24D, bomber aircraft such as the B-29, B-50, and B-36 became modified to perform the tanker mission. The KC-97 was an evolutionary development from the B-29 bomber and C-97 cargo transport aircraft. This aircraft was retired from active service in 1978. Not until the development of Boeing's model number 367-80 on 14 May 1954 was an aircraft originated exclusively for the refueling mission--from the ground up (Seventy Years of Air Refueling, 1990:14-29).

The final aircraft developed for the Air Force in fulfillment of the refueling mission requirement was the KC-10. "An increase in the number of receiver aircraft in the late 1970s created a need for more tankers....[SAC] wanted a dual-capable [Air Force refueling receptacle and Navy probe compatible] tanker which would allow Air Force, Navy or Marine receiver aircraft to refuel from single airborne tanker" (Ryan, 1992). Called the Advanced Tanker in SAC documentation dating back as far as 1967, the "KC-10 Extender" procurement began in 1978. A total of 57 (of a final total of 60) KC-10s were delivered by the end of 1988 (Seventy Years of Air Refueling, 1990:86).

## The Need for Air Refueling

Why air refuel? "A short and simple answer is--economics. It does not matter whether the aircraft is a bomber, an ocean submarine hunter, a transport, or a fighter; the operation of them all is fundamentally bound up in this one problem of how to obtain the maximum performance with the minimum of effort in aircraft, manpower, and capital outlay." Simply put, the in-flight refueling process is the only solution to the economical achievement of long-range flight (Abercrombie, 1955:1). Mr. Frank Futrell in Ideas, Concepts, Doctrine: Basic Thinking of the United States Air Force 1907 - 1960, says that Col Dale O. Smith recognized that Air Force bombers lacked global range. In 1947 the colonel suggested "that the Air Force might prepare crews to fly one-way atomic combat missions." The colonel concluded that "the crews would have a good chance to evade and survive" (Futrell, 1989:232-233). Considering a number of options, the "alternative favored by both the Strategic Air Command and the Air Materiel Command, was to develop air-to-air refueling equipment and to employ tanker aircraft that could refuel strike aircraft en route to the target" (Futrell, 1989:232-233). Bomber aircraft were not the only ones in need of air refueling. "As a means of extending the range of fighter-escort aircraft, General Vandenberg had urged aerial refueling in 1945." There would be a cost attached to air refueling. "Aerial refueling would be expensive, however, since two aircraft--a bomber and a tanker--would be required to accomplish a single sortie" (Futrell, 1989:232-233).

After Congress and the US military studied the matter, it was decided to develop equipment and techniques for the air-to-air refueling of intercontinental bombers. According to Futrell, however, the Air Force did not completely "close the door on the development of aircraft with built-in range" (Futrell, 1989:232-233). In fact, the development of a totally self-sufficient bomber--that is to say, a bomber not requiring aerial refueling--is still part of the Air Force vision (United States Air Force Scientific Advisory Board, 1992:I-3).

Aircraft range is at the center of Air Force Doctrine and strategy. General Spaatz believed that "Air strategy begins with airplane ranges. Airplane ranges determine the location of bases. The proximity to the target of the bases under one's control fixes the weight and rhythm of the attack" (Westenhoff, 1990:41).

During the years preceding the arrival of the KC-135 tanker, doctrinally-derived mission requirements of DoD strike aircraft became strongly linked to aerial refueling. In a book chronicling the history of Tactical Air Command (TAC), the importance of aerial refueling is summed up this way: "Cut off Air-to-Air Refueling and you cut off the legs of TAC--and SAC. Without refueling, neither would have the global range which is the secret of their power to prevent attacks" (Richards, 1961). Today, 35 years later, this statement still rings true.

The Advent of the KC-135 and Vietnam History

Faced with a choice between a purchase of cargo transports and tankers in July 1958, General Curtis E. LeMay preferred jet transports. However, "if you gave us money for jet airplanes, I would buy tankers, not airplanes for MATS [Military Air Transport Service, the predecessor to Military Airlift Command and today's Air Mobility Command]....I think we would increase our combat capability more in that manner." The C-135 prototype aircraft was procured primarily as a tanker but had a transporter version as well (Futrell, 1989:232-233).

At the heart of the Air Force's procurement of the KC-135 Stratotanker were the doctrinal requirements of the strategic bombing mission. These doctrine-driven requirements are still in force today. The primary role of the almost 600 jet tankers managed by the Air Force is to support operations by US-based strategic bombers. "That role emphasizes preplanned missions in which each tanker provides a large and predictable amount of fuel over great distances to one of several hundred strategic bombers. A secondary role is to support the deployment and employment of aircraft during a conventional conflict" (GAO, 1993:2).

The first KC-135 jet tanker was delivered to the 93rd Air Refueling Squadron at Castle Air Force Base, California, on 28 June 1958. Jet tankers reduced the time involved in air refueling. While refueling with a KC-97, a bomber had to slow down and descend to effect a hookup. This was unnecessary with a KC-135. Total flying time used during a January 1957 B-52 round-the-world flight--Operation Power Elite--could have been cut by five to six hours if KC-135s had been used instead of KC-97s (Hopkins, 1982:64).

Procured purely to support the B-52's nuclear mission, the KC-135 soon found a wide range of eager customers while cutting its teeth in a conventional war in Vietnam. In a belated--but well deserved--salute to Vietnam tankers, John L. Frisbee wrote a "Tribute to Tankers" printed in *Air Force Magazine* in January 1996. US combat operations in the southeast Asia war depended greatly upon support from Boeing KC-135 Stratotankers. "They made it possible for Guam-based B-52s to reach their targets and for fighters to range from one end of Vietnam to the other, greatly increasing the flexibility of tactical air operations. Fighter strikes in the northern route packages were totally dependent on the tankers" (Frisbee, 1996:49).

In what is perhaps the first recognized use of tactical--that is to say, in proximity to the battle area--air refueling, Frisbee asserts that tankers routinely ventured into enemy territory.

> Air refueling tracks flown by the KC-135s were in northern and eastern Thailand, northern Laos, and over the Gulf of Tonkin, north of the demilitarized zone (DMZ). Regardless of established limits on how far north they could go, however, tanker crews often went into North Vietnam and the extreme north of the Gulf [of Tonkin] to rescue F-105s and F-4s and often Navy fighters that needed fuel to get home. The number of aircraft and crews they saved cannot be precisely determined, but it was substantial. (Frisbee, 1996:49)

No one could have imagined how effectively the KC-135 would perform as a force multiplying workhorse. "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. Throughout the conflict, KC-135s staged from non-hostile airfields such as U-Tapao Thailand, Anderson AFB Guam and Kadena Air Base, Okinawa" (Ekwall, 1989:2). With the exception of special missions such as Linebacker I and II, during which tankers flew near North Vietnam's Haiphong Harbor area, refueling "anchors" were situated far from known surface-to-air (SAM) batteries and anti-aircraft positions. This resulted in a largely benign operating environment for tankers (Ekwall, 1989:2).

Strategic Air Command historians describe the typical--non-tactical--tanker air refueling mission in Vietnam: "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" (SAC Tanker Operations in the Southeast Asia War, 1979).

Becoming a key element for perhaps the first time in the history of combat operations, air refueling came into its own. Unfortunately for the tanker crews of Vietnam, few stories of their heroism were documented; but the levels of courage demonstrated by these crews is still considered legendary by veterans. Frisbee points to a tanker mission in 1967 to prove this point.

> A unique refueling mission on May 31, 1967, epitomizes the skill, determination, and heroism of the tanker crews. At the time, the thirty-odd KC-135s primarily responsible for refueling the fighters were under the 5258th Strategic Wing. A crew consisting of aircraft commander Maj. John H. Casteel, copilot Capt. Richard L. Trail, navigator Capt. Dean L. Hoar, and boom operator Msgt. Nathan C. Campbell was assigned a refueling track over the Gulf of Tonkin. There was no reason to think this mission would be anything more than a normal day's work.
>
> Soon after they had established their track, Major Casteel's crew was alerted to refuel a pair of Air Force F-104 fighters on a support mission north of the DMZ. (Early in the war, a few F-104s and F-102s were based briefly in South Vietnam, primarily for air defense.) While refueling the F-104s, Casteel was informed that two Navy KA-3 tankers, desperately short of fuel, were on the way to his tanker. Both KA-3s had fuel they could transfer but could not use themselves. After receiving a partial load, the F-104s stayed with Casteel's KC-135 to defend it against possible MiG attacks while it refueled the navy aircraft.
>
> The first Navy tanker took on a minimum of fuel then broke off to allow the second KA-3 to hook up. At this point, two Navy F-8s were vectored to the KC-135 for emergency refueling. One F-8 was so low on fuel that the pilot couldn't wait for the second KA-3 to complete refueling. The Navy pilot hooked up to the KA-3 that still was taking on fuel from the KC-135. That is believed to have been the first trilevel refueling ever. While the dual transfer was in progress, the first KA-3 passed fuel to the second F-8, then returned to the KC-135 to complete its own refueling.
>
> This joint-service operation was still in progress when two Navy F-4s with bingo fuel were vectored to the KC-135 for emergency service. While waiting for the F-4s to appear, Casteel's crew gave the two Air

> Force F-104s another shot of fuel, then transferred enough to the Navy F-4s to get them to their carrier. (Frisbee, 1996:49)

After this impressive display of tanker crew bravery, with 10 refuelings accomplished, Casteel's KC-135 was itself in bingo--empty fuel tanks--status. Unable to return to its originating base in Thailand, the crew diverted to a base in South Vietnam while tanking the two F-4s a third time. (Frisbee, 1996:49)

Of course, this was by no means an isolated example of KC-135 tactical air refueling capability. According to Vietnam veteran Lt. General Charles Horner,

> I think in any recent war, if you ask any fighter pilot who his hero is, he'd probably say the air-to-air tanker guys. I myself can remember in Vietnam being over Hainan island, almost out of gas. And here comes a KC-135, way up north of where he ought to be because of the enemy threat. And turning around to getting in behind, getting enough fuel to get home. (Horner, 1991)

Tanker crew heroism did have a professional cost. KC-135 crews were often under threat of punishment under the Universal Code of Military Justice for flying into North Vietnam to rescue fighters and other combat aircraft. "Because KC-135 crews could in no way anticipate the intensity of missions like the one Maj. Casteel and crew encountered, their magnificent performances under these conditions can only be attributed to their extreme dedication and patriotism" (Scolarici, 1994).

<u>KC-135 Stock Increases During the 1970s</u>

Even before hostilities in Vietnam ceased, commanders came to see the combat role of tankers as crucial to successful conduct of air campaigns. In a 26 March 1970 personal letter to General William W. Momyer, Commander of Tactical Air Command, General J.R. Holzapple, Commander of US Air Force Europe (USAFE) describes his view of KC-135 participation in his warplan--and those of other combatant commanders:

> Direct control of theater tanker resources]...would significantly increase this command's mission potential and flexibility....We (USAFE) strongly support the Concept of Operations you have proposed for Tactical Air Refueling. Complete control over theater tanker resources can only be achieved by assigning these tankers directly to the Air Component Commander of the appropriate unified command. (Holzapple, 1970)

This letter is the first documented use of the term "Tactical Air Refueling." With bomber support still the sole justification for the existence of the KC-135 in 1970, warlords of combatant commands outside of Strategic Air Command seemed to envision the tanker taking on a broader role among US airstrike capable assets--especially fighters. KC-135 tanker capability was becoming equally coveted by both the fighter and bomber communities. In his Air War College paper entitled "The Future Aerial Refueler: Modified KC-135 or ATCA [Advanced Tanker Cargo Aircraft]?," Lt. Col Larry A. Streitmatter said "The role of air refueling, in providing strategic and tactical mobility to our forces, can best be described as a crucial link. This is what truly gives our military forces global mobility. It has done more to increase the range and payloads of the Air Force's aircraft than any development in the history of aviation" (Streitmatter, 1977:1).

Now widely recognized as an important warfighting resource, the tanker became critical to the successful conduct of air operations. Lt. General Harley Hughes, Air Force Deputy Chief of Staff for Plans and Operations in 1989, considered tankers "the lifeblood of our fighting force, a national asset, irreplaceable" (Ekwall, 1989:4).

## KC-135s in DESERT STORM

KC-135s were essential to America's success in DESERT STORM. As mentioned previously, the DESERT STORM conflict was a showcase for US military technology--the F-117 in particular. According to *Discovery Channel* journalist Kurt Sayenga, "For targets in urban areas, the coalition opted for precision weapons. And for true precision, those bombs were dropped by F-117s. The accuracy of the Nighthawks was such that although they flew only 2 percent of total combat sorties in the Gulf, they covered 40 percent of all strategic targets. F-117s dropped over 2000 tons of bombs and flew more than 6900 combat hours" (Sayenga, 1991).

What makes this particular aircraft important from a doctrinal standpoint was the revolutionary efficiency it afforded planners. "The Air Force is fond of pointing out that a mission that would have taken 500 missions to destroy in World War II can be vaporized in one mission, with one bomb. And since stealth planes can fly into enemy territory without fighter escorts, jamming planes or other support aircraft, it saves pilots lives" (Sayenga, 1991).

F-117 pilot Lt. Col Ralph Getchel, talks about the professionalism of tanker crews in DESERT STORM:

> Tonight is an example, going as far as we did. When I finally pressed to cross the border into Saudi Arabia, I was at the point where I was very low on fuel. We were on either side of the tanker's wing and we proceeded across the border. We traveled about 50 or 60 miles when another unit apparently was going in on the outskirts of Baghdad. Baghdad, which hasn't been doing a whole lot against us because they can't see us, was apparently responding to all these conventional airplanes that they saw. And they were putting on another fantastic light show...which from 80, 90

> miles away was painfully apparent to our tanker crew. We saw their wings going back and forth, as they pondered whether this was the direction they were going or we were going. They are people dedicated to getting us the gas. (Ketchel, 1991)

From a purely statistical standpoint, DESERT STORM proved--beyond a shadow of doubt--the criticality of air refueling to modern warfare. The numbers of air refuelings which took place are a matter of some dispute; however, all collected figures point to a huge contribution. One source, Mr. David Lynch, writes in *Air Force Magazine*, "In the Persian Gulf War, Air Force KC-135 and KC-10 tankers performed more than 51,000 in-flight refuelings. These giant filling stations in the sky transferred some 125 million gallons of fuel to other planes. Moreover, the tanker force missed not a single wartime refueling rendezvous" (Lynch, 1993:54).

Even the General Accounting Office, in its November 1993 report to Congress, An Assessment of Aerial Refueling Operational Efficiency, could only find huge numbers when examining the air refueling effort: "A large coalition tanker fleet transferred over 700 million pounds of fuel during roughly 50,000 refuelings to about 2,000 aircraft over the 43 days of combat." (GAO, 1993:1)

And, like their predecessors of the Vietnam-era, KC-135 tanker aircrews were heralded as "heroes" by knowledgeable members of the strike community. On the very first day of the war a KC-135 "saved an F-117 Stealth Fighter." The tanker's aircraft commander, Captain David Horton, upon hearing a desperate call for fuel from an F-117 badly in need of fuel after striking Baghdad, somehow got the two aircraft together. Performing an infrequently practiced "toboggan" (descending) refueling, Horton and his crew succeeded in rescuing the fighter over Iraqi territory--in violation of pre-war (DESERT SHIELD) directives against operating there (Brunkow 1994:53).

The tales of tanker gallantry reached the highest levels of Air Force command in the Kuwaiti Theater of Operations. During a 1991 interview for television's *Discovery Channel*, Lt. General Buster Glosson, Campaign Planner for DESERT STORM, revealed that the tanker did, contrary to popular belief, frequently operate within range of enemy fire: "The unsung heroes in this war are the tankers because they filled the skies of Saudi Arabia and Iraq. And I might add over Iraq. Yes, there were tankers in the skies over Iraq refueling fighters and bombers" (Glosson, 1991).

This fact was reiterated by Lt. General Charles Horner, Joint Force Air Component Commander for DESERT STORM. In a televised interview which aired in late 1991, General Horner lauded his tanker crews for courage in the face of danger: "That takes a lot of guts to be sitting in an airplane loaded with gas and going into harm's way" (Horner, 1991).

In summary, tactical air refueling history is replete with tales of the unheralded gallantry of tanker crews. Without any of the specialized equipment or training afforded USAF strike aircraft, tanker crews performed above and beyond planned air refueling requirements. From the flight of the *Question Mark* in 1929 to the conclusion of DESERT STORM, the critical importance of air refueling to Air Force combat operations has been proven repeatedly. With little advance preparation tanker crews effectively operated in harm's way during Vietnam and DESERT STORM. The lessons of those conflicts should be reflected in the tanker training requirements of today. Unfortunately there is no established connection between the real-life combat experience of tanker crews and today's tanker crew training requirement development process.

## III. The Impact of Evolving Doctrine

The kinds of aggressive tactical employment that the tanker experienced in the Gulf War were unprecedented. The new Air Force doctrinal shift away from strategic bombing was vividly demonstrated during that operation. This strategy shift towards the F-117 as the core bomber brings with it a new direction for the tanker mission as well.

### What is Doctrine?

Before undertaking a discussion of just how current Air Force warfighting doctrine impacts--or fails to impact--upon day-to-training activities of KC-135 aircrews, a definition of the term doctrine is appropriate. According to Lt. Col John Furr, key member of the Air Force's College of Aerospace, Doctrine, Research, and Education (CADRE), "Joint Pub 1-02 tells us that 'doctrine consists of fundamental principles by which the military forces or elements thereof guide their actions in support of national objectives. It is authoritative but requires judgment in application'" (Furr, 1996). Air Force Manual 1-1, the basic air and space doctrine of the United States Air Force, holds that doctrine is what we hold true about air and space power and the best way to do the job of the Air Force (Air Force Manual 1-1, 1992:vii).

With this definition in mind, let us examine the critical attributes, or parts of Air Force Doctrine. Air Force Doctrine is based on historical experience--both ours and those of others. What we have learned about air and space power and its application since the dawn of powered flight is included.

Next, Air Force Doctrine serves as a guide for the exercise of professional judgment. This is to say that doctrine is not a set of hard and fast rules that are to be blindly obeyed, rather it is a starting point, or focus, for guiding our actions.

Third, Air Force Doctrine is a standard against which to measure our efforts. Looking back at our definition, that simply put, Air Force Doctrine is what we hold true about air and space power and the best way to do the job of the Air Force, it is easy to see how Air Force Doctrine serves as a benchmark for our activities.

Finally, "Air Force Doctrine needs to be alive. The world in which we live is not static. New experiences, reinterpretations of former experiences, advances in technology, changes in the threat, and cultural changes all impact our doctrine. It is only by paying close attention to these factors that we can ensure that our doctrine grows, evolves, and matures: in other words, remains alive" (Furr, 1996).

## Doctrinal Evolvement and Tanker Mission Requirements

Air Force doctrine has evolved along with technology during the KC-135's tenure as the core tanker. Some concepts considered today simply were not possible in years past. Probably the most important development in Air Force doctrine is the concept of "parallel war." As was demonstrated so brilliantly in DESERT STORM, the US accurately bombed a wide spectrum of enemy targets--simultaneously. Theorists excitedly describe this new found strategy:

> Such targeting, conducted against the spectrum of targets in a compressed time period, is called *parallel war*. The goal of parallel war is to simultaneously attack enemy centers of gravity across all levels of war (strategic, operational, and tactical)--at rates faster than the enemy can repair or adapt. This is a new method of war. (Barnett, 1996:9)

The precise delivery of munitions by the new breed of fighter-bomber aircraft like the F-117 has made this revolutionary concept a reality--a necessity even. "Future aerospace operations against the enemy at all levels of war and across all target categories must occur almost simultaneously. Near simultaneous attacks across the enemy target set will be the hallmark of future aerospace operations. Failure to conduct aggressive and overwhelming attacks across all facets of enemy power would waste a decisive capability (Barnett, 1996:8-9).

This overwhelming show of force has not--until recently--historically been available to US military strategists. Historically, however, Air Force bombers lacked the military capabilities to implement even near-simultaneous attacks. "During all of 1942-1943, for example, the Eighth Air Force attacked a total of only 124 distinct targets. At this low attack rate (averaging six days between attacks), the Germans had ample time to repair and adapt between raids" (Barnett, 1996:9).

To illustrate the vastly more rapid rate of attack seen in DESERT STORM, in the first 24 hours coalition air forces attacked 148 discrete targets--fifty within the first 90 minutes. Targets ran the gamut from national command and control nodes to key bridges to individual naval units. "The goal was to cripple the entire system to the point it could no longer efficiently operate, and to do so at rates high enough that the Iraqis could not repair or adapt" (Barnett, 1996:9).

Figure 1 points out the types of targets Barnett outlines in his book.

| LEVELS OF WAR | LEADERSHIP | PRODUCTION | INFRASTRUCTURE | POPULATION | MILITARY FORCES |
|---|---|---|---|---|---|
| STRATEGIC | POLITICAL MILITARY | NBC<br>REFINING<br>ELECTRIC | RR YARDS<br>TELEPHONE | NATIONAL WILL | ICBMs<br>WMD<br>LOYAL TROOPS |
| OPERATIONAL | CORPS HQs<br>ADOCs<br>FLEET HQ | THEATER SUPPLIES AND REPAIR | BRIDGES<br>FLEETSAT<br>AIR DEF NET | LONGSHORE-MEN<br>ALLIED OPINION | PORTs<br>AIRFIELDS<br>2D ECHEL. |
| TACTICAL | DIV HQ<br>AWACS<br>ABCCC<br>CIC | FOOD<br>WATER<br>AMMO<br>GENERATOR | TRUCKS<br>FREQUENCIES | CONTRACTORS | FLIGHTS<br>ARTY<br>TROOPS<br>SHIPs |

Figure 1. Target Categories (with examples) (Barnett, 1996:10)

Only recently has command and control technology become available to coordinate the many levels of simultaneous attacks. "Modern command control systems can plan and direct this offensive in near real time. These attributes of parallel war distinguish it from anything seen in military history" (Barnett, 1996:10-11). Ambassador Paul Nitze, in his editorial printed in *The Wall Street Journal* Editorial, observed the effect of parallel war in the 1991 Gulf War:

> After the first few minutes, there was literally nothing Saddam could do to restore his military situation. His means of communicating with his subordinate commanders were being progressively reduced. Thus Iraqi commanders had difficulty carrying out orders for a coordinated movement of their forces. Their command posts, air shelters, and even tanks buried in the sand were vulnerable to elimination by precision penetrating bomb attack. (Nitze, 1991:6)

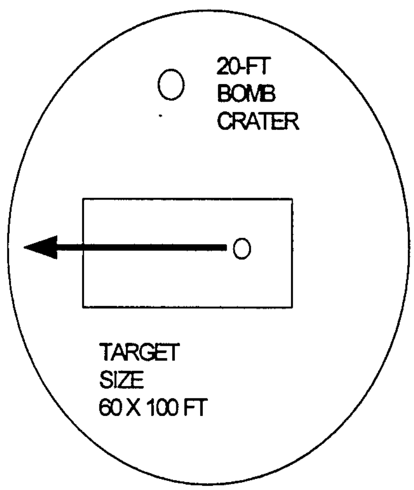
Air Force bombing doctrine has a predictably huge impact upon tanker wartime operations. As the circular error probable (CEP)--a measure of bombing accuracy--shrinks in response to developing precision technology, doctrine is forced to adjust. This new precision in bombing has come largely at the expense of strategic bombers like the B-52, whose numbers have shrunk. The extremely small CEPs in DESERT STORM were the result of mostly F-117 and F-15E laser-guided munitions. The increase in precision from the WW II to DESERT is graphically depicted in Col Jeffery R. Barnett's book entitled FUTURE WAR: An Assessment of Aerospace Campaigns in 2010 (See Figure 2).

Considering how much less fuel a fighter-bomber like the F-117 carries than a B-52, it seems that as the Air Force has reduced its CEP, the tanker's supportive air refueling orbits are necessarily closer to the target. This fact was emphatically emphasized by Robert C. Amos, Strategic Systems Mission Analysis Manager for Boeing Military Airplanes during his 30 October 1991 address to the Aerial Refueling Systems Advisory Group:

> The intial tactical orbit location for KC-135 and KC-10 aircraft has always been at least 100 miles from the FLOT (Forward Line of Troops). Because the new strike platforms--F-16s, for example--have a more persistent need for gas, our study indicates that alternate tactical orbit locations for tankers will be forward of the FLOT. Our analysis was

completed months before we heard about the DESERT STORM refuelings which occurred over Iraq. (Boeing, 1991)

| CONFLICT | CEP | BOMBS REQUIRED* |
|---|---|---|
| WWII | 3300 FEET | 9070 |
| KOREAN/VIETNAM | 400 FEET | 176 |
| DESERT STORM | < 10 FEET | 1 |
| FUTURE | < 10 FEET (ALL WEATHER) | 1 |




• CEP (CIRCULAR ERROR OF PROBABILITY) = RADIAL DISTANCE FROM A POINT IN WHICH 50% OF ALL BOMBS WILL LAND

* 90% PROBABILITY OF HIT, 2000-LB BOMB

Figure 2. Orders of Magnitude Improvement in Precision Munitions (Barnett, 1996:11)

Air Force doctrine, what we hold true about air and space power and the best way to fight, is alive and ever-changing. Technological developments have led the service to more aggressive employment concepts such as parallel war. The execution of this parallel warfare strategy has necessarily moved air refueling operations closer to the battle area. Today's theater combat refueling operations are therefore more tactical than ever before. Today's tanker crew training should prepare crews for these important challenges.

## IV. Training To "Answer The Mail"

### Early and Chronic Problems with KC-135 Training Realism

The tanker's importance to both strategic and tactical doctrine was firmly established during Vietnam. Doubtless SAC intended to institute a post-Vietnam tanker training program capable of maintaining the highest levels of combat proficiency. The command's effort to institute an aggressive tanker crew training program was impacted in 1973. the tanker crew training budget was severely reduced because of the world's scarcity of oil. Between the years 1973 and 1974 the Arab Oil Embargo put restrictive fiscal constraints upon KC-135 combat training. The curtailments in flying hours tanker crews suffered during this time represented a temporary setback for their battle readiness. This single event was something that the heretofore comprehensive crew program never recovered from--not even today. 1974 SAC documents charaterize the resultant flying hour reductions as "far reaching" in their impact on KC-135 aircrew training programs. In fact, fiscal constraints caused fiscal planners to investigate economical alternatives to flying training (SAC RO,1974:4).

To supplement the declining tanker flight hours during this period, SAC turned to aging and obsolete--1960s vintage--simulators called the MB-26. Permanently housed in railcars, the MB-26 was famous--or, more accurately, infamous--among SAC tanker pilots for its "hoakie, unwieldy, and unrealistic" cockpit training (Scolarici, 1996).

Six years later in 1980, at a time immediately preceding the favorable political climate of the Reagan Administration, persistent fiscal constraints conspired once again to curtail combat crew training for tanker crews. SAC was now scrambling to uncover all available options to make up for flying funding cuts.

> The goals established by the Office of Management and Budget (OMB) have been used as management objectives by this command in developing simulator requirements. These goals propose flying hour reductions in initial qualification and recurring operational training by 50 percent and 20 percent, respectively. The initial SAC efforts was for a KC-135 Weapons System Trainer (WST) to meet the OMB goal. However, action deleting production units of the WST and an increase in KC-135 air refueling support requirements downgraded SAC's ability to reduce KC-135 flying hours.
>
> KC-135 flying hour requirements are a combination of receiver support and non-air refueling (non-AR) training requirements, which together exceed funded flying hour allocations by more than 28,000 hours. In order to maintain KC-135 combat crew readiness, the crew non-AR training requirements are allocated flying hours for 100 percent of their requirements. We believe one of the 28,000 hour shortfall can be alleviated by using the OFT for instrument flight evaluations and applying the resultant savings in non-AR training hours to receiver support requirements. (SAC RO, 1980:6)

As early as ten years into the KC-135's existence, budget cuts made air refueling training an expensive peacetime luxury. Alternatives such as imaginative flying hour management and the use of simulators were thoroughly explored. Staying proficient in air refueling would prove a tough challenge. Tactical Air Refueling became only a secondary consideration given the fiscal realities imposed by the oil embargo. Theater commanders had no meaningful input into tanker crew training requirements.

Pre-DESERT STORM Training

Given these realities and little advance preparation for the rigorous challenges of theater conflict, would tanker crews be up to the task? Even before war in the desert, questions concerning the readiness of crews to thrive in--or, at least survive--today's combat environment were raised. In "KC-135 Survivability In A War In Europe" Lt. Col John Ekwall points to two important issues which would likely impact upon deploying KC-135 assets: 1) tanker survivability, and 2) the tanker tactics required to support fighter close air support (CAS) and battlefield air interdiction (BAI) missions in and near the Forward Line of Own (friendly) Troops (FLOT) (Ekwall,1989:5). America can no longer look forward to a Vietnam scenario where US air superiority allowed air refueling operations to be conducted unfettered by enemy aircraft and ground fire. In a European war scenario, for example, US forces can expect a significant air-to-air threat for several weeks. The US can also anticipate a significant surface-to-air (SAM) threat with the proliferation of state-of-the-art SAMs and precision antiaircraft artillery (AAA) (Ekwall, 1989:iii).

In the most unambiguous terms, Col Ekwall describes the shortcomings of tanker crew training:

> 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....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 of and near the next battlefield will be extremely lethal to the unarmed KC-135.

> 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 on tanker survivability, we *will* lose tankers in the next war! (Ekwall, 1989:4)

The ripple effect of the loss of a single tanker is a fact not lost on world foes, either. During a September 1988 interview, famous defector and MiG-25 Foxbat pilot Victor Bolenko commented on the attractiveness of a KC-135 target to a Soviet-trained fighter pilot: "Because of the strategic value of a single tanker, every Soviet pilot or trained pilot would prefer to shoot a KC-135 over an F-15, for example" (Bolenko,1988).

Understanding that the combat milieu will be fraught with threats to US aircraft survivability, Air Force tacticians have explored a variety of ideas. One technique considered by many as a way to survive today's threat environment is to fly low. Even the tanker has a low altitude tactic: low altitude air refueling.

## Low Altitude Air Refueling Training

According to the 1st Combat Evaluation Group (1CEVG), based at Barksdale Air Force Base in the year 1989, one of the biggest shortcomings of SAC tanker crew training was the high altitude aspect of their peacetime training. They asserted that high altitude (above 10,000 above ground level) air refueling procedures leave the KC-135 "extremely vulnerable because there are no means of active self-defense" (HQ SAC Message, 1987).

Strategic Air Command thoroughly investigated Low Altitude Air Refueling as a viable option for KC-135 combat survival. According to the History of Fifteenth Air Force, Low Altitude Air Refueling (LAAR) was a program to train Fifteenth Air Force crews for conventional operations (15AF, 1990:113). The Air Force had discovered in a number of operations--Elf-One, the Iranian hostage rescue attempt, Grenada, and El Dorado Canyon--that tanker crews operated "close to the action." In recognition of this fact, PACAF, MAC, and TAC all supported LAAR (below 3000 feet Above Ground Level (AGL)). LAAR allowed strike aircraft to carry larger payloads and attack deeper targets while delaying or avoiding detection by enemy radar. Supporting KC-135s had to fly at low altitudes in order to safely operate near a battle zone. Tankers, lined with fuel cells throughout the wings and body and having no camouflage paint-scheme, were ill-suited for combat. Additionally, with no Electronic Counter Measures (ECM) or even ejection seats, the tanker is extremely vulnerable to enemy action (15AF, 1990:113-114).

Because it was a 30 year old fleet, it was widely considered that LAAR would exact a heavy toll on the KC-135. When the LAAR program was first proposed, many experts at SAC and Boeing expressed concern that this aging airframe would not be able to withstand the stresses. "Even for a healthy airframe, flying at 3000 feet instead of 20,000 increased the rate of growth of a potential crack by 8.4 times. And if the frame could take the stress, the crews had to cope with a new set of unfamiliar circumstances." Flying at low altitude would expose tanker crews to low-flying aviation traffic, birds, towers, terrain features, and turbulence (15AF, 1990:114).

With these conditions clearly understood at Strategic Air Command, it pursued a cautious--but ambitious--course of action. Warplanners at SAC sought a more tactically-proficient tanker crew force. In 1987 SAC had identified Low Altitude Air Refueling (500 to 1000 feet) as a goal. In the fall of 1988 SAC established LAAR training down to 3000 feet. The command directed that a core crew from each unit would be trained; that core crew would in turn train others. SAC's LAAR training program stipulated several restrictions.

- LAAR had to be performed with carefully inspected KC-135s.
- Participating airframes had to undergo Time Compliance Technical Order (TCTOs) 989 and 1200 (underwing reskin).
- Low-level refueling had to be done under Visual Flight Rules.
- LAAR could only be conducted over either water or flat or rolling terrain in specially authorized airspace. (15AF, 1990:115)

In an effort to move LAAR to even lower altitudes and as an additional step towards the full institutionalization of LAAR, a high-level meeting took place at Offutt Air Force Base in January of 1989. Attended by participants from Air Force Safety, SAC, the SAC numbered air forces, and 1 CEVG, this meeting was called to set up a time table to implement a 1000 foot Above Ground Level LAAR training program. Two units were chosen to conduct over-water LAAR: the 305th Air Refueling Wing from Eighth Air Force and the 376th Strategic Wing from Fifteenth (15AF, 1990:115).

The LAAR training program implemented by SAC was still included in tanker training regulations when both DESERT SHIELD/STORM and the 1992 reorganization of tankers into the Air Mobility Command occurred. To perform LAAR, SAC Regulation 51-135, Flying Training C/EC/RC/KC-135 Aircrew Training, dated 30 June 1990 limited LAAR training to those crews specifically selected by the wing commander. Crews would be selected based upon "experience, demonstrated airmanship and retainability" (SAC Regulation 51-135, 1990:4-4.). To summarize, LAAR training was just beginning when Sadaam Husein caught the world off-guard by invading Kuwait. The SAC tanker fleet was simply not ready to perform LAAR.

This is why LAAR was performed by untrained crews flying over Saudi Arabia during the early phases of DESERT STORM. Ready or not, tankers supported a warplan designed to dislodge Kuwait from Sadaam Husein's grasp which called for LAAR (Scolarici, 1996).

In the post-DESERT STORM training environment, Air Mobility Command (AMC) has proven itself a proponent of tanker LAAR training. In its writing of the first Multi-Command regulation to govern KC-135 aircrew training--called MCM 51-1--the command uses wording similar to the previously described SAC regulation. Today "just about all active duty KC-135 units have a core crew actively air refueling training in the low altitude flight regime. The receivers have been exclusively Special Operations Command C-130 aircraft" (Scolarici, 1996).

This is where AMC's LAAR training program differs from that of SAC. Exclusively a KC-135 to C-130 training procedure, today's LAAR is not conducted in preparation for strike missions. Where the LAAR procedure was originally designed to support ingressing strike aircraft, no peacetime low altitude air refueling of strike aircraft occurs today. "Unfortunately for proponents of LAAR training, the DESERT STORM low altitude strike aircraft refuelings are largely undocumented and hard to prove to the tanker's new owners at AMC" (Scolarici, 1996). Therefore, despite the demonstrated modern wartime necessity for LAAR, the peacetime training requirement for LAAR in support of strikes is not a documented fact.

LAAR training is by no means an isolated example of shortfalls in combat preparatory training. Others point out failed initiatives such as "Quick Flow" and "Hitchhike" refueling. This procedure, known at EUCOM and PACOM by these respective names, was the brainchild of receiver fighter pilots. The goal was to lessen the "boom-cycle" time--the time required for a receiver to get his required fuel onload--by decreasing the distance between waiting fighter aircraft. This initiative also called for the fighters to improve their position by moving from right to left as they alternatively refueled on the boom. The tanker would, in clear violation flight publication directives, leave the non-delay air refueling pumps "on" so that the fighters would immediately receive fuel at the moment of contact between the boom and the receiver's receptacle. This innovation occurred to tacticians in both Europe and the Pacific in 1989. Almost simultaneously at Misawa Air Base, Japan and Ramstein Air Force Base, Germany fighter pilots championed the full-scale development of this technique. This tactic, under either name, appears in no tanker training regulation today, seven years after it was proposed. AMC never officially santioned this procedure even though its reliability was confirmed at exercises such as COPE THUNDER in 1989. The Quick Flow procedure was included in the DESERT SHIELD tanker tactics pamphlet authored by 17th Air Division and distributed to all tanker crews in theater. "Quick Flow was proven successful in DESERT STORM" (Scolaricci, 1996).

Training issues such as LAAR and Quick Flow clearly demonstrate a situation where the supporting MAJCOM is not "answering the mail" from supported combatant commanders. Clearly a situation has occurred where theater commands have no input into the training of their supporting tanker crews.

Tanker Training Requirement Development

Just how are tanker crew training requirements developed? Multicommand Instruction (MCI) 10-202 Volume 6 "prescribes specific policy guidance for training crewmembers in US Air Force KC-135 aircraft" (MCI 10-202, 1996:4). This publication is revised annually. Current inputs to the regulation can be accurately depicted as shown in Figure 3.


Figure 3. Tanker Training Requirement Inputs (derived from MCI 10-202, 1996)

According to 10-202, "training requirements are based on strategic and theater operational requirements in designated operational capability (DOC) statements" (MCI 10-202, 1996). Taken at face value, this statement alone would seem to indicate that the annual 10-202 revision conferences offer an excellent vehicle for theater commands to make inputs to tanker training requirements.

What is not described in this regulation is the very real impact of budget on the development process. The reality of how requirements are actually established belies the regulation's words. Unidentified sources from AMC indicate that the process of tanker crew training requirement development begins with an accounting of available tanker flying hours. The flying hours available through the budget process are divided equitably among the supported MAJCOMs. The goal for all receiver aircraft representatives attending this annual conference is the maintenance of basic air refueling skills. Conferencing to establish tanker training requirements is not new; it reflects a continuation of policies started under SAC.

Perhaps institutional barriers exist which act to prevent direct inputs from theater commands to the tanker training process. With the passage of the enactment of the Goldwater-Nichols DoD Reorganization Act in 1986, changes to the Unified Command structure became public law. It was in 1987 that US Transportation Command (USTRANSCOM) became a reality (History of the Unified Command Plan, 1995:108-115). KC-135 aircraft became part of TRANSCOM as a result of their absorbtion into AMC as part of the June 1992 Air Force Reorganization. Reposited in TRANSCOM's air component command, AMC, officers responsible for the establishment of KC-135 crew training requirements have several layers of bureaucracy between them and theater air components they support. Any exchange of information must necessarily be coordinated up from the theater component commands, through their associated theater joint staff, on to the TRANSCOM staff, and then finally to AMC itself. (derived from the History of the Unified Command Plan, 1995:108-115) Because of these layers of bureacracy, it becomes easier to understand how the fighter pilots from USAFE and PACAF would require almost inhuman tenacity to take their Quick Flow air refueling technique all the way from concept development to fully AMC-santioned tanker crew training program. The difficulties facing these pilots are real. The disconnect between tanker crews and their supported receiver pilots is not ideal. There must be a way for theater pilots to make an input into the combat preparations of their tankers.

## V. Integrating Wartime Tasks Into Tanker Combat Crew Continuation Training

How can tanker wartime tasks be more accurately reflected in tanker combat crew continuation training? If a list of tactical air refueling training events was composed, which ones could be practiced safely during actual flight? Which ones would be practiced only in a simulator?

Recognizing today's increasingly restrictive budgetary constraints, those responsible for the development of tanker continuation training requirements need to be more innovative than ever before. Given the expenses associated with crew in-flight training, every flying hour should be spent with a goal of realistic training. Some tactical air refueling tasks will be too unsafe for peacetime practice. Some air refueling tasks are too critical to the successful accomplishment of the mission to await in-theater training by tanker crews.

Perhaps there is no safer, more efficient means to develop a realistic tactical air refueling training program than to first simulate all tanker wartime activities using a wartime attrition model. An attrition model would be an excellent way to observe the performance of prospective tactical training events. Aircraft loss statistics produced during the simulated performance of tactical air refueling tasks could help identify training events which are suitable for in-flight use. The remaining tactical training activities would then be conducted exclusively in a KC-135 simulator.

The development of this training program could be based on results obtained from an attrition model called "Suppressor." This is the attrition model from which General Horner derived projected DESERT STORM aircraft losses. These figures were cited in his briefs to tanker crews in Saudi Arabia during DESERT SHIELD. Ironically, where Suppressor provided tanker aircrews some discomforting news in December of 1990, this model could provide information key to the success of crews supporting tactical operations in the next war. Suppressor could be the first step in the development of AMC's tactical air refueling training program.

## The Suppressor Attrition Model

According to Mr. Jordan Wescott (ASC/XRE), the Air Force has depended upon this attrition model for many years. In his briefing, entitled "An Analyst's View of Suppressor," Mr. Jordan Wescott outlined the history of the model:

| | |
|---|---|
| 1978 - 1981 | Developed by Calspan Corporation for USAF/SAGR |
| 1983 | ASD/RWX Assumes Model Sponsorship and converts to ANSI Standard FORTRAN and develops a full set of documentation |
| 1986 | Release 4.2 with Terrain Following, Terrain Avoidance, Threat Avoidance |
| 1987 | Release 5.0 with New Assignment and Jamming Logic |
| 1989 | Release 5.1 with New Engagement, Firing, and Movement Tactics |
| 1992 | Release 5.2 with Emission Control, Improved Tactics, and Release 1.0 Scenario Data User Friendly Interface |
| 1993 | Release 1.0 Type Data Base User Friendly Interface |
| 1994 | Release 5.3 with Dynamic Emitter Frequency Changing, More Output, More Antenna Patterns |

Figure 4. History of Suppressor (HQ ASC/XREa, 1996:Slide 6.)

Contrary to what might be believed by cynical tanker "crewdogs," the purpose of Suppressor is to model wartime aircraft loss rates for all DoD weapons systems against all possible theaters of conflict. "Suppressor is a general purpose, event stepped, mission level simulation model used for evaluating different weapons systems, sensor systems, tactics or command procedures in composite missions against an integrated air defense [IADS] using some combination of land, air and naval operations" (ASC/XREb,1996:1). Because DoD warfighting assets cover the entire spectrum of combat, "Players in Suppressor usually represent various types of aircraft, surface-to-air missile systems, antiaircraft artillery, radar or EW [electronic warfare] sites, command and control nodes, or targets" (ASC/XREb,1996:1).

So, in simple terms, how does Suppressor come up with "accurate" attrition numbers? According to Mr. Wescott, the principal means used by this model to derive loss rates is through "data base development." In fact, "Suppressor is a data driven model. This approach allows great flexibility, but requires more effort to develop data bases." In an effort to illustrate just how complex an effort data base development is for Suppressor, Mr. Wescott quotes the following numbers from a notional Basra scenario:

Table 2. Basra Scenario Data Requirements (HQ ASC/XREa, 1996:Slide 4.)

| | |
|---|---|
| **Lines in Scenario Data Base:** | **11,407** |
| **Total Players:** | **464 (25 lines per player)** |
| **Lines in Type Data Base:** | **58,406** |
| **Player Types:** | **74 (800 lines per player)** |

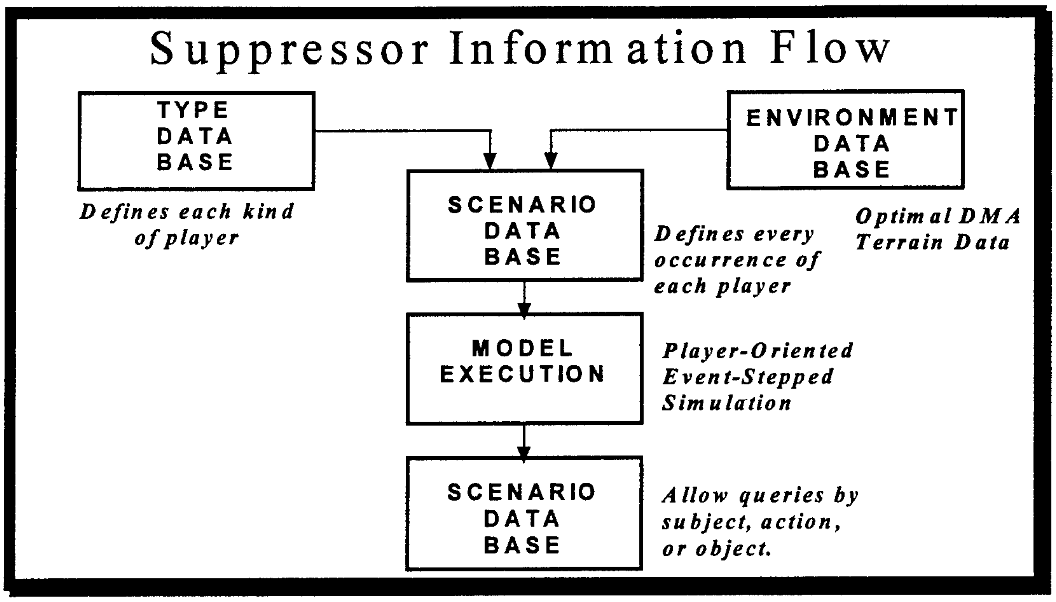



Figure 5. Suppressor Information Flow (HQ ASC/XREb, 1996:Slide 3.)

The Suppressor information flow is pictured in Figure 5. Despite vast amounts of data required by this model, a mainframe computer is not required to run it. "Suppressor is written in portable FORTRAN 77. Suppressor is operational on VAX, DEC, IBM, Sun Hewlett Packard, and Silicon Graphics Workstations, as well as PCs and mainframe computers," says Wescott (Wescott,1996).

Suppressor's Building Block Approach.

Organized in nine functional elements, Suppressor uses a combination of sophisticated algorithms, weapons performance data, and intelligence-based heuristics. The nine functional elements are described below:

- Perceptions - deal with the initiation, updating and deletion of perceptions using sensors and messages to provide stimuli to the IADS.

- Lethal engagement - includes the process from the initiation of a perception to the conclusion of an engagement with a weapon.
- Nonlethal engagement - relates to jammers (e.g., EF-111) or disrupters.
- Launch, and the initiation of movement - during model execution, deals with the commanders and subordinates that are part of the process that starts someone moving in cases other than ordinance launch at a specific target.
- Intelligence reporting - covers the sending and receipt of messages that contain information about objects seen with sensors.
- Communications chain - treats all messages that are sent and received, without regard to the specific content of the messages, though messages can be prioritized based upon the source of the message.
- Reactive maneuvers - encompass any changes made to a movement path during model execution, including the movement of ordnance toward a target.
- Thinking - is modeled without regard to the specific items or data being evaluated or processed. (HQ ASC/XREb, 1996:1)

Figure 6 shows a graphic depiction of the functional mapping of Suppressor. In the left two columns are user-defined player data. This feature of Suppressor explains the model's widely known flexibility. In fact, Suppressor players have included almost all world strike aircraft, decoys, standoff jamming aircraft, Early Warning/Ground Control Intercept (EW/GCI) sites, along with almost all known types of surface-to-air missiles (SAMs) and anti-aircraft artillery (AAA), according to ASC/XRE representatives.

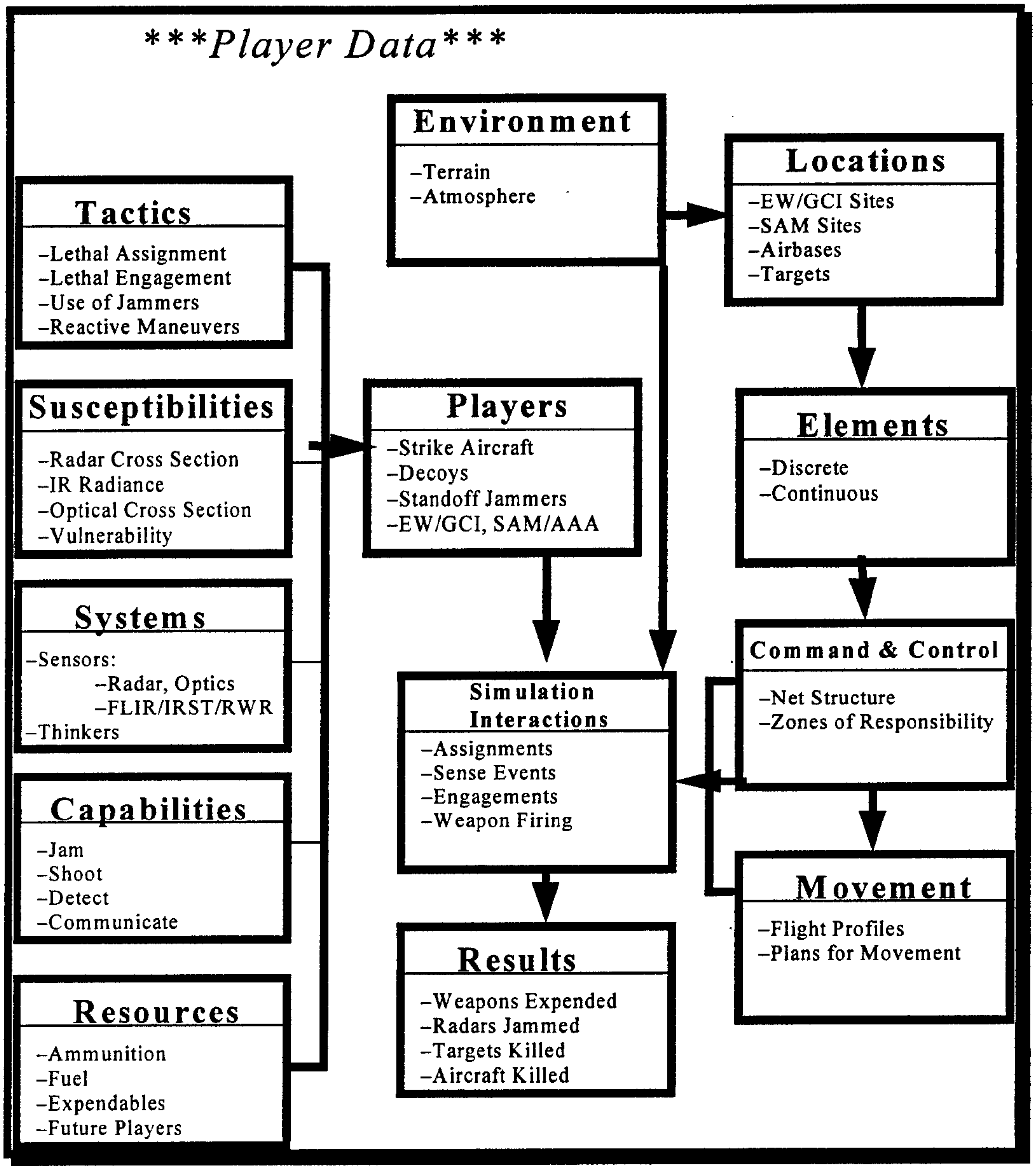



Figure 6. Suppressor Player Data (HQ ACS/XREb, 1996:2)

In the right column is the Scenario Data Base. Scenario specific data, coordinate (e.g., X,Y,Z; UTM; latitude/longitude) data for all locations, and the position of security control zones, just to name a few examples, are included in this column.

The middle column fills in the rest of Suppressor's simulation data. In what constitutes a huge amount of information, Suppressor incorporates Defense Mapping Agency digitized terrain elevation data in sufficient resolution to render multi-dimensional terrain models. These models are then used in Suppressor to describe all above ground level altitude values. In simulation, these values are used in evaluating the effects of terrain masking and track all player movement relative to the digitized ground information.

Incorporating all the previously mentioned information into a coherent diagram, Suppressor structure is described by something like this:

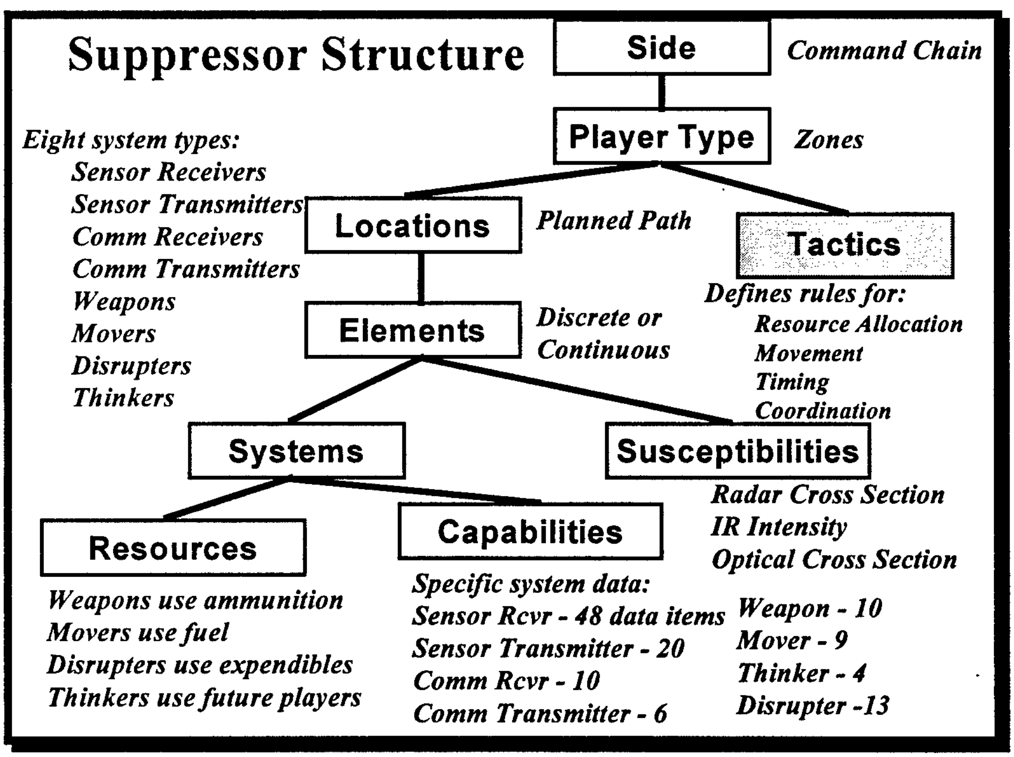



Figure 7. Suppressor Structure (HQ ASC/XREa, 1996:Slide 8.)

Description of Suppressor Methodology.

The Suppressor uses five different algorithms: Event Queue Manager; Sensor-Target Interactions; Tactics and Resource-Allocation; Movers and Reactive Movement and Thinker Systems.

Event Queue Manager.

The Event Queue Manager is a key player in the Suppressor Simulation process. This algorithm keeps a list of scheduled events. Every event is discrete; that is to say, in Suppressor every event happens during one instant in time. Every action taking place in Suppressor's modeling process is a separate event. Event examples include, Move, Shoot, Communicate, Sense, Disrupt, Think.

With the occurrence of a particularly complicated set of activities, event binary "event trees" would be formed with event nodes. These event nodes include the scheduled time for the event's occurrence, the player(s) participating in the event, and a specially assigned event code. As an event takes up more scheduled time, it correspondingly takes up more event nodes in the event trees. With the main scheduled event at the top of the tree, the succeeding branches would describe the activities and players involved in that particular block of scheduled event time (See Figure 8).

Sensor-Target Interactions.

Of course, no IADS is able to respond without first sensing the enemy target. In today's field of conflict, sensors are more numerous than weapons that destroy. In that

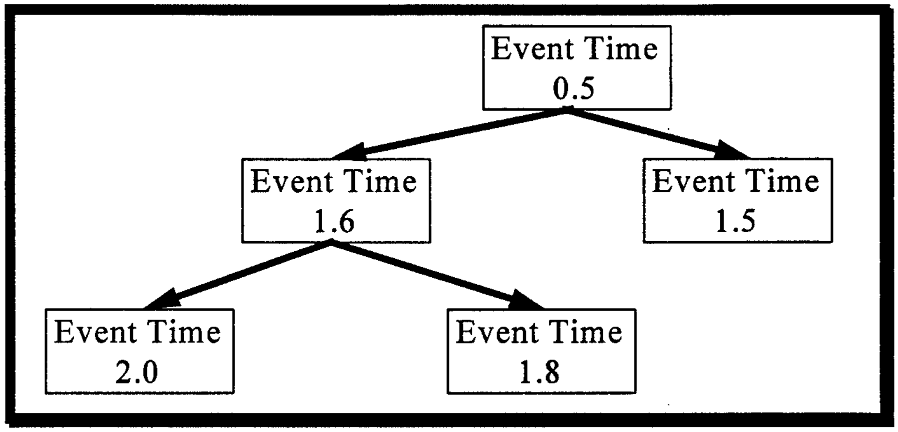



Figure 8. Event Queue Manager (HQ ASC/XREb, 1996:4)

vein, Sensor-Target Interactions algorithm is key because of the number of sensor-capable weapons systems. This is to say that in the modern field of combat, many weapons systems on both sides have the ability to detect the presence of friends and foes alike. This algorithm makes certain that sensor events are scheduled for all possible sensor/target combinations--given a certain number of sensor-capable assets in a particular theater of operations. This is done so that an individual sensor event is not necessary for every possible sensor/target pair.

This algorithm uses data structured in layered hexagonal address cells. A sensor occupies one position on a layer of these cells. The size of these hexagons depends on the range of the sensor. The job of this algorithm is to schedule sense events in the instance that a target crosses one of the sensor's six neighboring cells. As a direct result of this algorithm, Suppressor increases the overall efficiency by saving on the number of sensor events requiring time allocation. This setup is depicted in Figure 9.

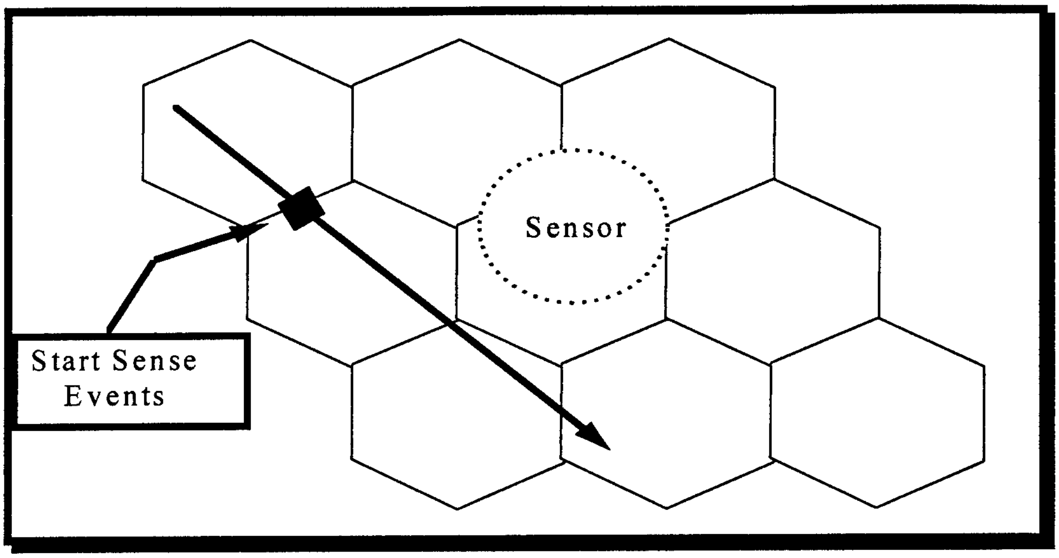



Figure 9. Sensor Events (HQ ASC/XREb, 1996:5)

Of course this sensitivity business is particularly complex. The equation (referred to as an algorithm by the folks at ASC/XRE) used by Suppressor for just Radar Warning Receiver (RWR) detection alone shown in Figure 10.

$$K = N_r + T - G_r + 10\ \mathrm{Log}(4\pi / C)^2 - L_r + 20\mathrm{Log}R$$

$$P = 10\mathrm{Log}P_t + L_t - 20\ \mathrm{Log}F + A_{atm}$$

Mainbeam detect if: $(P + G_{tm}) > K$

Backlobe detect if: $(P + G_{tm}) < K$

Figure 10. Radar Warning Receiver Algorithm (HQ ASC/XREb, 1996:11)

The legend for the above algorithm follows:

| Warning Receiver Sensing Equation Parameters | |
|---|---|
| $A_{atm}$ | Atmospheric attentuation (dB) from TRANSMISSION - LOSS |
| C | Speed of Light |
| F | Frequency (hertz) of target emitter, from XMIT - FREQ or SDB FREQ |
| $G_r$ | Gain from the warning receiver ANTENNA PATTERN (dB) |
| $G_{tm}$ | Gain from the target emitter ANTENNA PATTERN (dB) |
| $G_{tb}$ | Backlobe gain from the target emitter, RWR - BACKLOBE GAIN (dB) |
| $L_r$ | Receiver INTERNAL LOSSES (dB) from DETECTION SENSITIVITIES |
| $L_t$ | Transmitter INTERNAL LOSSES (dB) |
| $N_r$ | RECEIVER NOISE (dB) of the warning receiver |
| $P_t$ | PEAK POWER OUTPUT of target emitter (dB) |
| R | 3 - D range between receiver and target emitter (meters) |
| T | SENSING THRESHOLD (dB) of the warning receiver from DETECTION SENSITIVITIES |

Figure 11. Radar Warning Receiver Algorithm Legend (HQ ASC/XREb, 1996:11)

The "mainbeam" of a radar system is the most powerful portion of a radar's viewing area. An analogy for this is the area illuminated by the bulb of a flashlight, for example. The sidelobe is the areas (side, rear, etc) other than the mainbeam of an emitted radar signal which occur--despite the efforts of a radar antenna to focus the beam in one direction--because of the the radar emission's omnidirectional nature. In other words, the sidelobe sensing ability is the radar's ability to "see" a target despite not being pointed directly at it.

Included in this particular grouping are algorithms for radar sensing, moving target indicator attenuation, infrared sensing, optical sensing and, as previously mentioned, one for RWR sensing.

Tactics, Resource Allocation.

The Tactics, Resource Allocation algorithm is critical to Suppressor analysis as well. It allows users to define the tactics players will use in interaction with other players. This is key to commander decisions to allocate resources such as KC-135 to a particular refueling location. Or, in the case of an air-to-air asset, this algorithm will enable players to fire weapons at the doctrinally allowed weapons release parameters against a simulated enemy. There are currently 19 specific types of Tactics, Resource Allocation procedure types.

Table 3. Resource Allocation Procedures (HQ ASC/XREb, 1996:7)

| Category | Procedures | Resources |
|---|---|---|
| | | |
| Emission Control | EMCON/TURN-ON | Sensors |
| | EMCON/TURN-OFF | Sensors |
| Assignment | LETHAL-ASSIGNMENT-QUEUE-ADD | Subordinates |
| | LETHAL-ASSIGNMENT-QUEUE-DROP | Subordinates |
| | LETHAL-ASSIGNMENT-START | Subordinates |
| | LETHAL-ASSIGNMENT-STOP | Subordinates |
| Engagement | LETHAL-ENGAGE-QUEUE-ADD | Weapons |
| | LETHAL-ENGAGE-QUEUE-DROP | Weapons |
| | LETHAL-ENGAGE-START | Weapons |
| | LETHAL-ENGAGE-STOP | Weapons |
| | LETHAL-ENGAGE-FIRING-START | Weapons |
| | LETHAL-ENGAGE-FIRING-STOP | Weapons |
| Jamming | JAMMER-QUEUE-ADD | Weapons |
| | JAMMER-QUEUE-DROP | Jammers |
| | JAMMER-SPOT-ADD | Jammers |
| | JAMMER-SPOT-DROP | Jammers |
| Launch Order | LAUNCH-START | Subordinates |
| Mode-of-Control Change | GUNS-FREE | Subordinates |
| | GUNS-TIGHT | Subordinates |

The EMCON control procedures outlined in Table 3 are prescribed for players in the use of their sensors. For example, the APN-59 ground-mapping radar is a sensor on the KC-135. The KC-135 player's APN-59 sensor would be turned off or on, possibly in an effort to prevent passive detection by ground-based electronic support measures. This would be an example of tactical emissions control, nicknamed EMCON.

In the Assignment portion, a commander player instructs his/her subordinate players to commit on detected targets. Or, that same commander can cancel the commits already assigned based on a dynamically changing chain of events, new target pop-ups, etc.

Engagement procedures refer to weapons in the control of a player. The player can consider which target has been assigned, select a specific missile type for the encounter, or choose the volume of armament to be launched (e.g., salvo).

Jamming resources belong to a player's jamming systems. The jammers--be they communications or radar--can be turned OFF or ON. This model provides a player the capability to "spot" jam by focusing disruptive signals on a single radio frequency, for example.

Launch Order procedures account for a commander player's decision to actually send counter-air resources skyward. Also included are such vital decisions such as the number of sorties to scramble.

Mode-of-Control Change resources are the subordinate players themselves. Subordinate to the commander player, these forces can be told that a GUNS/WEAPONS

FREE order has been issued which allows the use of deadly force. The WEAPONS TIGHT ensures no release of weapons, which is especially important in the case of a change of mind by the commanding player.

Movers and Reactive Movement.

The algorithm for modeling Movement and Reactive Movement uses data compiled in the Tactics and Capabilities portion of the Type (player definition) Data Base, along with the planned routes input from the Scenario Data Base. With this algorithm, Suppressor can simulate player movement both in the air and on the ground. With a definition of reactive movement, Suppessor thus allows player movement in response to developing situations. Four actions are included in reactive movement: attack a target, stop a maneuver, wakeup to evaluate a plan, and wakeup for an a priori plan. A much more realistic, less scripted, simulation evolvement is the result.

A player's path incorporates three types of movement: start, update, and stop. A player's movement is included in data named The Future Path List (FPL). This list has X, Y, and Z-coordinates, among other information, for each movement. The FPL logs historical player movement and projects where the player will be in the future. With player reactive movement, the FPL updates with new projections. These paths are tracked and projected 3-dimensionally for air players and 1-dimensionally for ground players.

Thinker Systems.

The algorithms for Thinker Systems result from data defined in the Capabilities portion of the Type Data Base. Every player requiring the ability to assess and react--given a situation--is included in this system. Figure 12 is a sketch of the Thinker system.

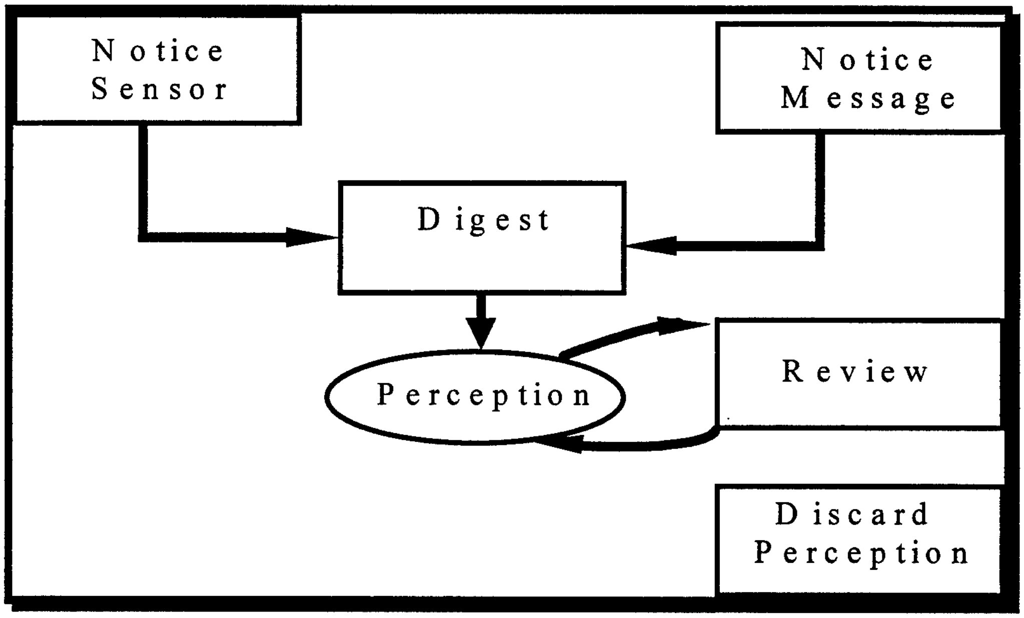



Figure 12. Suppressor Thinker System (HQ ASC/XREb, 1996:8)

Notice events encompass thinker actions which serve as a link between physical events and mental processing events. Notice events are stimulated in two ways: sensing a target, or the occurrence of a notice message received from another player. Digest events are representative of mental information processing and the resulting cognitive decisions a player might make in response to the notice event stimulus. The first of a series of review events occurs following the first digest event. Subsequent reviews happen at regular intervals until all target perceptions are dropped. In other words, after the initial digest event, the review events continue until there remains no perception of the target exists. This whole process is initiated and reiterated for the next target that the player perceives.

In summary, the Suppressor Model is fully capable of simulating tanker combat profiles. The simulation of theater warfighting tasks will make the most risky tactical air refueling tasks more visible to AMC. With this information AMC can more efficiently design its tanker training program to address both strategic and tactical wartime taskings more comprehensively than ever before. The model is not currently adapted for the tanker mission. Some insights which might make Suppressor more adaptable for the purposes outlined in this recommendation are explained in the following section.

How to Adapt Suppressor

To reiterate, Suppressor could be extremely useful in helping AMC develop a tactical air refueling training program. With no other models to compare Suppressor simulations to, Suppressor will no doubt be free to continue updating its rather huge data base in response to developing friend and foe combat capabilities. Based in some part on efforts to specify desired model characteristics, the following recommendations and findings are made:

- The model seems to be designed more for fighter/striker kinds of self defense capabilities. In interviews with Mr. Wescott, upon hearing the model would need to employ non-fighter maneuvering parameters, his answers were always, "it can be done." Inputing the amount of computer data required to accurately account for even a single aircraft's flight performance constitutes a huge undertaking. Understanding that limitation, the current process of inputting player data during the definition phase (Type Data Base) includes a description of the number degrees bank turn limits, altitude restrictions, etc. Tanker parameters in this regard are constantly changing, depending upon the portion of the mission it is on. During the climbout portion of the mission, the aircraft is typically heavily-laden with fuel and unable to withstand the maneuvers required to survive an SA-5 attack, for example. This situation improves dramatically, however, at the enroute descent portion of the tanker's flight profile where it is extremely light, much more nimble. Thus, simply inputting gross limits on maneuvering capabilities doesn't accurately account for the full range of possible tanker performance. Put another way, users--to include tanker users--need to be the ones making "rule of thumb" or heuristic inputs in areas such as this.

- The model does not take into account the impact of fuel or aerial refueling on mission duration. All players are not limited to a prescribed mission duration. Suppressor's intense focus on realistic simulation of players against their enemy counterparts fails to comprehend the logistical impact of fuel. Just like Hollywood gunslingers, no Suppressor aircraft is lost to fuel starvation. Players are removed from the scenario only as a result of direct enemy action.
- In real combat, tanker attrition results in mission cancellations and other bad effects. While Suppressor can predict the number of tanker targets lost in simulation, those losses are in no way translated into other aircraft losses or cancellations. To

recapitulate, the rippling effect of the loss of a single tanker is a fact not lost on world foes.

- Despite our need for "hard answers," the data would seem to be probabilistic. Whether intended or not, all the literature and interviews leaned toward Suppressor results being deterministic. Because of the data-intensive nature of the model, the generated numbers appear to be taken as near certainties. At least that is the common perception. As proven by the dire predictions for tanker losses in DESERT STORM, these figures are not perfect. As is the case in intelligence data where terms like "probability of kill" are used, perhaps Suppressor data should carry that type of implied disclaimer also.
- Suppressor should attempt to incorporate feeds from other AMC-run databases. An excellent example of one such program is the Contingency Mating and Ranging (CMARP) program which accurately computes and flight-plans tanker requirements based on user requirements. For example, given a specific Libyan target and an F-15E designated as the striker, CMARPS would be able to figure out the airbridging tanker refueling orbits.
- Suppressor could become even more jointly utilized. It would add another level of realism to have Navy Aircraft Carrier-based assets and their command and control procedures added to the simulations. Additionally, the Army Air Defense Artillery (ADA) is not, it seems fully integrated into the picture. Army Patriot batteries almost contributed to US aircraft losses during DESERT STORM, according to Major

Scolarici, KC-135 Tactician at the Air Mobility Warfare Center. Apparently recognizing this fact, the people at ASC/XRE recently funded an "effort to encapsulate Suppressor into the Joint Modeling and Simulation System (J-MASS) architecture"

To summarize, the Suppressor attrition model--given a few modifications--will capably aid AMC. AMC needs to be able to safely and efficiently preview theater-proposed tactical air refueling training events. The attrition statistics derived from the use of Suppressor would represent a giant step in AMC's effort to establish an effective tactical air refueling training program.

## VI. Recommendations and Conclusion

### Recommendations

Perhaps there are no easy solutions to the problems posed in this paper. The problems posed by a tanker force ill-prepared to fulfill its evolving wartime requirements are too obvious to allow the status quo to continue. The solutions offered in this paper are two-fold:

- A top-to-bottom review of the current training requirements. An effort similar to the Military Airlift Command and TRANSCOM congressionally mandated Mobility Requirements Study (MRS) should be undertaken. Where the MRS was intended to show the real wartime airlift requirement, the new study will show what the real wartime air refueling requirement is. During the conduct of this study AMC should examine theater-by-theater the refueling tasks required by the respective warplans. The command's thinking should be: "how can we better serve the theaters through training?"
- In an effort to efficiently determine the combat effectiveness these new tactical air refueling training events, an attrition model should be used. This model will aid AMC in its determination of in-flight and simulator training activities. Safety considerations make some training events better suited for frequent performance in a simulator than other more routine, less risky procedures. For example, a 500 foot overland refueling of an F-16 would be

better simulated than actually flown. A 10,000 foot refueling of an F-16 be more suitable for actual practice inflight. Therefore continuation training frequency for LAAR with strike aircraft, for example, would be based not on some arbitrary number, but on a carefully designed program based in some part upon attrition numbers obtained from Suppressor.

These steps will go a long way to help AMC in its quest to make tanker crews more effective during their response to rapidly developing theater conflict scenarios. These steps will help AMC become more responsive to theater commanders during peacetime. They will also make tanker crews more capable in answering the demands posed by theater warfare.

## Conclusion

The KC-135 Stratotanker has proven itself an incredibly reliable air machine with an impressive combat history. Tanker aircraft are projected to serve DoD well into the next century. The KC-135 can be expected to continue to perform up to its own high standards until the plane's inevitable retirement. There has been much precedence for the tactical use of the tanker. As recently as DESERT STORM the tanker has been aggresively employed over target area threats. The heroism and professionalism of tanker crews is widely acknowledged by strike aircrew and theater command alike. Little of this heroism has transcended from folklore and legend to recorded fact, however.

Air Force bombing doctrinal changes have a direct impact upon tanker wartime taskings. As the CEP gets smaller with the use of fighter-bomber-sized bombing aircraft, tankers will increasingly establish their orbits within easy reach of enemy targets.

AMC should make a concerted effort to identify training requirements considered mission-essential by theater commanders. Where SAC and AMC have frustrated theater efforts to make inputs into tanker training requirements, theater concerns should be moved to the top of the list. The most challenging tasks a tanker will ever perform will occur during theater conflict.

And, finally, in an effort to efficiently preview prospective theater-supportive training events, an attrition model should be used. The use of a model to simulate combat flight profiles will greatly aid the command's training decisions. The toughest tasks should be carefully identified and then assigned the proper emphasis in the training regulations.

The bottom line is that the crews of the KC-135 have been both lucky and good during the aircraft's long combat history. Perhaps the time has come for dedicated effort to prepare combat tanker crews in advance of theater combat. The tanker is too precious an asset to be needlessly squandered in wartime. The loss of a single tanker to combat would be tragic if that loss could have been prevented with peacetime preparation.

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## Vita

Major Keith W. Moncrief was born on 11 August 1960 in Topeka, Kansas. He graduated from Vanden High School at Travis Air Force Base, California in 1978 and entered undergraduate studies at Baylor University in Waco, Texas. He graduated with a Bachelor of Arts degree in Political Science in May 1982. He received his commission on 14 May 1982 through the Air Force Reserve Officer Training Corps.

Major Moncrief's first assignment was at McConnell Air Force Base, Kansas as a KC-135 navigator. His second assignment was at Kadena Air Base, Japan as the 376th Strategic Wing Chief, Tactics Division. In September 1989 he graduated with a Masters of Science degree in Education from Troy State University. In May 1991 he was selected to be initial cadre for Strategic Air Command's Tactics School at Ellsworth Air Force Base, South Dakota. In May 1994 the Major was picked to originate Air Mobility Command's Combat Aircrew Tactics Training Course at the Heaquarters Air Mobility Warfare Center (AMWC) at Fort Dix Army Installation, New Jersey. In September 1995, he entered the Advanced Study of Air Mobility program at the AMWC, sponsored by the Air Mobility Command and Air Force Institute of Technology. His follow on assignment is to United States Forces Korea (PACOM)/J-5 (contingency plans office).

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13. ABSTRACT (*Maximum 200 Words*)

Largely the result of military restructuring away from overseas basing to a strategy of forward presence, the Air Force has adopted a concept of **Global Power - Global Reach**. Air Mobility Command has been charged to provide the **Global Reach** needed to project power abroad. The venerable KC-135 is a key component of the mobility half of this national warfighting strategy. Since its creation in the mid-to-late 1950s, the KC-135 Strato-Tanker has been involved in every United States war, regional conflict, special, contingency, peacekeeping, relief and peacemaking operation. The training requirements levied upon tanker crew members are not based upon projected--or past--theater employment experience. This paper seeks to chronicle the wartime experiences of tanker crews. This paper concludes with two findings:

1. A 100% bottom-up review of current training requirements is needed.
2. Innovative modeling techniques should be used to select tactical air refueling training events for use in the simulator and during KC-135 flights.

The adoption of these strategies will more closely link day-to-day tanker training activity to tanker wartime taskings.

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