More Than Just a Tanker -
The Role of the KC-X in Combat Operations

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"The number one priority for us now is the tanker"
General T. Michael Moseley, USAF Chief of Staff, October 12th, 2006

Introduction

The time has come for the U.S. Air Force to buy a new tanker aircraft, and this is now the Service's number one acquisition priority. The venerable KC-135 fleet is nearly a half century old, its place in history assured even as it continues to serve as the primary tanker force supporting our nation's and allied air forces in the fight today and for the foreseeable future. Air refueling is one of the most important capabilities the Air Force provides to joint military operations, and the continuing viability of this vital national capability must be ensured. In recent years, the Department of Defense (DoD) and the Air Force have become increasingly concerned about the possibility of age-related problems grounding the aerial refueling fleet. While the aging U.S. air refueling fleet is large and operationally effective today, modernizing or replacing the current fleet of tankers presents DoD and USAF with difficult choices in terms of desired capabilities, force structure and budget.

The Air Force issued a draft Request for Proposal (RFP) to industry for a new KC-X tanker on December 15th, 2006, which provides significant details about expected missions, capabilities and system requirements for a new fleet of tanker aircraft. The KC-X program begins a long-term effort to recapitalize the forces that provide the nation's air refueling capability, with an anticipated production rate of up to 15-20 aircraft per year beginning by fiscal year 2012. Designed to provide an initial 179 tanker aircraft, decisions will be made later on whether to increase the number of aircraft purchased under this program or to acquire additional tanker aircraft through other programs.

The current schedule projects that recapitalizing the capability inherent in over 530 KC-135s could take up to five decades to complete and likely cost tens of billions of dollars. The average age of the KC-135 fleet in 2006 is 46 years; continued operation until 2050 would result in airplanes up to 90 years old. Operating military aircraft of this age is unprecedented in aviation history, and many questions remain unanswered about how long these aircraft can be operated safely and effectively. During the recapitalization period, it is likely that aircraft technology and aerial refueling needs will change significantly, as will U.S. national security imperatives, military strategies and operational concepts. Just as conditions in the first decade of the 21st century are dramatically different than they were 50 years ago when the KC-135 was introduced, so too will conditions be far different 40 to 50 years from now.

These and other issues impact our strategy to acquire new tanker capability. As the Air Force begins the process of obtaining a new primary air refueling aircraft, the legacy and operational history of the KC-135 and the KC-10 will surely shape the tanker requirements debate to come. In addition, several major studies have examined a wide range of safety, cost and operational issues related to the tanker fleet, with varying conclusions reached.

The range of technologies and capabilities required by the draft RFP and inherent in KC-X candidate aircraft make them far more capable than the KC-135 for airlift and other secondary missions, and as a result raise new questions about how these aircraft will and could be utilized. What characteristics and capabilities will these aircraft possess and which ones will carry greater weight in the selection process? How important is flexibility and adaptability to evolving warfighting requirements? The RFP addresses these questions to a degree, but many other complex questions and issues remain.

While the primary mission of air refueling will drive the KC-X requirement, it is absolutely essential that the full range of operational roles and missions that the aircraft could fulfill be considered in the development process. Building in greater flexibility and adaptability at the outset would increase the overall utility of the aircraft and provide the U.S. with substantially more warfighting capability options in the long run. Large, commercial-derivative aircraft offer significant advantages in range, payload, versatility and cost-effectiveness compared to military-unique aircraft, with opportunities to expand the role they play in combat operations. This next generation of tanker aircraft will possess a range of capabilities that provide the U.S. with many options for future use – if we can widen the discussion on the role of these aircraft in combat operations and eliminate historical constraints on how we utilize our tanker fleet. We must insist that the full potential of this aircraft be explored for other roles and missions, recognizing that significant operational, organizational and doctrinal issues must also be addressed. Given the significant investment by the American taxpayer to acquire the KC-X, and that these aircraft will likely remain in service for 40-plus years, addressing the flexibility of the aircraft is a matter of both cost effectiveness and military utility over time.

What emerges is no less than a debate about the role and management of large aircraft in combat operations, with an underlying assumption that aircraft capable of performing multiple roles will provide greater flexibility and warfighting options to future combatant commanders. A thorough review and discussion of these issues is needed, with the primary goal of optimizing the capabilities of the entire air mobility fleet and the Air Force at large. The KC-X is more than just a tanker – it could very well transform the nature of future air and joint operations.

History of the Current Tanker Fleet

The original KC-135 aircraft design and fleet size evolved from Cold War requirements to implement and support the U.S. strategy of containment. A large fleet of tankers was needed to refuel bombers that would carry out strategic operations in the event of nuclear war with the former Soviet Union. A derivative of Boeing's 707 commercial airliner, a total of 732 KC-135 aircraft were built and procured at a rate of 75 to 100 per year during the late 1950s and early 1960s. In its Cold War role, the KC-135 spent 30 percent of its time on nuclear alert ready for takeoff, but in reality was flown very little. During the post-Cold War era, the aerial refueling aircraft mission expanded to support global operations of all types of aircraft even while the KC-135 fleet was reduced in size to just over 530 aircraft. Over 90% of the Air Force's current air refueling capability resides in the KC-135 fleet.

The KC-135 can carry 200,000 lbs of fuel. It dispenses fuel to USAF aircraft through a flying boom, and a drogue can be attached to refuel Navy, Marine Corps or allied-country aircraft. A small percentage of KC-135s are equipped with air refueling receptacles that allow them to be refueled as well. In addition to its fuel payload, the KC-135 can carry 35,000 lbs of cargo and has room for six standard 463L pallets which can be loaded through a side cargo door. Depending on fuel storage and interior configuration, the KC-135 can carry up to 83,000 pounds

of cargo or 80 passengers. Since initial fleet delivery, the aircraft has undergone major structural repairs and been upgraded or improved with capability-enhancing modifications, including new engines and avionics. About one fourth of remaining KC-135s are E-model variants, while the rest have been upgraded to the R-model configuration. The Multi-Point Refueling System Program outfitted a number of KC-135Rs with wingtip pods that allow the aircraft to simultaneously refuel two probe-equipped aircraft. Upgraded avionics and communications equipment will allow unrestricted global operations and enable the aircraft to serve as an airborne data link. Fifty aircraft were modified with cargo roller sets in the 1990s to exploit its cargo-carrying capability, but the KC-135 has never truly been employed to a large degree in this role.

The Air Force also owns 59 dual-role KC-10 tanker cargo aircraft with an average fleet age of over 20 years. The KC-10 can carry 356,000 lbs of fuel, almost twice as much as the KC-135, and can simultaneously use the flying boom and its two wingtip probe and drogue systems to refuel most military receivers. Every KC-10 is itself equipped with an air refueling receptacle that enables them to be refueled in the air to increase their delivery range and endurance, and each can carry up to 75 troops and 170,000 lbs of cargo in addition to its fuel payload. As a result, the KC-10 fleet represents approximately 12% of DoD's organic airlift capability. Current plans call for the KC-10 to also remain in the active inventory through 2040.

In addition to the KC-135, another 88 C-135 aircraft were procured and modified over time to provide VIP passenger transport, reconnaissance, test and airborne warning, command and control, and a variety of other functions. These C-135 variants include the VC-137 "Air Force One" Presidential airlift force, the EC-135 "Looking Glass" airborne command post, NASA and USAF NKC-135 aerial test beds, the E-3 Sentry Airborne Warning and Control System (AWACS) aircraft, and the E-8C Joint Surveillance Target Attack Radar System (J-STARS). In addition, the RC-135 family of aircraft, including "Cobra Ball," "Rivet Joint" and WC-135 weather reconnaissance aircraft, were derived from the C-135. The aircraft's long range, cabin size and payload capabilities for its time made it an ideal conversion aircraft in which to incorporate a variety of specialized mission capabilities, and illustrate the versatility of large aircraft in combat operations. Each of these specialized mission aircraft resulted from extensive and expensive modifications to the basic C-135 airframe.

Analysis and Studies of Tanker Requirements

The need to replace the KC-135 has been gaining urgency for some time. These aircraft were not built with longevity as a key acquisition objective, even though the KC-135 was modified and adapted many times to meet evolving warfighting requirements. Its low overall utilization rates over the years lead to conclusions that the fleet still has significant service life remaining, yet corrosion and other issues raise doubts about the long-term viability of the fleet. Many questions remain unanswered about how long these aircraft can be safely and effectively operated, with several major studies examining a wide range of safety, cost and operational issues. These include a 2004 Congressional General Accounting Office (GAO) report on air refueling, a Defense Science Board (DSB) Task Force Report on Aerial Refueling Requirements completed in 2004, an Air Force Tanker Requirements Study in 2005 (TRS-05), and a RAND Corporation Analysis of Alternatives (AoA) completed in 2006, among others. The debate continues.

GAO Report on Air Refueling. A 2004 GAO report estimated that annual operations and support costs for the KC-135 fleet would increase by 130%, from about $2.2 billion in fiscal

year 2003 to $5.1 billion (in FY 2003 dollars) in fiscal year 2017. This $2.9 billion increase indicated a cost growth rate of about 6.2 percent per year. The report recommended that the Secretary of Defense conduct a requirements study to determine current and projected aerial refueling requirements and expand a planned analysis of alternatives to include new options for providing aerial refueling.

Defense Science Board Task Force Report on Aerial Refueling. In May 2004, the DSB Task Force published its independent assessment of the condition of the aerial refueling fleet and options to provide tanker capability. It refuted Air Force claims that the KC-135 fleet needed urgent replacement, and recommended that USAF consider several tanker enhancement options such as purchasing and converting used aircraft for aerial refueling, re-engining additional KC-135s, and increasing the use of contractor-provided aerial refueling services. The DSB also concluded that a mixed tanker fleet of large, long-range tankers and smaller, "tactical" tankers would form an operationally effective air refueling force.

In addition, the DSB report stated that new missions, new modes of operations and changing operational situations could either increase or decrease the demand for and nature of aerial refueling capabilities in the future. Homeland defense missions, for example, could demand over 100 KC-135 equivalents, depending on the number of cities and areas being covered by combat air patrol aircraft and the duration of these operations. Alternative concepts of operations, however, could significantly alter or reduce this number. The report also noted that recent reductions in organic firepower within U.S. ground forces and the resultant increase in precision firepower delivered from airborne assets drive demand for aerial refueling up. Other possibilities that alter the tanker requirement would be greater U.S. reliance on sea-based operations over long distances, or a transition to smaller tactical tankers in-theater, which may be necessary to avoid greater concentrations of larger tankers at fewer available airbases. Finally, the DSB report recognized that major geopolitical changes or reduced receiver force structure might lower the tanker requirement and that technical developments or breakthroughs might make a new design tanker aircraft an attractive alternative to its other recommendations.

Air Force Tanker Requirements Study 2005. TRS-05 highlighted a shortfall in the number of tanker aircraft and aircrews needed to meet worst case global refueling requirements, even though additional refueling requirements needed to support the Global War on Terrorism and homeland defense were not included in the study effort. TRS-05 estimated a tanker requirement of up to 600 KC-135-like aircraft, and postulated that the need for aerial refueling could grow in the future. It noted that the U.S. reduced by two-thirds the number of forward bases from which it can operate and that major overseas en route air bases have declined 69%. In order to maintain the same level of engagement with this new en route structure, the study concluded that U.S. forces must deploy more frequently and over greater distances, thus increasing the need for air refueling. Additional reductions or changes in forward basing and the en route structure could further alter the air refueling requirement.

A brief review of recent conflicts underscores the importance of tanker aircraft within the current geopolitical situation and global posture. In both Iraq and Afghanistan, U.S. military aircraft projected power over long distances and in theaters with less than desirable access to forward bases or neighboring airspace. Thus, combat and support aircraft had to fly great distances both to the theater and while in theater, significantly increasing the demand on aerial refueling assets.

RAND Corporation Analysis of Alternatives. RAND was tasked by the Air Force in 2004 to analyze a broad range of acquisition strategies to recapitalize the KC-135 fleet, including

the options of building new military tankers, acquiring used commercial planes and converting them to tankers, or outsourcing the air refueling mission to private contractors. Aircraft in the AoA were categorized into the following size categories:

- Small - less than 300,000 pounds maximum gross takeoff weight
- Medium - 300,000 to 550,000 pounds maximum gross takeoff weight
- Large - 550,000 to 1,000,000 pounds maximum gross takeoff weight
- Very large - greater than 1,000,000 pounds maximum gross takeoff weight

The AoA study analyzed air refueling requirements necessary to support operations included in future operating scenarios from the 2005 DoD Mobility Capabilities Study. The requirement is defined by the amount of fuel that aerial tankers must supply, at specific times and locations, for a set of mission categories in future military scenarios.

The Pentagon released an executive summary of the study, entitled "Analysis of Alternatives (AoA) for KC-135 Recapitalization," in March 2006. The RAND study recommended that DoD consider buying a new fleet of medium or large airplanes based on successful commercial aircraft currently in production. "The most cost-effective tanker replacement alternative is a fleet consisting of new commercial-derivative tankers in the medium-to-large size range (300,000 to 1,000,000 pounds maximum gross take-off weight)," according to the study. The study says that Airbus 330 and 340 models, as well as Boeing's 767, 787, 777 and 747 versions, are all suitable aircraft within this range. In addition, the AoA stated that estimates of the cost-effectiveness of these alternatives were close enough to each other that none of them should be excluded as competitive candidates, given the information developed for and analyzed in the study. The RAND AoA study ruled out several options as not cost-effective. These include buying smaller aircraft, development of new airplanes for refueling needs, retrofitting used aircraft for the tanker mission, pursuit of unmanned or stealthy tankers, and outsourcing of the air refueling mission to private contractors. Additionally, the study found that the Air Force's decision on when to replace the tankers is not tied to the cost of replacement.

The Tanker Recapitalization Plan

In April 2006, the Aeronautical Systems Center sent out a Request for Information (RFI) on a KC-135 replacement platform. Consistent with the findings of the AoA, the RFI focused on a commercial-derivative tanker aircraft in the 300,000 to 1 million pound take-off weight class. The RFI also asked for vendor inputs on capabilities that might complement the recapitalization effort, such as specialized commercial aerial refueling services or KC-135 modifications and upgrades.

The Air Force used this information to formulate a draft Request for Proposal (RFP) for a new KC-X tanker that it released in September 2006, with a revised draft RFP issued to industry in December. Industry proposals are expected by February 2007, and source selection will occur in the February-July 2007 timeframe under the planned schedule, with the contract awarded in August 2007.

The KC-X program begins a long-term effort to recapitalize the forces that provide the nation's air refueling capability, with an anticipated production rate of up to 15-20 aircraft per year beginning by fiscal year 2012. At this rate, it will take decades to recapitalize the capability inherent in the KC-135 fleet, and the Air Force is keeping its options open for up to three separate tanker acquisition programs. The draft RFP states that after one third of the current KC-

135 fleet is replaced, the Air Force will determine whether or not to continue producing the KC-X under this program, or to acquire more tanker aircraft under separate, follow-on programs known now as the KC-Y and KC-Z programs. The KC-X program is designed to provide an initial 179 aircraft over a 15-20 year period, with the first 4 built for test purposes and the next 175 aircraft for operational use. The current schedule projects that tanker fleet recapitalization could take five decades to complete. To put this in perspective, the process of replacing the KC-135 fleet on a one-to-one basis at a rate of 15 per year will take over 35 years to complete, concluding in 2047 at the earliest. At that time, there will be 90-year-old KC-135 aircraft still in the inventory, a situation unprecedented in aviation history.

Given these issues, the top priorities appear to be simply to get the program started and begin procuring aircraft as soon as possible. A Commercial Off-The-Shelf (COTS) program is the only feasible approach to achieving these goals, and the RFP clearly points industry in that direction. It states that the "KC-X program acquisition strategy is focused on commercial derivative, Federal Aviation Administration (FAA), or equivalent in accordance with approved bilateral airworthiness agreements, certified transport aircraft."

Only two companies are currently capable of fielding aircraft that meet the RFP requirements – Boeing and a Northrop Grumman/ EADS North America partnership. Within their production lines exist several commercial aircraft that would meet the KC-X requirement, albeit with modifications. They include Boeing's 767, 777, 787 and 747 airplanes, as well as the Airbus A-330 and the A-340. Northrop Grumman and EADS are teaming to offer the conceptual KC-30 tanker aircraft, which is based on the Airbus A-330. Boeing is proposing its KC-767 aerial refueler, but has said that if a larger plane is needed for the expected cargo mission, the company could enter a different airframe for the competition. The KC-767A has about the same fuel capacity as the KC-135R, but is larger, heavier, and more fuel efficient, with additional interior room for cargo and passengers. The KC-30 is considerably larger than both the KC-135 and the KC-767A, with about 20 percent greater fuel capacity and increased cargo and passenger carrying capacity.

KC-X Mission and Capability Requirements.

The RFP identifies primary KC-X air refueling operating missions as those supporting global attack, air-bridge, deployment, sustainment, employment, redeployment, homeland defense, theater support to joint, allied, and coalition air forces, and specialized national defense missions. Specialized air refueling missions include support for special operations and U.S. nuclear forces. In the air refueling role, the KC-X is required to provide worldwide, day and night, adverse weather aerial refueling on the same sortie to receiver capable fixed wing U.S., allied, and coalition military aircraft, to include unmanned air vehicles (UAVs). The RFP notes that the inherent flexibility of the KC-X platform will enable it to accommodate a diversity of secondary missions without significant impact to the primary aerial refueling mission. These include cargo and/or passenger transportation, aeromedical evacuation, plus Command, Control, Communications and Computers (C4) augmentation and treaty compliance missions.

The KC-X draft System Requirements Document (SRD) presents technical performance requirements for the new aircraft. The KC-X aircraft is expected to provide world-wide Communication, Navigation, Surveillance/Air Traffic Management (CNS/ATM) compliant capabilities and same-sortie boom/receptacle and probe/drogue capabilities with provisions for simultaneous multiple point probe and drogue aerial refueling. It will have significant inherent cargo, passenger handling, and aeromedical evacuation capabilities. The KC-X will operate in

medium threat areas with self-defense/protection capability and will be compatible with night vision imaging needs for special operations.

KC-X Reliability and Maintainability. The draft RFP requires the KC-X Mission Capable (MC) Rate to be at least 90-92% and it must be able to sustain sortie rates from 8-29% above the current KC-135 sortie rate. A four-hour ground maintenance turn time is considered optimum, and departure reliability is required to be at least 95%. Depot rate is expected to be about 5%. By comparison, the KC-135's current MC rate is below 77% and its depot rate around 17%, with associated costs rising. According to the RFP, the KC-X must be capable of operating from a 7,000 ft dry, hard-surface runway at sea level up to its maximum gross weight for takeoff. Depending on Air Force usage, expected service life for the aircraft is 40 years based on an estimated 750 to 1000 flight hours per year. The RFP also specifies a number of capabilities incorporated into the aircraft.

Cargo and Passenger Handling Capabilities. The cabin door and passenger/cargo compartment will permit the loading and movement of 463L pallets on the wide dimension, or coupled on the short-side, to be loadable with adequate room to turn. It will also have an integral cargo loading system capable of turning coupled pallets and loading all pallet positions without additional equipment once the pallets are on the aircraft. The aircraft will have an integrated capability to pull fully loaded 463L cargo pallets onboard from the loader, and will be able to move cargo pallets fore and aft throughout the cargo compartment. An objective requirement is for the aircraft to have a powered system with remote hand controls. The threshold requirement is to be able to carry six 463L pallets and 50 passengers, approximately what the KC-135 carries today.

Aircrew, Passenger and Patient Support. The RFP specifies that separate crew rest accommodations will be provided for three to six crewmembers, and that it must be capable of supporting up to a 15-member crew and a maximum passenger or aeromedical evacuation patient load with sufficient lavatory and galley needs. At the minimum, it must be able to use existing patient support pallets for 50 total patients, with provisions for 16 litter and 34 ambulatory patients.

Communications and Information Systems. One of the most noteworthy sections of the KC-X RFP is the description of the communication systems requirements in the Net Ready Appendix to the SRD. A Key Performance Parameter requires that the KC-X be capable of supporting secure net-centric military operations and of accomplishing all identified joint, critical operational activities.

The KC-X will support the USAF Command and Control constellation, be fully connected to the Global Information Grid (GID) and contain Network Centric architectures to provide global connectivity and interoperability with enhanced reach-back and reach-forward support, asset status, and reporting capabilities. Additionally, the aircraft will provide a clear growth path to future communications and intelligence systems that emphasize data transmission capability. Command and control (C2) will be exercised through present C2 channels and future systems which utilize data transfer capability. During mission execution, the KC-X will receive information flow from multiple sources, with links to various C2 and Intelligence, Surveillance and Reconnaissance (ISR) platforms such as Airborne Warning and Control System (AWACS) and other mission aircraft.

The KC-X may support the Joint Force Commander with airborne network capability, C2 and enhanced battlespace awareness through modular payloads. With various types of payload packages onboard, the aircraft would be capable of enhanced communications relay or other

mission-specific functions. These systems will allow Joint Force Commanders to communicate with and direct combat forces via advanced communications routing capability aboard the KC-X. Additionally, information coming from intelligence gathering assets or provided by other combat aircraft can be relayed to Joint Force Commanders through its airborne networking capability. Finally, the KC-X will provide an onboard local area network (LAN) with multiple commercial compatible connections distributed throughout the aircraft, including the flight deck, boom control and cargo areas. The LAN will provide crew and passengers with connectivity to the GIG.

Cabin Power and Electrical Systems. A number of 110-volt AC electrical outlets will be available and readily accessible on the flight deck and galley area to support any current or future mission needs. Additional outlets will also be available to meet passenger and aeromedical evacuation requirements and spaced on the right and left sides throughout the cabin and in the patient support area

Aircraft Self-Protection Measures and Defensive Systems. A global mission, air refueling is subject to a wide range of threats, including chemical and biological environments and strategic or tactical use of Electro Magnetic Pulse (EMP). Directed energy weapons represent an emerging threat to the KC-X and include lasers and radio frequency weapons that could pose a threat primarily during ground operations and during takeoff and landings. The most likely threat elements are electro-optical radar and infrared surface-to-air-missiles (including man portable missiles), antiaircraft artillery and counter air aircraft. The most stressing threats are long range radio frequency (RF) surface to air missiles and long range RF air-to-air missiles. While the KC-X will not operate in an area of a known high threat envelope without requesting suppression of enemy air defenses and air support, the KC-X must be able to operate in medium threat or hostile environments through the use of aircraft self-protection measures and onboard defensive systems.

Improved reliability and maintainability, in combination with this set of capability requirements, opens the door to a wide range of potential future uses for the airplane. The large cabin, with its built-in electrical, communications and information systems, could be adapted to support multiple mission needs though modular payloads or permanent modifications.

Operational, Organizational and Doctrinal Issues

In the past, the Air Force has resisted suggestions to fully combine airlift, air refueling and other missions simultaneously on a single large aircraft. The KC-10 is recognized as a dual-role tanker-transport aircraft, but neither it nor the KC-135 have routinely been employed in the cargo role. Originally dubbed the "Advanced Tanker Cargo Aircraft," organizational priorities and management practices prevent the KC-10's airlift capabilities from being fully utilized and its contributions in numerous mobility studies are marginalized through assumptions about its planned use. While the reasons for this range from the organizational separation of the air refueling and airlift communities to a lack of compatible cargo loaders available worldwide, a key element is that the limited KC-10 fleet size has made the aircraft a high demand, low density asset. Whether the KC-X suffers the same fate has yet to be seen.

USAF senior leaders have emphasized that airlift is a vital capability for the new tanker fleet, as have Combatant Commanders, the Army and the Marine Corps, all of whom rely on airlift to move troops and equipment. Even though adding cargo- and passenger-carrying capability to the tanker fleet requires additional aircraft structure and systems at an increased cost, this is a prudent investment in future aircraft adaptability and flexibility. There will also be

a slight tradeoff in capability because the weight of the additional structure and systems potentially reduces the amount of fuel that each aircraft can carry. Since the KC-X RFP already requires built-in airlift capability enhancements, it appears the Air Force embraces this requirement.

In the RFP, the Key Performance Parameter (KPP) for airlift says that "the aircraft shall be capable of efficiently transporting equipment and personnel," although there is no threshold or objective requirement established. There is no apparent weighting of the airlift KPP among the ten KPPs identified within the RFP, and no underlying metrics or analysis associated with it to date. A clearly articulated method to evaluate the value of this capability for source selection is also not evident. The value of the airlift KPP should be appropriately weighted relative to the air refueling KPPs, and there should be a clear method to evaluate value gained for pallets, passengers and litters. Otherwise industry will strive to maximize fuel offload capability at the expense of potentially very significant airlift capability. Historically, this occurred during acquisition of the KC-10, which did not incorporate adequate environmental and other capabilities to fully capitalize on its passenger carrying potential. In short, let's not miss the opportunity to ensure that this important program is defined to optimize the versatility of this aircraft in both the air refueling and airlift mission.

Air Mobility Fleet Optimization. There is little dispute that the KC-X has the potential to increase overall air refueling and airlift capabilities and effectiveness, but changing the doctrine to operationally employ the KC-X to take advantage of these new multi-role capabilities is an entirely different matter. In addition to integrating the aircraft into the air refueling management and tasking system, efforts should be made to incorporate the KC-X fully into airlift management and tasking systems as well. This will allow greater use of its airlift capabilities if and when overall demand for air refueling stabilizes or dips to low levels.

The KC-X program presents opportunities to improve the utility of the entire air mobility fleet. By design, commercial airliners and their derivative aircraft are optimized to carry passengers and cargo payloads efficiently and cost effectively over long distances. Military airlifters, by comparison, are designed to carry military equipment of all sizes and transport them directly to or as close to the fight as possible, thereby trading efficiency for military effectiveness. Tactical capabilities such as roll-on/roll-off compatibility, airdrop, short field capability and the ability to transport over and outsize cargo are all examples of military-unique airlift requirements that create inefficiencies in other areas. It should therefore come as no surprise that both KC-X candidates can carry more pallets and passengers than the C-17, for example, which makes sense because their original design as commercial carriers optimizes them for that role. But they also lack the military-unique airlift attributes of the C-17, C-5 and C-130 described above that could be employed in a tactical environment.

The airlift capability inherent in the KC-X is not trivial; depending on the aircraft selected it will be able to carry 20 to 32 cargo pallets, 200 to 280 passengers, and 80 to 120 aeromedical evacuation litters. By comparison, the C-17 carries 18 pallets or 102 troops, the C-5 can carry up to 36 pallets and 73 passengers, and the KC-10's cargo compartment can accommodate loads ranging from 27 pallets to a mix of 17 pallets and 75 passengers. The KC-X is clearly more than just a tanker, and will provide significant additional cargo capability and capacity for the Defense Transportation System. Some may fear that emphasizing the airlift capabilities of the tanker fleet may detract from C-17, C-5, C-130 and other airlift missions and acquisition priorities, but in reality the KC-X would likely complement the nation's airlift force and better optimize the use of air mobility forces in general.

The KC-X will be an incredibly efficient strategic transporter of people, patients, and palletized or bulk cargo when not needed for air refueling. Used in this manner, it could provide a welcome relief to and complement the over-tasked airlift fleet, and allow those forces to be focused towards satisfying unique or specialized airlift needs that they were specifically designed to support. The C-5 and C-17 could be used more effectively to transport rolling, over and out-sized equipment over strategic distances, or the C-17 could be freed up to perform combat delivery missions into austere areas, a mission for which it is optimized. With its defensive systems and aircraft self-protection measures, the KC-X would also transport passengers and cargo into medium threat environments and combat zone airfields that civilian contract carrier aircraft could not risk flying into.

In addition, there is a historical supply/demand mismatch in air mobility forces that might be resolved with the KC-X. In recent years, the day-to-day demand for airlift capability has exceeded the supply available, while the tanker fleet has been historically underutilized except during wartime surges or limited phase operations. The low crew ratio of the tanker force is one variable that precludes achieving higher utilization rates for the fleet, and this is another area that deserves special attention. If higher tanker utilization rates can be realized, the ability to dynamically re-task tankers into an airlift role and back again, or to combine airlift and air refueling missions, has the potential to revolutionize air mobility operations by allowing the system to adapt more readily to surge demands in both tanker and airlift needs.

Aircraft Size, Parking and Fuel Considerations. The RAND AoA identified two other issues for decision makers to consider when choosing among alternatives. First, tanker alternatives differ in how much airfield parking area they require and from what airfields they can be operated. This is a feature of interest because of constraints on airfield parking areas, runway lengths and fuel availability in some theaters of operation. Smaller aircraft use less area but carry less fuel, and are thus reliant on the availability of fuel in forward operating areas. Alternatively, large aircraft that carry more fuel could offset low availability of fuel in theater. Since these requirements are specific both to the aircraft and the theater, how to value the airfield access issues and operational characteristics of the alternatives is a matter for discussion. There does not appear to be a methodology in the KC-X selection process to determine the relative value of aircraft size and parking versus fuel offload capacity, nor are assumptions about the availability of fuel in theater addressed. We cannot assume that fuel will be readily available at forward bases and areas where the KC-X is expected to operate, and the aircraft might very well find itself in a fuel delivery mission.

Fleet Mix. The Defense Science Board Task Force air refueling report reported that a tanker fleet consisting of at least two different types of aircraft is likely to be the most cost-effective hedge against a massive, unanticipated problem grounding a fleet of a single airframe type. Furthermore, it surmised that some missions are dependent on large numbers of tanker aircraft (during fighter employment for example, when refueling is widely dispersed in area but compressed in time), whereas other missions could be more efficiently served by fewer, larger capacity aircraft, such as strategic bomber missions or during fighter deployment and redeployment. RAND's AoA study also found that a mixed fleet consisting of more than one of these alternative candidates had comparable cost-effectiveness, so the study concluded that there is no reason to exclude the possibility of a mixed Airbus-Boeing aircraft purchase on cost-effectiveness grounds alone. In summary, a mix of large tankers for strategic and deployment missions and smaller, tactical tankers for employment missions may be an option for USAF to consider in the long run. Historical use of the KC-135 and KC-10 illustrate the value of having

both large and small aircraft in a mixed tanker fleet. The significant question that needs to be addressed is whether or not we need to increase the percentage of large aircraft in the mix. Historical demand and use of the KC-10 indicates that we currently do not have enough large dual-role tanker-cargo aircraft in USAF.

The Role of Large Aircraft in Combat Operations

The range of technologies and capabilities required by the RFP and inherent in KC-X candidate aircraft make them far more capable than the KC-135 for airlift and other secondary missions, and as a result raise new questions about how these aircraft will and could be utilized. These imbedded capabilities enhance the inherent flexibility of the KC-X platform to execute a wide variety of additional roles and missions in a manner that does not significantly detract from its primary aerial refueling mission. How important is flexibility and adaptability to evolving warfighting requirements and to what extent will the new tanker take on additional roles and missions? How will value be applied to these variables and what characteristics and capabilities will carry greater weight in the selection process? These questions spur a debate about the role and management of large aircraft in combat operations, with an underlying assumption that aircraft capable of performing multiple roles will provide greater flexibility and more warfighting options to future combatant commanders. The nature of this debate is driven by the expected future operating environment for these aircraft and how concepts of operations for these aircraft and their mission might change. A thorough discussion and study of all these issues is needed, with the primary goal of optimizing the capabilities of the entire air mobility fleet and Air Force capabilities at large.

The long and storied history of the C/KC-135 fleet provides insights into how the KC-X might be employed during the next 40 to 50 years. In the future, large commercial-derivative aircraft are expected to employ airborne laser and other energy weapons, serve as UAV "mother ships," launch space vehicles, or perform any number of as yet undetermined missions, with reductions in payload size, increases in stand-off and precision capabilities, and other technological developments driving potential changes. The key attributes that contribute to future adaptability and flexibility are being incorporated into the KC-X, including its long range and endurance, ability to be air refueled, built-in cargo and passenger handling capacity and capabilities, plus its electrical power capacity and net-centric communications capabilities. By incorporating a technological and communications architecture that is open-ended, the KC-X could evolve into a true multi-mission capable aircraft, with future modifications either permanent in nature or attained through the addition of payload modules and adaptations both within and outside the aircraft. Its ability to remain on station through air refueling could also lead to more "persistent" air operations, with mission length measured in days – or weeks – rather than hours. Persistent operations of this nature would require a revision in on-board crew and passenger support capabilities and development of new concepts of operations. No longer constrained to a single mission, the role of large aircraft in combat operations could be expanded with acquisition of the KC-X and its follow-on aircraft.

Conclusion

Air refueling is one of the most important capabilities the Air Force provides to joint military operations, and we must ensure the continuing viability of this vital national capability. While the KC-X program is principally a tanker recapitalization program to replace the capability inherent in the current air refueling fleet, it is absolutely essential that the full range of

operational roles and missions that the aircraft could fulfill be considered in the development process. We've learned a great deal from the history of the KC-135/C-135 fleet, and how its long range, endurance, fuselage size, and fuel receiving capability contributed to its utilization in a variety of air missions. This next generation of tanker aircraft will possess an even greater range of capabilities that provide the U.S. with many more options for future use – if we can widen the discussion on the role of this aircraft in combat operations and eliminate historical constraints on how we utilize our tanker fleet. Acquiring an aircraft that simply replaces the current capacity and capability of the KC-135 on a one-for-one basis does little to enhance the nation's long-term warfighting options, and USAF should be careful not to constrain the role of the KC-X. While the primary mission of air refueling will drive the KC-X requirement, we must insist that the full potential of this aircraft be explored for other roles and missions it might fulfill during the next 50 to 75 years. Building in the capability to maximize cargo handling, passenger support and aeromedical evacuation capabilities is a good start, as is increasing the communications, information processing, battlespace awareness and defensive capabilities of the aircraft. The cost of doing so is a worthy investment, as building in greater flexibility and adaptability at the outset will increase the overall utility of the aircraft over time, provide greater value to the American taxpayer, and give warfighting commanders substantially more capability options in the future. The next step is to consider the potential operational, organizational and doctrinal implications of this aircraft. In the end, the KC-X and its successors might very well transform the nature of future air and joint operations, providing we don't treat them as "just" another tanker.