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# *Global Strike, Global Mobility:*

## The Advanced Multi-role Tanker-Transport

by
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NORTHROP GRUMMAN

# Contents

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## The Advanced Multi-role Tanker-Transport

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*As the United States military faces an uncertain security environment, the importance of its mobility fleet of tanker and airlift aircraft continues to increase. But the forty-year old tanker fleet is aging rapidly, and the airlift fleet is also in need of recapitalization. A historical review of tanker and airlifter employment reveals that changes in requirements, capabilities, mission and vision over those years now prompt the need for adaptive planning and smart procurement. A multi-role tanker-transport aircraft whose primary function is air refueling, but which also can become a mobility multiplier for the Joint Force, is the best solution for the current US Air Force tanker replacement program.*

# I. Introduction

"Rapid Strike, Global Mobility" is a phrase uttered by Air Force leaders, often without acknowledging that those capabilities are totally dependent upon air refueling and airlift. The US Air Force operates the largest air mobility fleet in the world, which allows the United States to project military power anywhere on earth, quickly.

The importance of that mobility fleet is increasing. Regarding tankers, Figure 1 shows that the percentage of tanker sorties relative to all combat sorties flown during recent conflicts has grown dramatically.

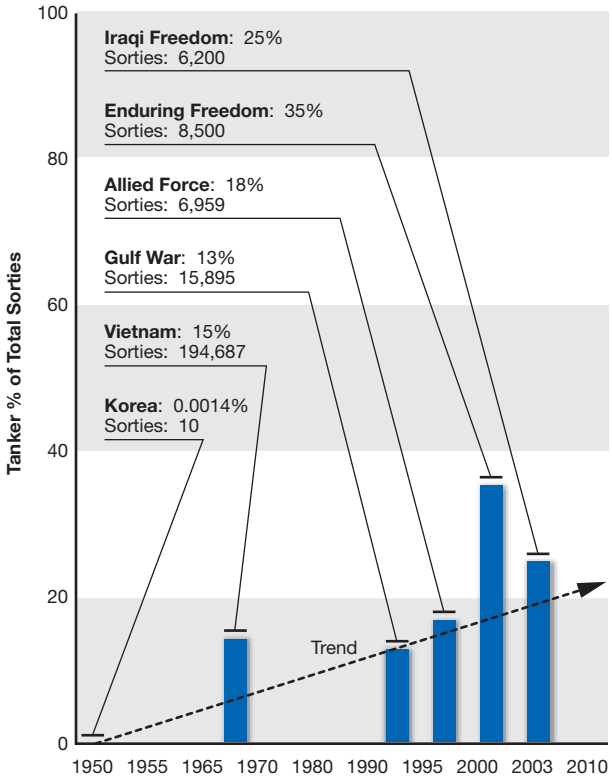


*Figure 1: USAF Air Refueling in Major Conflicts*[1]

The increased demand for tankers is due to several factors, most not anticipated when the planes were procured over forty years ago:

- The reduction of overseas bases by two-thirds after the Cold War ended meant that deploying strike aircraft would have to fly farther to arrive at airfields in a crisis area; these "expeditionary" bases were often sited far from prospective targets, meaning the planes needed more gas to carry out their missions. That fuel would not always be available at austere locations.
- The introduction of improved radar, infrared sensors and GPS has allowed strike aircraft and ISR platforms to operate 24/7 and in virtually any type of weather—that means tankers must do so as well.
- The shift to fleeting and time-sensitive targets—the norm when tracking down terrorists—demands greater persistence. Strike aircraft are now often launched without pre-planned targets; instead, they proceed to designated "kill boxes" and wait for controllers to pass them "pop-up" targets. As a result, strike sorties once lasting two hours must now be extended two or three times that long.
- As the Army moves to shed its organic artillery to become more agile, it will rely heavily on air-delivered firepower, thus increasing tanker demands as fighters are tasked to loiter in the battlespace for longer periods.
- The US always responds to natural disasters, such as the tsunami of 2004, the earthquake in Pakistan, and hurricane Katrina. These crises saw a massive airlift of medical supplies, food, clothing, water, tents and other necessities into the stricken areas, while taking the injured and homeless out. Such activities will continue.

[1] Figure provided by HQ USAF/XPX, Sep 2004.

All of these conditions highlight the increased requirement for air refueling to enable the long range and persistence needed by other air assets. But the tanker fleet is aging. The planes comprising the bulk of this fleet, the KC-135s, now approach 45 years in age. They've received new skins, new engines, new floors, new cockpit instruments and new avionics, but they are still old and need more and costlier maintenance to keep them flying. The US military, which increasingly conducts its operations as an integrated Joint Force, needs a new tanker.

The Joint Force, which is increasingly expeditionary in its form, also depends on airlift, as Figure 2 illustrates. That trend is also likely to continue.

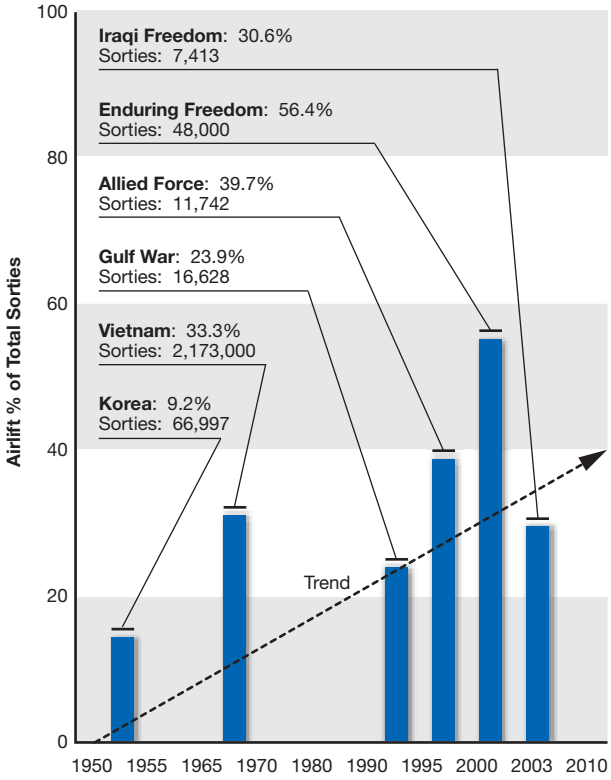


*Figure 2: USAF Airlift in Major Conflicts*[2]

Cuts in overseas bases and restrictions placed on operating from them by host countries mean airlifters must carry loads over greater distances. In addition, the requirement for all of our forces to become more agile and more quickly deployable puts airlift in increasing demand and serves as a force multiplier, giving our leaders more options. To cite two examples: In 1999 the US Army used 500 C-17 sorties to move an Apache helicopter battalion from Germany to Albania during Operation Allied Force.[3] In 2003, Turkey's refusal to support Operation Iraqi Freedom resulted in C-17s picking up the 173rd Airborne Brigade in Germany and air-dropping it into northern Iraq—one of the largest combat paratroop drops since World War II.[4]

Like the tankers, the airlift fleet is also in need of recapitalization. The C-141, the airlift workhorse for over three decades, is now being retired and soon will disappear from the inventory. The C-5A, almost as old, has a poor Mission Capability Rate that must be remedied. Soon after taking over US Transportation Command, General Norton Schwartz called for a study to examine how best to recapitalize, rapidly, the nation's airlift force.[5] He was responding to a steady drop in the number of inter-theater airlifters from 345 in 1992 to only 238 a decade later.[6] Given these shortages in refueling and lift, the Air Force is examining its options to fill these looming capability gaps.

The Air Force lists recapitalization as one of its greatest challenges, and the Chief of Staff sees tankers as the system most in need of renovation.[7] The Defense Science Board echoed this view: "Key to global responsiveness and reach are the air refueling capabilities of the United States Air Force . . . but [we must] emphasize that the need to begin recapitalizing that tanker fleet, especially the KC-135 fleet, is paramount."[8]

[2] Data from multiple historical sources. Note that the statistics for Vietnam include only intra-theater airlift—C-7s, C-123s and C-130s.

[3] Benjamin S. Lambeth, *NATO's Air War for Kosovo* (Santa Monica: RAND, 2001), 150.

[4] See on line at: www.af.mil/news/story.asp?storyID=32803378.

[5] See on line at: www.af.mil/news/story.asp?ID=123012707.

[6] HQ USAF/XPX, "2005 QDR Smartbook," May 11, 2005, pp. 4-10.

[7] Gen T. Michael Moseley, "The Adaptive and Flexible Air Force for the Future," speech before American Enterprise Institute, Oct 11, 2005. On line at: www.af.mil/library/speeches/speech.asp?id=179.

[8] Defense Science Board, "Task Force on Mobility," Dec 2005, pp. 69-70.

In 2003 the Air Force advanced a plan to plug the tanker gap by leasing one hundred new aircraft.[9] Although ending unhappily, the leasing plan's demise has now allowed an opportunity to revisit the tanker recapitalization issue while also addressing the deficiencies in our airlift capabilities. In order to move ahead, however, we must first understand where we have been. The following sections review three distinct periods of tanker history, and tanker employment is reviewed during those periods through four lenses: Requirements, Capabilities, Mission, and Vision.

It is important to note that in the nearly six decades that air refueling and airlift have been core responsibilities of the Air Force, their requirements, capabilities, mission and vision have undergone profound changes prompting adaptive planning and procurement. Similarly, an uncertain future security environment demands a robust and adaptable multi-role platform with enough growth potential to last for another sixty years.

[9] For what went wrong, see the DOD Inspector General Report, "Management Accountability Review of the Boeing KC-767A Tanker Program," May 13, 2005.

# II. The Early Years: Global Strike

## Requirements

Air refueling underpins virtually all the Joint air forces do, but it was seen initially solely in terms of extending the range of Air Force bombers. World War II showed the need for aircraft with continent-spanning range, especially in the Pacific. The response to this range requirement was the B-29, which could cover those distances, barely.

After the war, the US and its allies faced off against the Soviet Union. NATO's ground forces were heavily outnumbered, and it seemed foolish and unaffordable to try to match the Soviet and Warsaw Pact divisions with conventional forces. The deterrence strategy formulated was a policy of "Massive Retaliation" using nuclear weapons to be delivered by air. However, Moscow and other strategic targets remained beyond the reach of the B-29, so the Air Force sought alternative basing locations.

A 1954 RAND study chartered to determine the best forward locations for US bombers in Europe, North Africa, the Middle East and the Pacific reached a startling conclusion: a Soviet first strike using its own long-range aircraft could easily wipe out these airfields, rendering them and the atomic strike plan that depended on them, useless.[10] In response, the Air Force pulled its bombers back out of harm's way.

Forward basing had become vulnerable, so long-range bombers were seen as a solution to the range problem—the B-36 and B-52. The highly successful B-52—many of which are still flying—had the speed, range and payload to hit targets across the Soviet Union and its satellites from the continental US, but it would still require air refueling to allow it to fly non-stop from the US to its targets and back.

## Capabilities

Support for the strategic bomber's global strike role shaped the airborne tanker's capabilities. When the Air Force moved to aerial refueling in the years following World War II, it looked at various methods to mate tankers with receivers. Two emerged as the most practical: the "boom" and the "probe and drogue" system. The boom employed a rigid pole that extended down from the tanker and plugged into a receptacle on the receiver aircraft. The alternative probe and drogue system used a hose reeled out from the tanker with a basket attached that looked like a huge shuttlecock. The receiver aircraft was equipped with a probe that plugged into the basket. This method worked well for fighters, but large aircraft were too difficult to maneuver while trying to plug a basket. In addition, the rate of fuel transfer with the probe method was only about one-quarter the speed of the boom system—a serious limitation for bombers needing tens of thousands of pounds of gas.

Unfortunately, the option of using a boom or a probe and drogue system became a symbol of inter-service rivalry over the next several decades. The Air Force used a boom and Navy/Marine aircraft were equipped with a probe for in-flight refueling from organic assets—they had no heavy bombers requiring a high fuel transfer rate.[11] Although work-arounds have been plentiful enough to enable cross-service tanking, to be a true Joint Force multiplier the next tanker must have both capabilities.

As the Air Force moved to an all-jet bomber force in the mid-1950s, it needed a jet tanker that could operate at the same altitude and speed of the new bombers. Air refueling operations with the KB-50 and KC-97 proved inadequate: the

[10] A.J. Wohlstetter, et. al., "Selection and Use of Strategic Airbases," RAND Study R-266, Apr 1954.

[11] For overviews of this debate, which are still on-going, see General Accounting Office, "Aerial Refueling Initiative: Cross-Service Analysis Needed to Determine Best Approach," GAO/NSIAD Report 93-186, Jul 1993; and Government Accountability Office, "Air Force Assessment of the Joint Strike Fighter's Aerial Refueling Method," Mar 14, 2005.

piston-engine tankers were too slow and their altitude capabilities too feeble to allow them to work effectively with jet-powered B-52s and B-47s.[12] The solution was the KC-135—the military counterpart to the 707 commercial airliner. A total of 732 "Stratotankers" were purchased in a scant seven years, and the majority of these planes are still flying. They were equipped with a boom, not a hose and reel assembly, owing to the operational requirements of the nuclear deterrence mission: the tankers were built for the primary purpose of refueling Air Force bombers.

## Mission

Requirements for tanker fleet size and refueling capabilities were driven by the nuclear strike mission of Strategic Air Command (SAC). The SAC concept of operations was straightforward: bombers and tankers sat alert together and launched together. When scrambled during exercises or launched on a training mission, the tanker's flight profile was fairly mundane—the aircraft would climb to altitude, cruise a few thousand miles, refuel the bomber, and return to base. Part of the reason the KC-135s are still operational is due to this relatively non-stressful operational profile that granted the aircraft an extended service life.[13] On the other hand, the mating of the tankers with the bombers to support SAC's nuclear deterrent posture, largely to the exclusion of other aircraft, would have negative doctrinal and operational consequences. One of these was a focus on a single mission.

Although the KC-135s had a sizable cargo area, this airlift capability was seldom used due to the difficulty in loading cargo through the side door and the weight restrictions placed on the plane's floor. Certainly, loose cargo and some maintenance personnel could deploy with the aircraft on exercises, but the mission of SAC was carrying nuclear weapons, not cargo and passengers. This narrow vision of the tanker's mission and the reluctance to leverage its multi-role capability would become a recurring theme in the history of air refueling.

## Vision

SAC's tanker vision was myopic. This was partly due to the single-mission focus of SAC planning. But it was also because the tanker community within the Air Force never enjoyed influence commensurate with its utility. Although tankers were essential to the SAC mission, they had but a supporting role and were therefore treated like second-class citizens within the command.

There were virtually no Tanker Wings in SAC during its heyday, but there were dozens of Bomb Wings consisting of bomber and tanker squadrons.[14] Although tanker pilots often commanded tanker squadrons, they were generally seen as unqualified to command a Bomb Wing. This narrow vision had several consequences, most notably the tendency to limit a large, capable aircraft to a single mission—the refueling capability the bomber pilots wanted.

[12] Worse, a catastrophic wing failure in 1964 of a KB-50 due to corrosion resulted in the immediate and permanent grounding of the entire fleet of 130 KB-50s then in service.

[13] Some would argue that decades of sitting alert in harsh northern US climates while fully fueled was certainly not conducive to KC-135 service life due to the stress it put on the plane's wings.

[14] In 1960 there were 59 bomb wings in SAC but only a single tanker wing—and it was a training unit. Two years later even that tanker wing disappeared. The first operational tanker wing was not stood up until 1988—the year before the Berlin Wall fell. Norman Polmar and Timothy M. Laur, *Strategic Air Command: People, Aircraft, and Missiles*, Revised Edition (Baltimore: Nautical and Aviation, 1990), pp. 66, 79, 201.

# III. War and Crisis Response: Global Mobility

## Requirements

Within a decade of introduction, the tankers' utility had exceeded expectations. The first crisis to show the need for air refueling in combat operations was the Vietnam War—virtually every Air Force strike sortie flown against North Vietnam required air refueling.[15] But Navy and Marine fighters required refueling as well, and this again raised the issue of tanking tactics and equipment. Because Air Force fighter planes had been raised on probe and drogue refueling systems, the Stratotankers initially used a boom adapter—a short hose and drogue attachment fitted to the end of the boom—to refuel most Air Force fighters.[16] This adapter was important because Navy/Marine fighter aircraft, which also have probes, often returned from strikes dangerously low on fuel due either to battle damage or combat maneuvering, and were gassed up by KC-135s.[17] This emergency procedure would set a precedent that was later of great import: the tankers were a force multiplier that made the entire Joint Force more effective.

The Vietnam War generated an appetite for air refueling that could not easily be sated, and in its aftermath fighters, from all the services, demanded more tankers for exercises and deployments. In 1960 there were 2,000 air refuelable aircraft in the Air Force inventory; by 1980 that number had jumped to 4,500, of which 3,000 were fighters. In fact, SAC was also doing almost as much refueling for the Navy and Marines as it was for itself.[18]

The demand placed on KC-135s during the Vietnam War was a shock to SAC. It had never anticipated such a heavy drain on what it considered to be *its* resources. At the same time, a basic element of SAC's nuclear strike mission was called into question.

Soviet development and deployment of surface-to-air missiles (SAMs) was a nasty surprise to the US Air Force. In 1960 a high-flying U-2 spy plane was downed in Soviet airspace by an SA-2. Soon after, these SAMs were sent to North Vietnam, and although American aviators modified their tactics and developed special radar jammers and radar homing missiles, the SAMs remained a serious hazard throughout the war, downing 150 Air Force aircraft.[19] SAC watched these events with alarm: going in at high altitude would no longer assure survivability for its bombers in a future war; instead, the B-52s would have to go in "on the deck"—below Soviet radar coverage. This was an unanticipated turn of events with major consequences—the B-52s would need more gas for this low-level profile. Because jet engines consume more fuel at low altitudes, the nuclear strike plan now required the tankers to accompany the bombers nearly to the edge of Soviet airspace. There the bombers would gas up and descend for an attack run.[20]

[15] Over a nine-year period the tankers flew nearly 200,000 sorties, providing over 800,000 air refuelings—around 250 per day—and offloading almost 9 billion pounds of gas. Charles K. Hopkins, "SAC Tanker Operations in the Southeast Asia War," SAC Historical Study, 1979, pp. 106-07.

[16] The F-101and F-105 were built with both a probe and a receptacle. In 1960 the Air Force standardized on the boom/receptacle system for all of its fixed-wing aircraft, but the changeover took several years.

[17] Hopkins, 18. Because the adapter was fitted to the end of the boom by ground personnel before flight, receptacle-equipped aircraft could not then refuel from these KC-135s.

[18] Maj Marck R. Cobb, "Air Refueling: The Need for a Multipoint, Dual-System Capability," Airpower Research Institute, Report AU-ARI-CP-87-3, Jul 1987, p. 30.

[19] John T. Correll, "The Vietnam War Almanac," *Air Force Magazine*, Sep 2004, p. 57.

[20] Undersecretary of Defense, "Memorandum for the Secretary of the Air Force, Decision Coordinating Paper # 148, KC-10 Advanced Tanker/Cargo Aircraft," Nov 6, 1978, AF Archives, File K168.024-12, Annex A.

The combination of this change to SAC refueling plans, combined with the tanker demands of the fighter force, meant the KC-135 fleet was inadequate. In 1967 SAC submitted a request for a new tanker. Specifically, it wanted a wide-body design that could carry enough gas to refuel its bombers far from US shores. Due to the budget constraints imposed by the ongoing war in Southeast Asia, however, the SAC proposal went nowhere. But there was soon help from an unlikely source: the airlift community.[21]

The C-5 "Galaxy" is a massive cargo plane that can haul twice as much as the C-141, as well as outsize cargo, and it can do so at global range. (See Figure 3.) Unfortunately, almost immediately after entering service in 1970 the plane developed problems with its main wing spar that severely limited the tonnage it could carry over long ranges.[22] Military Airlift Command (MAC) therefore wanted a new airlifter, and in order to hold down development costs (the C-5 had become infamous for its well-documented cost overruns), it sought a plane based on proven commercial cargo designs.

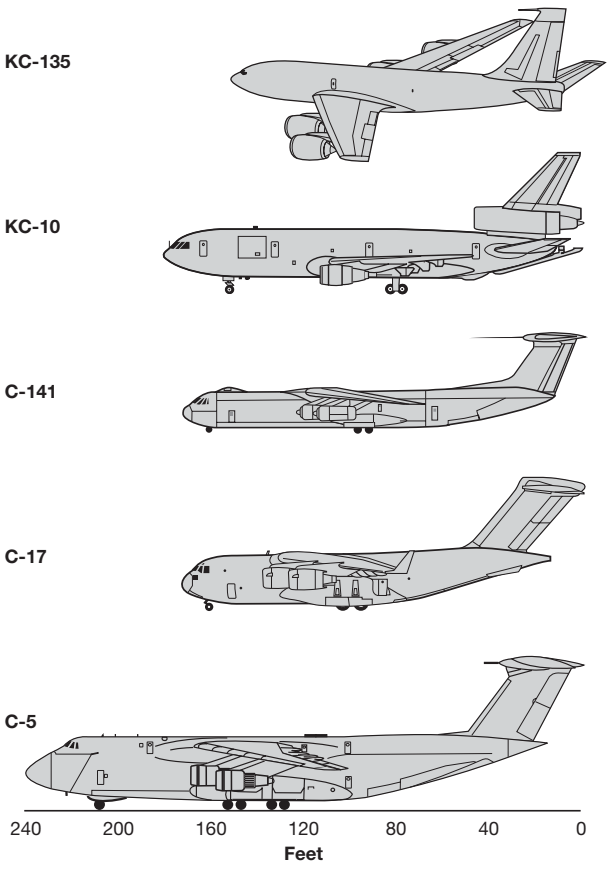


*Figure 3: Relative Size of Various Airlift and Tanker Aircraft*

In this case, SAC and MAC—along with the fighter community—combined their requirements and suggested a single airframe, an Advanced Tanker/Cargo Airplane (ATCA) based on an existing commercial design, which could affordably meet everyone's needs.[23]

## Capabilities

The ATCA proposal received little traction until an unexpected crisis arose. In October 1973 Egypt and Syria attacked Israel, which soon found itself in dire straits. The US moved to supply weapons and spare parts to Israel, but Arab oil-producing nations retaliated with an embargo on the US and any nation assisting it. In response, most European countries refused landing rights to US aircraft en route to Israel. The exception was Portugal; it agreed to allow the use of Lajes airfield in the Azores, an island group 800 miles west of Lisbon.

For the next month US airlifters flew to the Azores, refueled, and then went on to Israel. Without the use of Lajes, the airlift operation, termed NICKEL GRASS, would have been virtually impossible. This experience led air mobility planners to two important conclusions: 1) airlifters would be far more efficient if they were air refuelable and, 2) if tankers were of sufficient size, they could perform double duty hauling much-needed cargo along with fuel.

The combination of SAC's concerns over its refueling tactics, TAC's deployment needs, and MAC's experiences in the Middle East, demonstrated a need for a large tanker that could also augment the airlift force. To avoid the cost concerns that had thwarted earlier programs, the Air Force renewed its insistence that the new multi-role platform be an adaptation of an

[21] Ibid. The XB-70, a high-altitude mach 3 bomber program, was cancelled in 1969 largely because of the Soviet SAM threat.

[22] See the Federation of American Scientists website: www.fas.org/man/dod-101/sys/ac/c-5.htm and also www.globalsecurity.org/military/systems/aircraft/c-5.htm.

[23] HQ USAF, "Program Management Directive for Engineering Development, Advanced Tanker/Cargo Aircraft," Jul 31, 1974. AF Archives, File K168.110-353.

existing commercial design. In August 1975, freighter versions of a DC-10 and 747 were leased by the Air Force, modified with both a boom and hose, and tested for six months in a variety of challenging scenarios.[24]

In December 1977 the Air Force announced the DC-10 had won the competition. Although the 747 was larger and could carry more payload, the Air Force opted for the flexibility and affordability offered by the smaller DC-10 that could operate into smaller, and thus more available, airfields worldwide. In addition, the military version of the DC-10, soon dubbed the KC-10 "Extender," was not only far cheaper than an airlifter like the C-5, but its fly-away cost was less than that of its commercial brother.[25]

The KC-10 offered a huge capability increase as a tanker and airlifter. As a tanker, it carries more than 356,000 lbs. of fuel or 170,000 lbs. of cargo up to a distance of 4,450 miles—figures nearly double that of a KC-135. Equipped with both a boom and a hose, it can refuel either type of receiver on the same flight. KC-10s were also modified to accommodate wing pods holding hoses and drogues so it could refuel two aircraft simultaneously. As an airlifter, the KC-10 can carry up to 27 pallets, or it can seat 75 passengers with fewer cargo pallets. (In comparison, the KC-135 can haul but six pallets or 37 passengers.)[26]

## Mission

The KC-10, the outgrowth of the ATCA initiative, seemed a balanced effort to serve the needs of all parties. But the decision was not easily implemented. Despite an outward show of cooperation between SAC and MAC, disagreements remained regarding the relative importance of air refueling and airlift. The Air Force at the time was still dominated by bomber pilots.[27] On the other hand, some in Congress sided with MAC, arguing the needs of the airlift community. During the House Appropriations Committee's hearings on the new aircraft, Congressman John J. Flynt stated the mission of the KC-10 in strong terms: "The objectives of this program are (1) to enhance the Air Force's strategic airlift capability by augmenting the current cargo/transport force, and (2) to assure adequate aerial refueling support for Air Force airlift, Strategic and General Purpose Forces' mission by eliminating the inherent deficiencies in the current tanker force."[28] Congressman Flynt saw the KC-10 as an airlifter first and foremost. But other observers noted that the ATCA program should be spelled with a capital "T" and lower case "c" because SAC was clearly driving the program. When the KC-10 was brought into the Air Force inventory as a SAC asset in 1981—much to the chagrin of MAC who thought they were to be given operational control—the rumors seemed confirmed.[29]

Regardless of the power struggles occurring within the Air Force, the fact was the missions performed by air refueling aircraft increased dramatically starting with the Vietnam War and then again as a result of the 1973 Middle East War. The unitary focus of supporting the nuclear warplan was transformed: supporting SAC bombers was now one of *several* missions required of the tankers. Operations such as NICKEL GRASS had demonstrated the need for air refuelable cargo planes, so the entire C-141 fleet was stretched to carry more cargo, and the planes were fitted with a receptacle. The C-5 was already air refuelable and the C-17, then on the drawing board, was similarly programmed to have a receptacle.

[24] Although all the major Air Force combat commands leant their support to the ATCA effort, SAC and MAC were the key players. Of note, even the Navy and Marines were asked to participate in developing requirements for the new platform.

[25] In 1981 dollars the AF pegged the cost of a KC-10 at $52 million, a C-5 at $118 million, and the projected C-17 at $112 million. A commercial DC-10 was $3.5 million more expensive than a KC-10. General James R. Allen, "Presentation to the Senate Committee on Appropriations," May 1982, AF Archives, File K300.01 Vol. 6, "Airlift Enhancement" Annex, p. 4.

[26] The KC-10 has only two air conditioning packs (which provide emergency oxygen capability) instead of the three on the commercial DC-10 version; as a result, it is limited to carrying only 75 passengers.

[27] The chief of staff, Lew Allen, was a bomber pilot as were his deputy chief of staff for operations, Lt Gen Jerry O'Malley and his point man on the ACTA issue, Lt Gen Kelly Burke. Of note, both MAC commanders during 1981, "Dutch" Huyser and James Allen, had bomber backgrounds.

[28] Quoted in Lt Col Thomas L. Gibson, "The Death of 'Superman': The Case Against Specialized Tanker Aircraft in the USAF," Maxwell AFB, School of Advanced Airpower Studies thesis, Jun 2002, p. 20.

[29] A retired Air Force chief of staff remembers as a young colonel being charged with the unhappy task of escorting his boss, Lt Gen Burke, to a frosty meeting with Gen Allen at MAC where Allen officially got the bad news that SAC would be getting the new KC-10. The reception was so icy the colonel wondered if they'd even be able to get a ride home!

Saddam Hussein's invasion of Kuwait in 1990 provoked a rapid US mobilization: within days, mountains of materiel and hundreds of thousands of personnel began moving into the region. Over the next six months, US airlifters—enabled by Air Force tankers—hauled 200,000 people and 400,000 tons of cargo into the theater, making it the most massive airlift in history. Approximately 100 tankers formed an "air bridge" across the oceans to refuel those airlifters while simultaneously deploying over 1,000 aircraft from several countries. During DESERT STORM itself, the tankers flew 16,868 sorties to offload over 800 million lbs. of gas in 51,696 hook-ups. On any given day tankers accounted for around 20 percent of all coalition sorties flown. Of importance, the KC-135s and KC-10s refueled not just Air Force aircraft—24 percent of all refueling events were for Navy and Marine aircraft.[30] This scale of activity would be repeated in military operations over Serbia (1999), Afghanistan (2001) and Iraq (2003).

In short, the Air Force entered the post-Cold War era with a major increase in the number and character of the missions demanded of its tanker force, an appetite that continues to grow. Would the vision be equally broad to execute those varied missions?

## Vision

As noted, The Middle East War in 1973 had caught the Air Force unprepared for global air mobility, as evidenced by the lack of air-refuelable cargo planes. Although the C-5 had been built with a refueling receptacle, at the beginning of the crisis only nineteen C-5 crews were proficient in air refueling, and the Air Force vice chief of staff commented that such expertise provided "too marginal a capability" to be pursued.[31] Events soon proved otherwise. During the 32 days of NICKEL GRASS the airlifters delivered over 22,000 tons of much-needed supplies to the beleaguered Israelis.

Still, innovative thinking regarding the multi-role aspects of tanker use was lacking. Ostensibly due to cost concerns and the increased training requirements involved, refueling receptacles were not put on the KC-135 fleet.[32] This was shortsighted: a recent Air Staff study argues that tanker capability could be boosted by 20 percent if all tankers were air refuelable. It noted that during Operation ENDURING FREEDOM in Afghanistan and Operation Iraqi Freedom over 50 percent of all KC-10s—which are air refuelable—received unplanned fuel downloads from other tankers. The KC-10s could then stay on-station nearly twice as long (nine hours versus five hours) and refuel 35 percent more aircraft than planned—a tremendous boost in productivity.[33]

Part of this myopia can be attributed to SAC conservatism where the decision was made to forego a receptacle on the KC-135s. Things could have changed when SAC stood down in 1992 and the tankers were moved into the new Air Mobility Command (AMC) that combined airlifters and tankers. In truth, little changed and leadership had much to do with maintaining the status quo. AMC has seen seven commanders: three have been fighter pilots, three have been airlifters, and one was a bomber pilot. Despite the fact that tankers today comprise nearly 14 percent of the Air Force combat aircraft strength, there has never been a tanker pilot who has reached the four-star level.[34]

Without a champion at upper Air Force echelons the needs of aerial refueling have often been pushed to the side. In November 2001 the AMC commander stated that his command's first emphasis was airlift: "As the airlift priority is met, AMC will begin to shift its resources to address the next air refueling platform in the mid-to-long

[30] Eliot A. Cohen (ed.) *Gulf War Air Power Survey*, V vols. (Washington: Government Printing Office, 1993), III, pp. 177-86 and V, pp. 76, 80.

[31] Lt Col Robert A. Colella, "De-Ranged: Global Power and Air Mobility for the New Millennium," School of Advanced Airpower Studies thesis, Maxwell AFB, Jul 2002, pp. 46-47.

[32] There are eight KC-135RT models that were originally built as electronic sensor or cargo planes and equipped with refueling receptacles. They were later converted to tanker use but kept the receptacles. Today the RTs are used largely to support special operations air missions.

[33] Lt Col Donald R. Anderson, "Implications of Air Refuelable Tankers on US Air Force Doctrine," HQ USAF Study, Dec 17, 2004, pp. 15-16. This capability was also demonstrated in 1986 when Air Force F-111s bombed Libya in retaliation for terrorist attacks. Because France and Spain did not grant over-fly permission, air refueling was essential. During the mission 29 tankers were employed: KC-135s were used to top off the KC-10s, which then provided multiple air refuelings to the F-111s en route.

[34] Currently, of the approximately 40 three-star generals in the Air Force, four are tanker pilots; it remains to be seen if any of them will move up.

term."[35] That shift in resources is still in the future because the demand for airlift has necessitated the procurement of a robust C-17 fleet, a costly program.

In 2000 the General Accounting Office (GAO) reported that during fiscal years 2001 to 2006 the Air Force was programmed to spend $18 billion on mobility forces, but of that amount, only $300 million would be on tankers.[36] In truth, the Air Force has traditionally allocated a certain portion of its budget for mobility force procurement and upgrades. Over the past several decades most of that budget wedge has gone towards buying and upgrading airlifters. However, in the current constrained budget environment this slice is unlikely to increase, thus pitting the needs of airlift against those of air refueling—*unless a single platform is procured to perform both functions*.

Of additional concern during this struggle for mission and resources was the reluctance to use the KC-10's airlift capacity to its full potential. Initially, this may have been due to the difficulty in loading cargo—the side cargo door proved a major challenge early-on. Basically, the height of the cargo door above the ground makes loading and off-loading a time-consuming project. It was only the development of new Tunner and Halvorsen loaders that solved this problem.[37] Yet, under-utilization persists. A recent GAO report states that 81.7 percent of all KC-10 missions are flown below the payload planning factor.[38] This is regrettable because the KC-10 has nearly the same lift capacity as a C-17. During DESERT STORM in 1991, KC-10s were used as freighters on regular "channel" missions, moving over 25,000 tons of cargo and over 4,000 passengers. This important capability needs to be fully exploited as the tanker fleet is recapitalized to ensure maximum capability is provided to the Joint Force.

[35] Quoted in General Accounting Office, "Military Aircraft: DOD Needs to Determine Its Aerial Refueling Aircraft Requirements," GAO-04-349, Jun 2004, p. 7.

[36] General Accounting Office, "Military Readiness: Air Transport Capability Falls Short of Requirements," GAO/NSIAD Report 00-135, Jun 2000, p. 7.

[37] William Tunner and Gail Halvorsen were noted airlift pilots who had gained fame during the Berlin Airlift of 1948-49.

[38] Government Accountability Office, "Defense Transportation: Air Mobility Command Needs to Collect and Analyze Better Data to Assess Aircraft Utilization," GAO-05-819, Sep 2005, p. 12. The payload planning factor for the KC-10 is to carry a minimum of 32.6 tons or 54 percent of its capacity. In other words, GAO argued that over 80 percent of the time, KC-10s took off nearly half empty.

# IV. A Multi-role Future: Global Strike and Global Mobility

## Requirements—Tanker and Airlift

Despite extensive upgrades, the KC-135s are wearing out. In 1979 they began receiving new CFM-56 engines that allowed a 50 percent greater fuel offload while being 25 percent more fuel efficient: two re-engined KC-135Rs could now do the work of three KC-135As. To cut costs, Congress insisted that 157 other planes get *used* engines. Although not as powerful as the CFM-56s, they were cheaper. A tanker with used engines was designated a KC-135E. In penny-wise and pound-foolish reasoning, the used engine option was pushed because it would save one percent of the recapitalization costs—a savings now dwarfed by the expense of replacing the KC-135E fleet—a need only briefly postponed by that engine decision.[39]

The Mission Capability rate of the KC-135Es is worse than that of the other tankers (see Figure 4), and this situation will deteriorate further in the years ahead.[40] As aircraft grow older they require more maintenance to keep them flying; this maintenance takes longer to accomplish and is more costly. In 2003 the GAO estimated that maintenance costs on the KC-135 fleet would grow from $2.2 billion per year in 2003 to $5.1 billion per year in 2017—an increase of 130 percent.[41] The worst offenders were the "E"s. The GAO found that the average cost to operate an E model was $4.6 million per year; an R model was only $3.7 million. In addition, because these old aircraft spend more time in the hangar, a heavier burden is placed on those planes still on the flight line—thus causing them to wear out faster and speed up their next trip to the depot.

Recapitalization of the tanker force is essential, especially regarding the old E models. In October 2005 the GAO found that, without major modifications, the KC-135s were "likely to reach the end of their useful lives in this decade." More worrisome was that "the future of the KC-135 fleet and the Air Force's tanker strategy are unknown."[43]

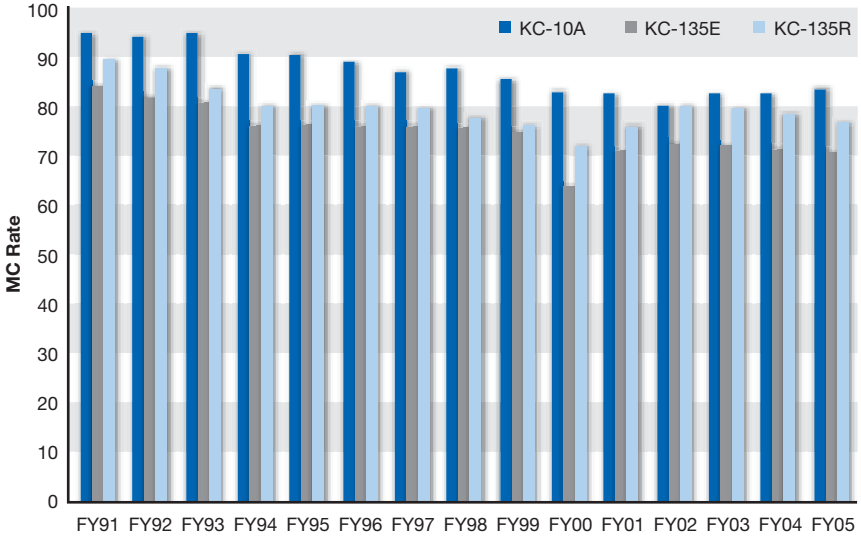


*Figure 4: AMC Aerial Refueling Aircraft Mission Capable Rates.*[42]

[39] Congressional Budget Office, "Aerial Tanker Force Modernization," Mar 1982, p. xiii; GAO, letter to SECAF, "Potential for Reducing Costs by Using More JT3D Engines on the KC-135 Reengining Program," Sep 23, 1983, p. 10. The JT3Ds were the used engines.

[40] Edward G. Keating and Matthew Dixon, "Investigating Optimal Replacement of Aging Air Force Systems," RAND Report, MR-1763-AF, 2003, p. 18.

[41] GAO, "Military Aircraft," 3.

[42] Figure provided by HQ USAF/XOXS, Oct 2005.

[43] Government Accountability Office, "Military Readiness: DOD Needs to Identify and Address Gaps and Potential Risks in Program Strategies and Funding Priorities for Selected Equipment," GAO-06-141, Oct 2005, pp. 5-7, 130.

Some studies show that US mobility forces are inadequate—in 2000 the GAO cited a 29 percent shortfall in the airlift fleet.[44] (See Figure 5.) In 2005 the Defense Science Board recommended that additional C-17 airlifters be purchased to compensate for the aging C-5 fleet. An airlift dearth will put an increased burden on the existing airframes, causing them to wear out more quickly than planned. A vicious, downward spiral will result. Indeed, as Chart 6 indicates, the C-17 fleet has been flown far more than was originally programmed—more than 25 percent over the past three years. Yet, the Air Force has announced that no more C-17s will be purchased beyond the 180 currently on order.[45] The airlift gap must therefore be met in other ways.

As shown in Figure 5, there is also a 19 percent deficiency in air refueling capability, and this gap will increase as KC-135Es are forced into retirement.[47] Given these shortages in lift and air refueling, it is obvious that a new tanker must do more than fill the refueling gap. A multi-role aircraft can help meet both requirements.[48]

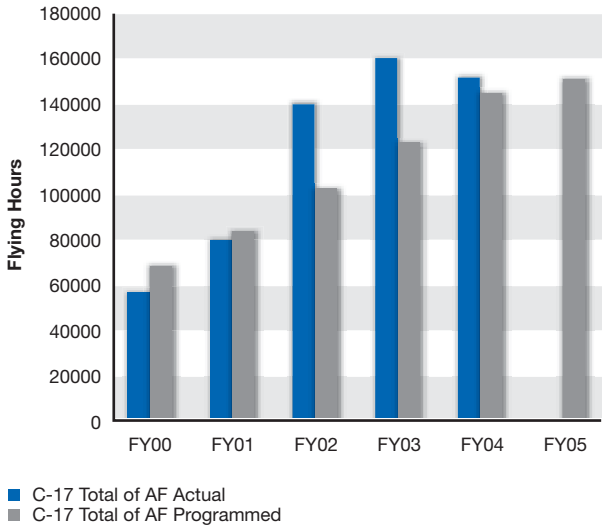


*Figure 6: C-17 Flying Hours—Programmed vs. Actual.*[49]

## Capabilities—Tanker and Airlift

The capabilities a new tanker must possess are both diverse and challenging. A partial list of the capabilities required for such a platform includes the following:

| | Military Wartime Requirement | Current Peactime Capability | Shortfall (overage) | Percentage Total Shortfall (overage) |
|---|---|---|---|---|
| C-5 | 12.98 MTM/D | 9.52 MTM/D | 3.46 MTM/D | 11.85 |
| KC-10 | 3.08 MTM/D | 3.19 MTM/D | (0.11) MTM/D | (0.37) |
| C-17/C-141 | 13.14 MTM/D | 7.93 MTM/D | 5.23 MTM/D | 17.90 |
| **Total Military Airlift** | **29.20 MTM/D** | **20.64 MTM/D** | **8.58 MTM/D** | **29.38** |
| KC-135 | 402 aircraft | 317 aircraft | 85 aircraft | 19.19 |
| KC-10 | 41 aircraft | 42 aircraft | (1) aircraft | (0.23) |
| **Total Refueling Aircraft** | **443 aircraft** | **359 aircraft** | **84 aircraft** | **18.96** |
| KC-135 | 74.8 MPF/D | 59.0 MPF/D | 15.8 MPF/D | 14.9 |
| KC-10 | 31.3 MPF/D | 32.4 MPF/D | (1.1) MPF/D | (1.0) |
| **Total Refueling Capacity** | **106.1 MPF/D** | **91.4 MPF/D** | **14.7 MPF/D** | **13.9** |

*Figure 5: Mobility Shortfalls—Airlift and Tankers—Identified by the GAO.*[46]

- ***Multipoint Refueling:*** for reasons of efficiency and operational flexibility, the tanker must be capable of refueling two aircraft simultaneously.
- ***Dual Method Capability:*** the tanker must be equipped with both a boom and reel/drogue assembly to refuel aircraft from all the services plus those of allies.
- ***Refuelable:*** the platform must itself be air refuelable. Although

[44] Ibid., 5.

[45] Tony Capaccio, "No More Boeing C-17s Needed by U.S. Air Force, Giambastiani Says," Bloomberg.com, Nov 15, 2005; "180 C-17s Enough, Air Force Says," *Los Angeles Times*, Dec 14, 2005.

[46] GAO, "Military Readiness," 10. Note: MTM/D = million-ton miles per day; MPF/D = million pounds of fuel per day.

[47] GAO, "Defense Transportation," 12.

[48] Similar sentiments were expressed by the outgoing head of US Transportation Command and the Air Force chief of staff. "US Air Force Needs More 'KC-10-Like' Tankers, General Says," *Aerospace Daily and Defense Report*, Aug 3, 2005; "Tankers could Bear Some Airlift Burden: U.S. Air Force Chief," *Defense News* online, Aug 30, 2005. The in-coming commander was even more forceful. See "DOD's New Transportation Chief Seeks Multi-Mission Tanker," *Aerospace Daily*, Dec 1, 2005.

[49] Figure provided by HQ USAF/XOXS, Dec 2005.

inter-theater airlifters are now so equipped, only the KC-10s and eight KC-135RTs have receptacles, which grants tremendous flexibility for operational planners.

- ***Cargo Capacity and Adaptability:*** the platform must be a serious airlifter; that is, it must be able to carry two to three dozen standard pallets (loaded with existing equipment), some oversize cargo, and/or at least 200 passengers. It must also be quickly reconfigurable for medical evacuation.
- ***Self Defense:*** the proliferation of portable surface-to-air missiles, especially heat-seekers, has placed airlifters and tankers at increased risk.[50] A defensive system to ward off such attacks is essential.
- ***High Performance in Austere Environments:*** the new platform should be able to operate from runways 8,000 feet long or less, at moderate altitudes, and in hot weather—capabilities currently lacking in the KC-135 fleet.[51]
- ***Maintainability:*** because these platforms can be expected to deploy anywhere on the globe, to include austere, expeditionary airfields, they must stress ease of maintenance and ready access to the logistic system for spare parts.
- ***Fuel Efficiency:*** less fuel required to power the tanker means more can be offloaded to receivers or more cargo can be carried. In addition, the engines must be engineered to the highest pollution and noise abatement standards.[52]
- ***Growth Potential:*** the future is uncertain, but the new platform must be built with enough flexibility to last for fifty years and to accommodate unforeseen modifications to its structure and function.

A single platform should and can include all of these capabilities. It must be able to fly long distances efficiently, haul a large payload of fuel, cargo, passengers or litters, have some defense against ground threats, and be able to operate in austere locations.

## Vision

The Air Force must think broadly about the *strategic* uses of the new tanker. The new platform must be a multi-role asset and not just an air refueler. The KC-10 was procured because it could serve as both a tanker and an airlifter. Given its large size, that cargo capacity is a major factor in mobility planning—comprising 12 percent of the Air Force's strategic airlift capability.[53] Yet, internal struggles over who would control the planes and what would be their primary mission caused friction and inefficiency. AMC, which combines the essential and interdependent functions of air refueling and airlift, should ensure such fruitless rivalry does not recur, but the Air Force must insist on the new platform's multi-role capabilities.

Air Staff planners can do this by devising scenarios that *assume* multi-role platforms and that strive to optimize the characteristics of all aircraft, and then insert those capabilities into requirements documents. For example, the C-17 was designed to carry oversize and outsize cargo into austere locations with short runways. Because expeditionary airbases are often located in a combat zone, the C-17 was designed with a fat fuselage, high wing and T-tail. These features allow the plane to carry, for example, Bradley armored vehicles and deliver them to airfields where they can be quickly driven off the back ramp. Although these features make the C-17 a valuable tactical airlifter, they also make it less efficient for strategic hauling into major air hubs.

Similarly, the KC-10 is an excellent tanker for refueling large aircraft like bombers and airlifters because it can carry a large fuel load over great distances, although not too efficiently because of

[50] A C-5, C-17 and commercial airliner have been hit by heat-seekers in Iraq during the past two years.

[51] Lt Col Juan Narvid, "Tanker-Force Structure: Recapitalization of the KC-135," Air War College Paper, Aug 2004, p. 5. A fully loaded KC-135 requires a 12,000 foot runway, but due to high altitude and temperature conditions in OEF and OIF, they were forced to take off with greatly reduced fuel loads.

[52] DoD is the main government user of fuels in the US—93%; of that, 58% is used by AF; of that, 81% is aviation fuel; of that, 54.2% is consumed by mobility aircraft—tankers and airlifters. "Technology Options for Improved Air Vehicle Fuel and Efficiency," AF Scientific Advisory Board study, Jan 26, 2006.

[53] Christopher Bolkcom, "Air Force Aerial Refueling," Congressional Research Service report, May 4, 2004, p. 2.

its old engines. Because it is a commercial airliner derivative, the KC-10 is most useful when flying in and out of major airports. Although it cannot carry outsize cargo, it is able to haul a large number of standard pallets or passengers. Unlike the C-17, it is not equipped with a self-defense system, which limits its deployability into some locations.[54] At the same time, it is equipped with older and therefore less fuel-efficient engines. As a result, it is less effective than a KC-135—which burns fuel at one-half the rate of a KC-10—to be placed in orbit for long periods of time to refuel the boom-equipped fighters of the Air Force. In short, the Extender is best used as a tanker to deploy big aircraft over great distances, and as an airlifter to haul standard pallets or passengers into major airbases.

The new multi-role platform, if it has the characteristics noted in the box above, can reasonably be expected to do many missions virtually interchangeably with C-17s, KC-10s, and even KC-135s and C-5s in many circumstances.

A reasonable scenario involving deployment of a Joint Force to a crisis area and subsequent combat operations could resemble the following:

*C-17s and C-5s load up with essential outsize equipment such as helicopters, Patriot batteries and tracked vehicles. En route to the theater they are refueled by KC-10s and new Advanced Multi-role Tanker Transports (AMTT). Some aircraft also carry a load of pallets, some have passengers—the initial cadre of maintenance and support personnel needed to set up a forward base—while others carry the maximum amount of fuel. Air Force and Navy fighters accompany the armada, being refueled multiple times en route.*

*Upon landing at various airfields in theater, the airlifters offload their cargo, including huge fuel bladders necessary for use at austere airfields lacking a supply of aviation fuel or an underground storing/pumping capability. Some of the AMTTs have husbanded their fuel loads during the ocean passage and are now able to download excess fuel into these bladders to begin building a local reserve for the deployed fighter aircraft.*

*The platforms are then reconfigured: some AMTTs serve as straight air refuelers, some as straight airlifters, and others as a combination of both. Because many aircraft—bombers, fighters or even airlifters—may be constrained by short expeditionary airfields, they take off with a maximum operational payload but a small fuel load. After getting airborne they are refueled by the tankers so they can complete their mission. Still other platforms reconfigure to take on the wounded and other cargo and then medevac the patients to hospitals in other theaters. Over time, the diversity and number of sorties flown, by all types of aircraft, will vary depending on the weather and the ebb and flow of combat operations. The platforms must be flexible enough to adapt to these cycles.*[55]

*Humanitarian operations require a similarly flexible CONOPS. Outsize airlifters like the C-5 and C-17 can be used to haul the helicopters, water purification systems, heavy equipment and fuel bladders that will be required in the disaster area, while the AMTTs refuel those airlifters en route, and carrying bulk cargo—tents, medical supplies, food and also medical and relief personnel. Reconfigured for medevac, they then take out large numbers of the injured and homeless.*

*The number of possible scenarios that can be devised using versatile and flexible multi-role platforms is constrained only by the imagination of the planners—but must be included in the requirements documents formulated by the Joint Staff. The guiding principle is simply to allow aircraft—airlifters or tankers—to perform the tasks for which they are best suited; the use of AMTTs allows this synergy to take place.*

[54] It should be noted that the civilian airliners of the Civil Reserve Air Fleet, although essential in a crisis, are similarly defenseless and therefore limited to landing at major, safe airports. A proposal to equip the CRAF and additional civil airliners with directed infra-red countermeasures (DIRCM) is under study by the Department of Homeland Security.

[55] During the Vietnam War a number of KC-135s were configured as communication relay platforms, while also serving as tankers. This "Combat Lightning" program flew nearly 6,000 sorties. Hopkins, 106, 115. The AMTT should be built with a flexibility of design that allows such future configurations as circumstances dictate.

Perhaps the most enduring theme of air and space power revolves around its global character that allows the US to project its influence worldwide at any time and at any place. The key instrument of that power projection is the large aerial refueling fleet allowing virtually all Air Force, Navy and Marine aircraft to deploy globally and to fight at long range, persistently. All Joint US military forces, directly or indirectly, rely on air refueling. Yet, the country's dependence on an aging and obsolescent tanker fleet could turn this pillar of strength into an Achilles' heel. A catastrophic structural failure affecting the entire fleet—as happened with the KB-50s in 1964—would be disastrous.[56] The edifice upon which America's power projection rests is aging, with the KC-135 force now approaching 45 years old. The least capable of these aircraft, the E models that comprise 22 percent of Stratotanker assets, are increasingly difficult and costly to maintain. The country's mobility forces are already short of what is needed—the air refuelers by 19 percent—so losing an additional 111 aircraft would be a severe blow.

And so, the tanker fleet must be recapitalized; but in order to ensure new planes are the most capable and flexible, the Air Force needs to think through its requirements. Replacing the "E"s with aircraft of similar capabilities would fix the immediate problem, but much more should be done. If the Air Force inventory remains a receptacle-equipped force, which appears likely, then "boom cycle time"—the time it takes for a receiver aircraft to hook up, refuel, disconnect and move away while another receiver then moves into position—will remain a limiting factor. In short, no matter how big the tanker and how much gas it carries, if it only has a single boom than it can only refuel one aircraft at a time and can pass just so much gas in a given time frame. During periods of high tempo—as in war—this causes major problems.[57]

The new platform will be expected to last for over fifty years. During those decades the threats facing the US, as well as our own military responsibilities and capabilities, will change. Unmanned air vehicles, precision-guided munitions, stealth, and network-centric ISR will all become more prevalent and have an impact on the size and characteristics of the air refueling fleet. Strategy, tactics and operational concepts will evolve accordingly. At the same time, budget constraints will make it difficult to buy more airlifters *and* simultaneously recapitalize the tanker fleet. The key will be to devise a solution to the air refueling problem—the most pressing concern—while simultaneously addressing the airlift capability gap. The answer is a platform that is able to combine these disparate requirements effectively and efficiently. A multi-role aircraft whose primary function is air refueling, but which also has the growth capacity to become a mobility force multiplier for other services and systems, is the best solution: it endows the Air Force and the nation with Global Strike and Global Mobility for the foreseeable future.

[56] More recently, when a KC-135E crashed at Geilenkirchen in 1999 with four fatalities it resulted in the grounding—fortunately only temporary—of 70 percent of the Stratotanker force.

[57] For detailed discussions of the boom cycle time problem see Michael H. Bednarek, "Alternative Concepts for Aerial Refueling of Deploying Tactical Fighters," RAND Note, Aug 1990; and General Accounting Office, "Operation Desert Storm: An Assessment of Aerial Refueling Operational Efficiency," GAO/NSIAD-94-68, Nov 1993. Technical difficulties—torsion loads placed on the wings—have thus far made it impossible to equip a tanker with more than one boom.

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