

AIR REFUELING:



Without Tankers,
We Cannot...

Front Cover: A US Air Force KC-135R Stratotanker aircraft sets on the runway at Niagra Falls Air Reserve Station, New York, on 4 October 2006. The aircraft was assigned to the 107th Air Refueling Wing. (US Air Force photo by SMSgt Ray Lloyd)

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A 10,000-pound Fokker C-2 is refueled in flight by a modified Douglas C-1 transport aircraft during an operation dubbed “Question Mark” in 1929.

FOREWORD

TANKERS: FROM A QUESTION MARK TO TODAY'S FIGHT

General Arthur J. Lichte

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Air refueling operations continue to be amazing aerial feats, especially for people who witness the process for the first time. As mobility Airmen, we consider it simply part of what we do but, in reality, it is quite remarkable to have two aircraft meeting less than 50 feet apart at more than 20,000 feet above the ground traveling at speeds close to 400 miles per hour while a tanker replenishes another aircraft with the fuel necessary to continue the mission.

The amazement is even greater when one considers the first major air refueling operation happened 80 years ago when the Question Mark, a tri-engined Fokker C-2 aircraft with a crew of five, climbed into the southern California sky January 1, 1929. Over the next seven days, the crew kept the aircraft airborne through air refueling from two, three-manned crews operating Douglas C-1 single-engine transports that had been transformed into tankers with the addition of two 150-gallon tanks to off-load fuel.

Combined, those historic tankers made 43 take-offs and landings to deliver 5,660 gallons of fuel, 245 gallons of engine oil, storage batteries, spare parts, tools, food, clothing and mail during the Question Mark's 150-hour and 40-minute operation.

Today's tanker fleet continues to play the vital role of sustaining operations. The tanker underwrites our nation's ability to project power; the aircraft extends our reach to deliver the clenched fist of US power to our adversaries, or the open hand of assistance to people in need. Without tankers, our combat aircraft cannot reach their targets. Without tankers, our resupply aircraft and humanitarian relief materials cannot always reach their destinations. Without tankers, we cannot move our wounded warriors non-stop from the battlefield to the US for the medical care they need.

As a nation, we're overdue on building new tankers. We must make delivery of this capability a high priority for our nation. We simply must get on with it. We're working hard to ensure Air Mobility Command is ready when the next effort begins to choose the industry partner to build our next-generation tanker.

I can understand how the group of Airmen felt at the beginning of the New Year 80 years ago. Their thoughts were likely focused on how to not only successfully demonstrate the air-refueling capability, but also make people aware of its potential significant military contributions.

Today, the question isn't how critical is the tanker to our warfighters and our national security. We know the need for a tanker is critical; it's a capability our nation simply cannot do without.

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Flight of the “Question Mark”

On 1 January 1929, a tri-engined Fokker C-2 aircraft, with a crew of five aboard, climbed into the southern California sky. This aircraft, dubbed the Question Mark, was not history’s first air refueling mission, but it played a crucial role in the beginning of air refueling efforts and in the development of the US Army Air Corps.

In fact, the first attempts at air refueling started in 1921 with five-gallon gas cans. On 2 October 1921, a US Navy lieutenant in the back of a Huff-Daland HD-4 used a grappling hook to snag a gas can from a float in the Potomac River, and on 21 November, a wing walker with a gas can strapped to his back climbed from an airborne Lincoln Standard to a Curtiss JN-4 and proceeded to pour the gas into the aircraft’s tank. While these two publicity stunts deserve mention, the first air-to-air refueling using a gravity-flow hose occurred in 1923. Earlier that year, the US Army Air Service had equipped two De Haviland DH-4Bs with inflight hoses. After installation, testing, and preparation, the Army Air Service was ready to put it to use, and on 27 June, one of the DH-4s flew a 6-hour and 38-minute flight that included two air refuelings. Testing continued through much of 1923 until 18 November, when the hose became entangled in the right wings of the two aircraft. Lieutenant P. T. Wagner, the pilot of the refueler, was killed in the accident.

At that time, however, the Army’s budget was very limited, and the aviation branch, in particular, had not yet recovered from the 1919 demobilization. The tests in 1923 attempted to show the practicality of air refueling, with a flight-duration (37.25 hours) and distance (3,293 miles) record set in August and a border-to-border flight from Lamas, Washington, to Tijuana, Mexico, in October. Still, between the budgetary constraints and the lack of an actual application, the testing slowly ground to a halt, and the November accident caused the US Army Air Service to cease it altogether.

The idea for the Question Mark flight started with Lieutenant Elwood R. “Pete” Quesada. Years later, retired General Quesada recalled that it was actually an incidental thought, rather than a planned objective. By 1928, Belgium restarted air-refueling experiments, picking up where other countries had left off. In the process, the Belgians set a new record of 60 hours and 7 minutes aloft. Additionally in 1928, a German aircraft, The Bremen, attempted to fly across the Atlantic. However, it was forced to land in a barren area of Labrador. When the German government requested help from the US State Department, the US Army Air Corps accepted the task. Major General James E. Fechet, head of the Army Air Corps, led a flight team, which consisted of Quesada and Captain Ira C. Eaker. Despite poor weather and periods of heavy ground fog, they found The Bremen and her crew safe and sound. Quesada said he was surprised when Eaker “decided to go over the ground fog. I said, my God, what are we going to do if we get caught up here. So then I began to think,

my God, wouldn't it be nice if we had a gas station. We could just pull in to a gas station and fill up with gas again."

Eaker took the idea one step further and began organizing the effort for a prolonged refueling technique, with a demonstration that would attract a lot of attention for the US Army Air Corps. The receiving aircraft, the Question Mark, a Fokker C-2, was a high-winged monoplane with two 96-gallon wing tanks supplemented by two 150-gallon tanks installed in the cabin. The two refueling aircraft were Douglas C-1 single-engine bi-planes with two 150-gallon tanks for offloading and a refueling hose passed through a hatch cut in the floor. The Question Mark's crew consisted of Major Carl A. Spatz (he later changed spelling to Spaatz), Captain Ira C. Eaker, Lieutenant Elwood "Pete" Quesada, Lieutenant Harry A. Halverson, and Staff Sergeant Roy W. Hooe. The crews of the tankers were Captain Ross G. Hoyt and Lieutenants Auby C. Strickland and Irwin A. Woodring in number 1, and Lieutenants Odas Moon, Joseph G. Hopkins, and Andrew F. Salter in number 2. Captain Hugh M. Elmendorf was in charge of ground operations and logistics for the mission.

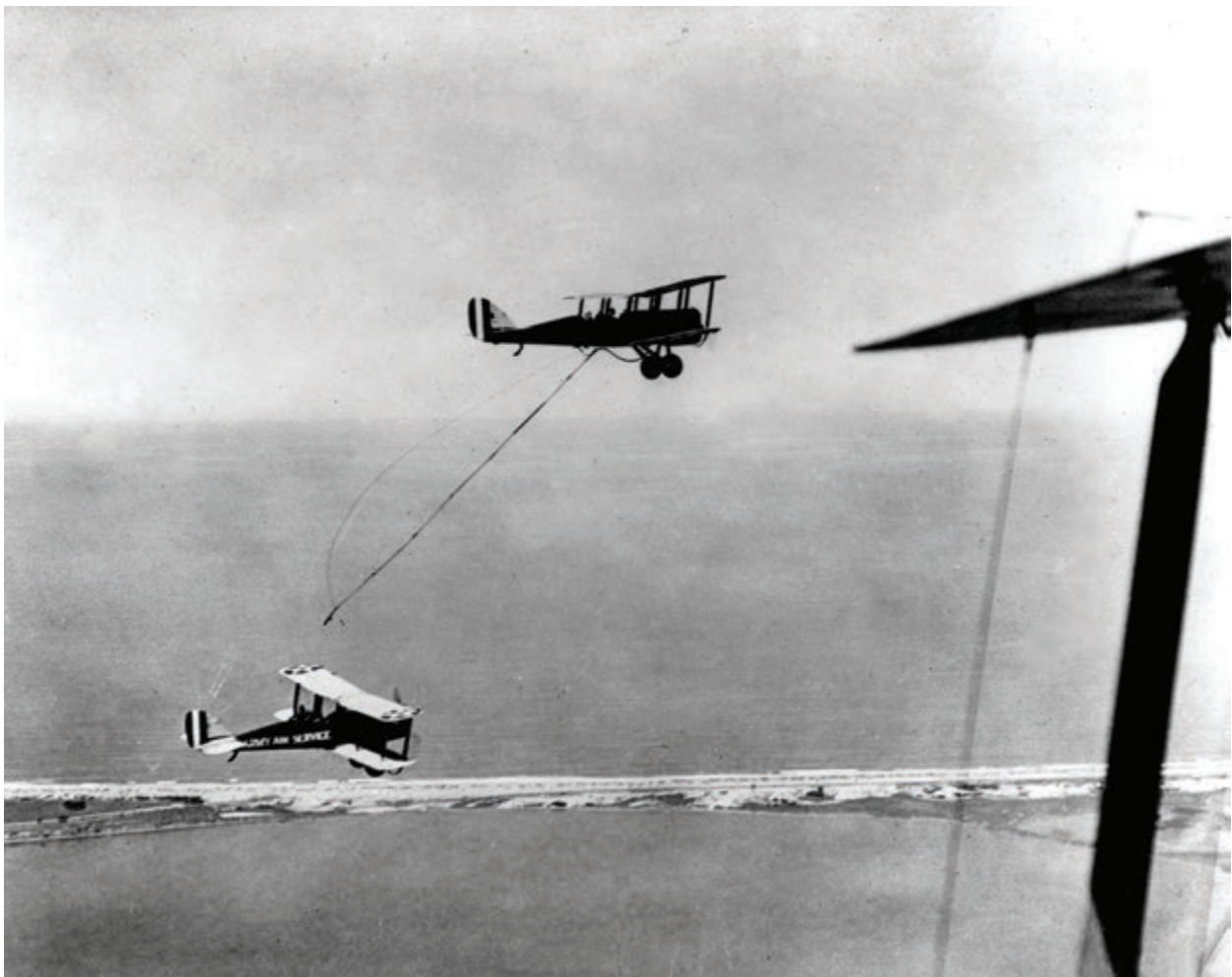
The flight lasted from 1 through 7 January 1929, a total of 150 hours and 40 minutes. They flew a 110-mile track from Santa Monica to San Diego, California. They also flew over the New Year's Day Rose Bowl football game. During the flight, they made 43 contacts with the tanker aircraft. Each contact lasted about 7.5 minutes, with the aircraft about 15 to 20 feet apart. Day contacts took place at an altitude between 2,000 and 3,000 feet, night contacts between 5,000 and 7,000 feet. All told, the Question Mark received 5,700 gallons of fuel. In addition, the tanker crews passed oil, food, water, and other items, by means of a rope, during these contacts. Because of their weight and unreliability, neither the Question Mark nor the two refuelers were equipped with radios. The crews maintained communications via notes dropped to the ground, hand and flashlight signals, written messages displayed by ground panels, and messages written on blackboards carried on the planes.

The Question Mark's mission portended little militarily. Based on the success of this air refueling mission, the US Army Air Corps scheduled a formal demonstration in the spring of 1929 as part of an Army war-game maneuver. During the demonstration, a Keystone B-3A bomber, accompanied by a Douglas tanker, was to fly from Dayton, Ohio, on a simulated bombing mission over New York City's harbor, and return. Refueling was to occur over Washington DC during both parts of the mission. However, a network of thunderstorms between Ohio and Washington caused the aircraft to become separated. Icing conditions forced the tanker to make an emergency landing in Uniontown, Pennsylvania, where it lodged itself in the mud. The bomber successfully pressed on to New York City and returned to Washington without the tanker's support. With this disappointment, the US Army Department then shelved the idea of air refueling for another 12 years.

Still, in its primary objective, the Question Mark was a huge success. As General Quesada reflected, "It got tremendous public attention, which is exactly what [we] had in mind. The Question Mark had no noble purpose. It wasn't going to create an operational procedure that would plunge the Air Force into a great superior power

that would make it unnecessary to have an Army or a Navy. The purpose was to attract attention. I think it would be somewhat abusive not to recognize that.” In fact, it captured the public’s imagination. American aviators were enthralled with the concept of air refueling. By 26 May 1929, a pair of commercial pilots in Texas, using a reconditioned Ryan Brougham monoplane, broke the Question Mark’s record with 172 hours and 32 minutes in the air. For the next several years, the record continued to be extended until Alan and Fred Key kept a Curtiss Robin aircraft, nicknamed Ole Miss, in the air for 653 hours and 34 minutes in 1935. James Keeton and William Ward used another Curtiss Robin as the tanker, making 484 midair contacts delivering about 6,000 gallons of fuel.

The Question Mark and subsequent record-breakers also sparked more interest among British aviators. One of them, Flight Lieutenant Richard Atcherly, invented one of the first formal air refueling systems.



The first air-to-air refueling using a gravity-flow hose occurred on 27 June 1923. The upper De Havilland DH-4B dangled a hose, while a crewmember handled the hose and connection in the lower DH-4B.



The crew of the "Question Mark," from left: Lieutenant Harry A. Halverson, Captain Ira C. Eaker, Sergeant Roy W. Hooe, Major Carl A. Spaatz, Lieutenant Elwood "Pete" Quesada, and an unknown crewman. (January 1929)



Lieutenant Pete Quesada adjusts the gas line aboard the Question Mark.

Air Refueling Development Lags

After the publicity success of the Question Mark's flight and the operational shortcomings of the spring 1929 Army war-game maneuver, the US Army Air Corps spent little time thinking about aerial refueling. This is not to say that nothing was done with the air refueling concept through the 1930s, but most was accomplished thanks to civilian aviators. The Question Mark also rekindled Britain's interest in air refueling.

From 1930 until 1937, the Royal Air Establishment at Farnborough, Hampshire, England, conducted a series of air refueling experiments. The Royal Air Force looked at air refueling not so much as to a way to extend an aircraft's reach, but more to help lighten take-off weights, reducing wear and tear on the aircraft and grass airfields. They also looked at it as, perhaps, a way to supplement the capability of bombers if the League of Nations implemented size restrictions then under consideration--less fuel on take-off meant more bombs could be loaded on the allowable aircraft.

These experiments began with the Question Mark's techniques (improved by US barnstorming efforts) of the dangle-and-grab method. To accomplish this, the tanker aircraft would feed out hose that someone in the receiving aircraft had to reach out and grasp. In September 1934, Flight Lieutenant Richard Atcherly introduced his newly patented looped-hose aerial refueling system.

This new technique put most of the operational effort on the tanker crew. Both the tanker and receiver trailed cables with grapnels on the ends. The receiver flew a straight line, while the tanker crossed its path from behind allowing the grapnels to catch. The receiver then reeled in the cables, along with a hose from the tanker. Once the two aircraft were connected with about 300 feet of hose, the tanker pilot would then maneuver to a higher position and let gravity do the rest.

These experiments continued until 1937, but, by then, even the Royal Air Force had decided that air refueling offered a limited application at best. Aircraft technology had surpassed any perceived need for air refueling. Before this date, the standard aircraft were bi-planes (although monoplanes had started becoming more frequent), which used "doped" linen fabric and fixed landing gear, with only a little consideration given to aerodynamics. By 1933, two American corporations built the first all-metal, low-wing monoplanes--the Douglas DC-1 and the Martin B-10 bomber. These aircraft, each weighing about 17,000 pounds, had retractable landing gear, cowled engines, and high-lift devices to improve take-off. They also utilized the new controllable pitch propeller. These advances did not do much for payloads, but they doubled the DC-1's and B-10's airspeed and operating range over their contemporary aircraft.

British commercial interests, however, soon returned to the idea of air refueling. Companies began looking at "flying boats" to connect the widespread British Empire,

and they hoped air refueling would improve their operation. Sir Alan Cobham and Flight Refuelling Limited (FRL) further refined the looped-hose system. From 5 August to 30 September 1939, Imperial Airways took advantage of the first commercial air refuelings. The company flew Short S.30 flying boats for weekly mail-service flights between Southampton, England, and New York City. FRL used two obsolete Handley Page HP.54 Harrow bombers as tankers--one at Gander, Newfoundland, and the other at Rineana, Ireland. These air refuelings were not intended to extend the flight times, but to allow the flying boats to take off with minimal fuel and more mail. Imperial Airways flew 15 of these transatlantic missions before Britain was involved in World War II.

World War II offered many examples of how air refueling could have been used. For example, Britain depended on shipping to stay alive, and aircraft technology provided only limited support. Bomber operational ranges early in the war meant they were not very useful in helping to suppress the German submarine threat. Still, in wartime, many innovations are examined and tested. During World War II, air refueling was among them.

Just after Pearl Harbor, the US Army Air Forces began working on an air refueling solution. With the help of Hugh Johnson, the man who had been in charge of FRL's Gander operations, they studied three primary concepts. First, planners looked at launching B-17 Flying Fortresses from Midway Island against Japan, with the idea of using modified B-24 Liberators as tankers. Second, they considered using B-24s from Hawaii with tanker support from US Navy seaplanes. The third concept called for B-17s to tow fuel-laden gliders to serve as tankers.

Testing, using a variation of the looped-hose method, began in the summer of 1943 at Eglin Field, Florida. A B-17E served as the receiver and a modified B-24D as the tanker. The successful tests extended the B-17's range (with three tons of bombs) from 1,000 to 1,500 miles. The new problem now was how would the country's taxed manufacturers build the equipment for squadrons of B-24 tankers and B-17 receivers? Added to this dilemma was the time required for the modifications and training of the crews. Additionally, by mid-1943, Boeing began rolling out the B-29 Superfortress. The B-29 had a combat radius of 1,500 miles and carried twice the bomb load of the B-17.

In 1944, the US Army Air Forces began studies on the feasibility of equipping the B-29 with an air refueling capability. The engineers at Wright Field, Ohio, determined it was possible to modify the aircraft, but the 1,500-gallon capacity of a B-24 tanker only extended the B-29's range by 830 miles. At the same time, the British developed plans to convert 600 Lancaster bombers to serve as tankers in the Pacific, serving 600 Lincoln bombers. However, before any air refueling plans to support the bombing mission reached fruition, Allied forces began seizing islands within striking distance of Japan.

The US Army Air Forces also looked at a possible refueling method for smaller fighter aircraft. A contractor, All American Aviation, equipped and tested a specially modified P-38 Lightning and a B-24 tanker. In the test, the B-24 suspended an external fuel tank on a cable. The P-38 was to catch that cable, securing it into

a device mounted on the forward fuselage. The fighter would then descend to the tank, which was to lodge into the securing device while the cable broke away. A nitrogen bottle fired to force the fuel into the fighter before ejector springs released the tank. The tests proved highly unsuccessful, and in March 1945, the Army Air Forces cancelled the experiment.

While air refueling was not used operationally, World War II led the US Army Air Forces to examine its potential. These studies and the testing of new equipment showed what air refueling could offer to future contingency operations. By 1947, when the Department of the Air Force became a separate service, these wartime studies and the continued post-war testing ensured air refueling would soon serve as a critical component of modern air power.



The Martin B-10 was the fastest and most heavily armed bomber at the time (1934). It had a gross weight of 14,731 pounds, a 4-man crew, and was powered with 2 Wright 740 horsepower engines capable of a top speed of 212 miles per hour.



A tanker of a different type: An emptied gas cargo ship, a C-109, which was a converted B-24J from the Willow Run Bomber Plant, takes off from Myitkyina, Burma, in 1943.

Extending “the Reach”

On 6 August 1946, the world’s largest bomber took to the air from the Consolidated-Vultee plant on the south side of Lake Worth, west of Fort Worth, Texas. The huge, six-engine B-36 was a wartime design, built for non-stop, round-trip flights from the United States to Germany in the event of the loss of bases in England. The first production models were delivered to the Strategic Air Command (SAC) in late 1948. The B-36 was certainly big enough to carry the large nuclear weapons of the time and carried enough fuel--over 183,000 pounds--to make the 10,000-mile, round-trip flight to Europe and back.

However, the B-36 lacked speed and maneuverability and, during the early 1950s, became highly vulnerable to jet fighter aircraft. Fortunately, the Boeing Airplane Company had the B-36’s replacements in development: the jet-propelled B-47 and B-52. However, these new aircraft--unlike the B-36, which they would ultimately replace--needed air refueling in order to hit targets in the Soviet Union. At the time of their development, no tankers existed.

In January 1948, General Carl A. “Tooe” Spaatz, a former bomber commander and first US Air Force Chief of Staff, identified inflight refueling as the young service’s highest initial priority. Two months later, Air Force personnel from Wright-Patterson Air Force Base, Ohio, visited Britain’s Flight Refueling Limited (FRL), evaluated company founder Sir Alan Cobham’s loop-hose air refueling system design, and bought two examples. The Air Force also ordered 40 additional sets and acquired manufacturing rights for the system.

Upon arrival in the United States, the two refueling systems went to Boeing’s Wichita, Kansas, plant for installation in B-29s. The subsequent conversion program resulted in the production of 40 KB-29M tankers and 40 B-29MR receivers. On 30 June 1948, Strategic Air Command activated its first two KB-29M squadrons: the 43d Air Refueling Squadron at Davis-Monthan Air Force Base, Arizona, and the 509th Air Refueling Squadron at Walker Air Force Base, New Mexico.

The introduction of dedicated tanker aircraft and crews allowed SAC to extend the range of its B-29 and B-50A bombers. Concurrently, SAC and the Air Force made the decision to equip *all* future bombers with an inflight refueling capability. However, the loop-hose system proved unwieldy and difficult, particularly in bad weather. With a 2 1/2-inch diameter refueling hose, the FRL-developed system transferred fuel at a rate of only 110 gallons per minute. With new high-speed, high-altitude jet bombers coming on line, capable of operating at night and in bad weather, it quickly became apparent that something better was needed.

Interestingly enough, Boeing already had a better system in mind. The company developed a “flying boom,” which featured a telescoping pipe with fins--termed “ruddervators,” as they functioned as both rudders and elevators--at the nozzle end.

The operator, sitting in the B-29's converted tail turret, literally flew the boom into a receptacle on the upper fuselage of the receiver aircraft. This design allowed more positive control of the air-to-air refueling operation and--with the boom's 4-inch diameter--much faster fuel transfer. The Air Force responded by ordering over 100 B-29s fitted with the flying-boom system, designated the KB-29P. The first KB-29Ps went into service with the 97th Air Refueling Squadron at Biggs Air Force Base, Texas, on 1 September 1950.

In the meantime, training continued with the KB-29Ms, including periodic attempts at record-breaking flights. For example, on 7 through 9 December 1948, a 43d Bombardment Group B-50A, commanded by Lieutenant Colonel Michael N. W. McCoy, flew from Carswell Air Force Base, Texas, to Hawaii, dropped a practice bomb, and then returned to Carswell. KB-29Ms from the 43d and 509th Air Refueling Squadrons made the flight possible.

The Air Force followed up with a non-stop, around-the-world flight. Again, the 43d Bombardment Group got the call, although the first attempt on 25 February 1949 came to a quick end when the B-50A "Global Queen" sustained engine problems and landed at Lajes Air Base, Azores. The next day, the back-up plane, commanded by Captain James Gallagher and named "Lucky Lady II," launched from Carswell. It returned to Texas on 2 March, having completed a 94-hour and 1-minute flight of 23,452 miles with four inflight refuelings. Afterwards, General Curtis E. LeMay, Commander of Strategic Air Command, told the press the obvious: SAC could now deliver an atomic bomb anywhere in the world, and tankers made it possible.

Subsequently, SAC converted its KB-29Ms to a probe and drogue system, using another design pioneered by Flight Refueling Limited. It featured a refueling hose mounted on an electrically driven reel inside the tanker, with the receiver aircraft taking on fuel through a fixed refueling probe. While initially tested with bombers, the design later proved particularly useful with fighters.

However, the B-29's aging airframe and limited fuel offload capability definitely made it an interim tanker (although the last ones didn't retire from SAC until November 1957). In the meantime, Boeing came up with an improvement, the KC-97.

Based on the Model 377 "Stratocruiser" trans-oceanic airliner, the KC-97 featured a unique double-bubble fuselage with plenty of space available inside for fuel, cargo, and passengers, combined with the wings and engines of the Boeing B-50. The first prototype YC-97A transport was used by the Military Air Transport Service during the Berlin Airlift in 1949 and went into full production that same year. In 1950, Boeing introduced the KC-97 variant, equipped with the flying-boom system.

Dubbed the "Stratotanker," the KC-97 quickly became the most numerous SAC tanker, with over 800 built. The first aircraft went into service with the 306th Air Refueling Squadron at MacDill Air Force Base, Florida, in 1951. By 1953, Strategic Air Command operated almost 30 air refueling squadrons with 502 tankers--the majority of the squadrons flying KC-97s. Nearly every B-47 wing had a KC-97 air refueling squadron assigned to it. When B-47s deployed overseas, their tankers went

with them, enabling the mass deployment of entire wings of bombers to bases in Europe and the Far East for Operation Reflex.

However, even the new KC-97 operated with several limitations. While a single KC-97 could adequately refuel a B-47, it took two or more to provide one refueling to a B-52. In addition, it took a long time for a fully laden KC-97 to get to its cruising altitude. This forced SAC to deploy its tankers for extended periods to locations in Alaska and Canada, strategically located along the routes the bombers would use to get to their targets. With adequate warning, the KC-97s would get to altitude in time to refuel the bombers coming from the United States.

However, speed disparity between the KC-97 and its receivers proved to be the biggest problem. In order to refuel, the bomber had to slow down and drop to the KC-97's altitude. Once they joined up, the tanker went in to a dive, allowing the bomber to maintain enough speed to stay in the air. As the receiver took on more fuel, it grew heavier, which made the maneuver--known as "tobogganing"--even more difficult. When done in poor or marginal weather, the task proved even more challenging. Once the two aircraft completed the refueling, the jet bomber had to climb back up to its cruise altitude, which burned a lot of the fuel it had just taken on.

Fortunately, a suitable replacement for the KC-97 was already on the way--and this aircraft would feature jet propulsion.



A KB-29P assigned to the 91st Air Refueling Squadron, Barksdale Air Force Base, Louisiana, puts Strategic Air Command's long reach into practice by refueling an RB-45C, which was assigned to the 91st Strategic Reconnaissance Wing.



Boomer at work--unlike his predecessors in the KB-29, the boomer in the KC-97 was able to sit upright while working the aircraft's flying boom.



During Operation Ready Go in August 1964, these KC-97Gs, assigned to the Illinois Air National Guard's 126th Air Refueling Wing at O'Hare International Airport, refuel Air National Guard F-100D "Super Sabres" in the first non-stop trans-Atlantic deployment of Guard fighters to Europe.

Refueling Fighters

Strategic Air Command (SAC) entered the 1950s on a roll. It operated a growing fleet of tanker aircraft, and the first jet bombers, commencing with the B-47 Stratojet, were coming on line. The combination of tankers and bombers made SAC a truly global strike force, with mission duration only limited by crew endurance. However, one question remained: what was the proper role of SAC's small escort fighter force?

During World War II, fighters, such as the legendary P-47 Thunderbolt and P-51 Mustang, escorted the bombers over the targets. However, the postwar jet-propelled fighters such as the F-80 Shooting Star and F-84 Thunderjet used fuel at a much higher rate and were, therefore, range-limited. They could no longer escort the bombers.

The Air Force regularly transferred fighter units overseas, particularly after the outbreak of the Korean War on 25 June 1950. The standard method involved using US Navy or Navy-contracted vessels--primarily World War II-era escort aircraft carriers--to physically ship the aircraft. This took weeks, and, more often than not and despite protective efforts, upon arrival the fighters required extensive maintenance due to salt air exposure, which caused corrosion.

The answer was simple: find a way to extend the range of fighter aircraft. Initial efforts included projects with the names of Tip-Tow, Tom-Tom, and FICON (for "Fighter Conveyor"). These did not involve actual inflight refueling, but instead involved literally "towing" fighter aircraft, albeit under rather unusual circumstances.

Project Tip-Tow employed a modified B-29 and two F-84Ds, which attached to the bomber at either wing tip through a clamping device. Project Tom-Tom, tested in 1953, was similar and involved the coupling of RF-84F reconnaissance aircraft to the wing tips of a modified B-36. The FICON proposal involved the actual carriage of a modified RF-84F in the bomb bay of a B-36, slung beneath a trapeze.

During testing, flying the fighters in close proximity to large bombers and hooking up proved supremely challenging, even in perfect weather. A fatal crash involving the Tip-Tow B-29 and one of the F-84s in April 1953 led to the cancellation of Tip-Tow. Doing such hook-ups operationally, possibly in combat and in bad weather, and most likely at night, made the efforts even more risky. Fortunately, advances in air refueling of fighters made all three of these difficult and complex "towing" methods unnecessary.

As during the early development of Strategic Air Command's tankers, the United Kingdom's Flight Refueling Limited (FRL) led the way. The company fabricated external drop tanks with integral refueling probes, suitable for using with the probe and drogue system. On 22 October 1950--barely four months after the start of the Korean War--US Air Force Colonel David C. Schilling used this system to make the first non-stop, air-refueled flight by a fighter across the Atlantic Ocean.

Colonel Schilling had commanded the 62d Fighter Squadron and the 56th Fighter Group in the European Theater during World War II. In July 1948, he had led the F-80s of the 56th Fighter Wing from Selfridge Air Force Base, Michigan, across the Atlantic to the Royal Air Force (RAF) installation at Odiham, England. Accomplished under the name "Fox Able One"--for "Fighters Atlantic, Operation No. 1"--Schilling's pilots landed for refueling at Bangor, Maine; Goose Bay, Labrador; Bluie West 1/Narsarsuaq, Greenland; Meeks Field, Iceland; and RAF Stornaway, the Hebrides. Because of the refueling stops and the weather, the 16 fighters took 10 days to get to Europe.

In October 1950, Colonel Schilling made the trip in the reverse direction in an incredible 10 hours and 8 minutes. After taking off from RAF Manston, England, in two modified F-84Es, Schilling and Colonel William Ritchie refueled from FRL-operated Avro Lincoln bombers/tankers over Scotland and Iceland. Unfortunately, one of Ritchie's probes sustained damage during the contact over Iceland. Unable to take on fuel, he literally ran out of gas and ejected, but, fortunately, was quickly rescued.

With the Korean War well underway and its high demand for fighter aircraft, the Wright Air Development Center at Wright-Patterson Air Force Base, Ohio, designed additional external drop tanks with fixed refueling probes and dispatched them to the theater. Republic Aviation, the manufacturer of the F-84, concurrently started delivery of the F-84G, which had a refueling receptacle, compatible with SAC's boom-equipped KB-29Ps, in the leading edge of the left wing.

On 6 July 1951, the first combat air refueling of fighter-type aircraft took place over Korea. Three RF-80As launched from Taegu with the modified tip-tanks and rendezvoused with a tanker offshore of Wonsan, North Korea. Through inflight refueling, the RF-80s effectively doubled their range, which enabled them to photograph valuable targets in North Korea.

The big test came with plans for the movement of an entire fighter wing to the Korean theater. On 4 July 1952, 60 F-84Gs took off from Turner Air Force Base, Georgia, and flew 1,800 nautical miles to Travis Air Force Base, California, non-stop. Refueled en route by 24 KB-29Ps over Texas, this served as the rehearsal for the main event, designated Fox Peter One.

Organized by Colonel Schilling--who then served as the commander of Turner Air Force Base's 31st Fighter Escort Wing (FEW)--Fox Peter One kicked off on 6 July when the first of the 31 FEW's three squadrons of F-84Gs headed west from Georgia to Travis. Over the following three days, KB-29Ps refueled each squadron's aircraft over Texas.

At 1,860 nautical miles and with no alternate landing sites or divert fields, the Travis Air Force Base to Hickam Air Force Base, Hawaii, leg was the longest of the trans-Pacific flight. All of the fighters made it and then island-hopped the rest of the way to Yokota Air Base, Japan, via Midway Island, Wake Island, Eniwetok, Guam, and Iwo Jima. The arrival of the last aircraft in Japan on 16 July, less than two weeks after leaving Georgia, marked Fox Peter One as a resounding success.

The following October, the 27 FEW from Bergstrom Air Force Base, Texas, replicated the route and the inflight refuelings and relieved the 31 FEW. The 27 FEW's commander was Colonel Donald Blakeslee, another famous World War II pilot and ace.

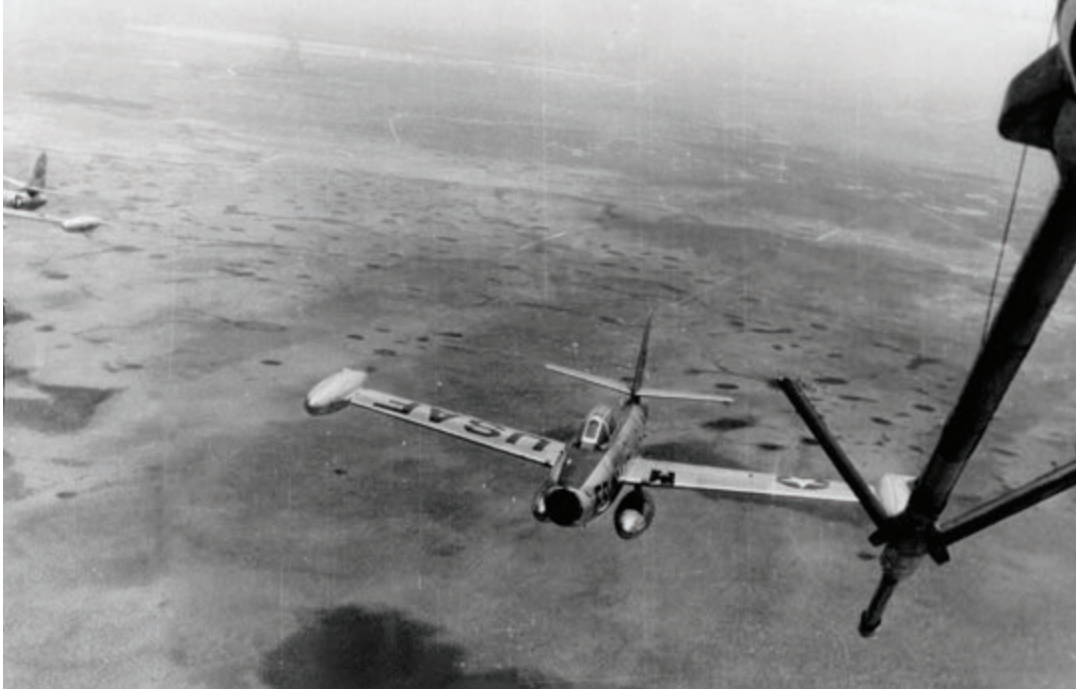
More record flights followed, including October 1953's Operation Longstride, during which Colonel Schilling's 31st--now designated a strategic fighter wing (SFW)--dispatched eight F-84Gs to Nouasseur Air Base, French Morocco. The aircraft covered 3,800 miles in 10 hours and 20 minutes, thanks to inflight refueling by brand-new SAC KC-97s in the vicinity of Bermuda and the Azores.

Concurrently, Colonel Thayer S. Olds, commander of Turner Air Force Base's 40th Air Division, led 20 F-84Gs of the 508 SFW to RAF Lakenheath, England. Three of the fighters landed at Keflavik, Iceland, due to mechanical problems, but the others successfully hooked up with the orbiting KC-97s and made it to England in one flight.

SAC's fighter units transferred to Tactical Air Command or were inactivated in 1957 as part of a reorganization of Air Force strategic and tactical assets. However, they set the standard; by the end of the 1950s, trans-oceanic flights became commonplace. The Air Force never bought another fighter aircraft without inflight refueling capability, a capability which proved its worth a few years later when the Vietnam Conflict heated up.



Prior to developing inflight refueling for fighters, the Air Force experimented with ideas such as "Project Tip-Tow," which investigated the towing of aircraft like these two F-84s by bombers such as the B-29.



High over western Texas, two F-84Gs assigned to the 31st Fighter Escort Wing pull in behind a waiting KB-29P during Operation Fox Peter One.



Two air policemen at Travis Air Force Base, California, monitor a flightline full of 31st Fighter Escort Wing F-84Gs prior to the fighters' launch for Hickam Air Force Base, Territory of Hawaii, as part of Operation Fox Peter One. The large transport aircraft in the background are Military Air Transport Service C-74 Globemasters, part of the support force.

Development of the Modern Air Refuelers

By the early 1950s, Air Force air refueling tankers consisted of converted bomber and cargo aircraft. The introduction of the eight-engined B-52 Stratofortress in 1952, however, made these existing tankers highly ineffective. A KC-97 Stratofreighter with an offload capacity of 53,000 pounds of fuel could effectively refuel two B-47 Stratojets. The larger fuel tanks (243,000 pounds) and the higher fuel consumption rate of the B-52 required more KC-97s to support the fleet. Additionally, mission planners had to take into consideration the differences in technology between the piston-engined KC-97 and the turbojet B-52. Because of the speed differential, the KC-97 tanker had to be based approximately 1,000 miles ahead of the B-52 before a rendezvous could take place. Additionally, the B-52 had to descend to the KC-97's operating altitude and then burn extra fuel to return to its cruising altitude.

As an example, the Strategic Air Command (SAC) conducted Operation Power Flite in 1957. Designed to test and display the intercontinental capability of the B-52, the mission consisted of three B-52Bs from Castle Air Force Base, California. These three aircraft, led by the Lucky Lady III, piloted by the commander of Fifteenth Air Force, Major General Archie J. Old, Jr., flew around the world, a distance of 21,135 nautical miles, and successfully completed the route in 45 hours and 19 minutes, less than half the time taken by the Lucky Lady II, a B-50A, in 1949. Despite General Curtis E. LeMay, SAC Commander in Chief, calling Operation Power Flite a "demonstration of SAC's capabilities to strike any target on the face of the earth," SAC planners also took note of the most challenging aspect of the mission: air refueling. The three B-52s of Operation Power Flite required the support of 78 KC-97s, plus several more standing alert at bases along the route in case of adverse winds. The operation showed it took two KC-97s to provide 26 percent of one B-52B's refueling requirements. The operation left little doubt that SAC needed a new tanker capable of enhancing the intercontinental mission.

By this point, though, the Boeing Corporation had already initiated development, with its own funds, of a new turbojet aircraft. Boeing officials invested in such an aircraft because it would be able to serve as a base-model for a tanker, a military cargo aircraft, and even a commercial airliner. The corporation began construction of the prototype Model 367-80 (informally known as the Dash 80) in October 1952. In July 1954, the Dash 80 flew for the first time, with further testing and development following rapidly.

In November 1953, SAC issued a requirement for 200 jet tankers. The Air Force received three proposals in response--paper-only designs from the Douglas and Lockheed Corporations. While the other companies talked about possible designs, only Boeing had an operating model. Because of the urgency of SAC's need, the Air Force procured 29 Boeing KC-135 Stratotankers as an interim measure in 1957. The

number of interim tankers increased to 88, then to 118, and then 157. The Air Force ended up procuring 830 KC-135s, of which, 732 were initially identified as interim tankers.

For the next 20 years, SAC maintained nearly a one-to-one ratio of KC-135s to B-52s. Often, they were on alert status together, with the tanker providing fuel in a “buddy” fashion. On the other hand, forward-basing the tankers to rendezvous with the bombers offered a significant advantage: forward-based tankers had more fuel to give the bombers since they did not have to travel such a great distance. With this in mind, SAC based KC-135s at places like Westover Air Force Base, Massachusetts, and Dow Air Force Base, Maine. Secret agreements with Canada also allowed SAC to base KC-97s at Cold Lake and Namao in Alberta.

Through the years, the Air Force modified the KC-135s. The first modifications began in July 1962 when SAC developed the Q-model. A total of 56 KC-135As received fuel tanks to hold special fuel for the SR-71 and additional communication equipment used during fuel transfer operations. In later years, when the KC-135Qs were refitted with CFM-56 engines, the aircraft were redesignated as KC-135Ts. Another model, the B-model, was created in July 1964 as Boeing added specialized communications equipment and an air refueling receptacle in 17 KC-135As. Essentially an airborne command post, the KC-135B was redesignated the EC-135C on 1 January 1965. The two major KC-135 modernization programs began in the 1980s. The KC-135E was refitted with JT-3d engines. By the end of the program, 157 Air Force Reserve and Air National Guard KC-135s were updated. In July 1984, SAC formally accepted the first KC-135R, equipped with new fuel-efficient CFM-56 engines and over 25 other updates to equipment, such as generators and the main landing gear. The KC-135R had 1.5 times the fuel offload capacity of the KC-135A. Over 410 KC-135s were re-engined by 9 June 2005.

In June 1967, SAC published a requirement for an advanced capability tanker to supplement the KC-135 force. While ideal for supporting the bomber mission, planners judged the KC-135 as inadequate to support a general force deployment of attack, rescue, air defense, and airlift aircraft. Although Headquarters Air Force endorsed the concept, little was done while the Vietnam Conflict continued. A tanker support study in 1970 called for adapting a current wide-body transport aircraft as the most cost-effective solution. A limited number of feasibility tests followed in 1971 and 1972. United States material support during the October 1973 Yom Kippur War (a coalition of Arab states against Israel) highlighted the need for air refueling of airlift forces.

In December 1973, SAC reissued its tanker requirement, entitled the Advanced Tanker Cargo Aircraft (ATCA). The Military Airlift Command and Tactical Air Command agreed that the new aircraft should be primarily a tanker, with an airlift augmentation capability. As such, they agreed “that SAC should be the single manager for planned new tanker/cargo aircraft.” Two companies responded to the ATCA program. Boeing based its proposal on its 747, while McDonnell Douglas based its on the KC-10. On 19 December 1977, the Air Force selected the KC-10A as the

more advantageous aircraft. While the 747 version offered a larger capacity, the KC-10 was cheaper and offered the ability to take off with a maximum load from a shorter runway. From 1981 to 1990, the Air Force received 60 KC-10s.

SAC originally assigned the 60 aircraft to three bases: Barksdale Air Force Base, Louisiana; March Air Force Base, California; and Seymour Johnson Air Force Base, North Carolina. Following the Air Force's reorganization and the creation of Air Mobility Command (AMC) in 1992, leaders consolidated the KC-10s at McGuire Air Force Base, New Jersey, and Travis Air Force Base, California.

Both the KC-10 and KC-135, despite their age and heavy use, continue to ensure AMC accomplishes its rapid global mobility mission, as well as sustaining America's deployed forces. They remain ready and respond to an important calling in the nation's defense.



At March Air Force Base, California, on 18 January 1957, General Curtis E. LeMay presents the Distinguished Flying Cross to the crew of the Lucky Lady III. At the far left is Major General Archie J. Old, Jr., Fifteenth Air Force Commander. The aide behind General Lemay is Major David C. Jones, later to become Air Force Chief of Staff and Chairman of the Joint Chiefs.



A boom operator on a KC-135 uses a boom-drogue adapter to refuel a US Navy F-14 Tomcat.



The prototype McDonnell Douglas KC-10A over Southern California.

A Wing Perspective of Air Refueling History

The 92d wing at Fairchild Air Force Base near Spokane, Washington--whether it was a bombardment wing during the Cold War or an air refueling wing now--has a long and distinguished history of air refueling. The air refueling mission at Fairchild began in 1957, when the 92d Air Refueling Squadron activated and began flying the KB-29. The KB-29 was a tanker modified from WW II-era B-29 bombers. The KB-29 was assigned to the 92d Bombardment Wing for only one year, as the new all-jet KC-135A Stratotanker began arriving at Fairchild in February 1958. The Air Force delivered the first KC-135 to Castle Air Force Base, California, in 1957, and the first squadron to receive it was the 93d Air Refueling Squadron, a unit now stationed at Fairchild. With the arrival of the all-jet B-52 bomber, and then the all-jet tanker, Strategic Air Command (SAC) had a formidable air refueling/bomber team to serve as a potent deterrent to nuclear attack during the Cold War.

After the arrival of the KC-135 to the Spokane area, it didn't take long for a Fairchild tanker to put its stamp on aviation history. On 17 September 1958, Captain Charles E. Gibbs commanded a KC-135 crew on a world-record-setting flight. The 92d Air Refueling Squadron crew achieved four world records: distance in a closed circuit without refueling, speed for 2,000 kilometers, speed for closed circuit with various payloads, and speed for 5,000 kilometers with various payloads.

In 1966, the air refueling capability at Fairchild doubled after the arrival of the 43d Air Refueling Squadron. The 43d came from Larson Air Force Base, Washington, and had already established its own mark on air refueling history. The 43d was the Air Force's first air refueling unit, activated on 12 July 1948. As its emblem indicated, the squadron was the "First Refuelers Global," having participated in the circumnavigation flight of the Lucky Lady II in February 1949--refueling the first aircraft to fly non-stop around the world. Over the years, the collective name of the 92d and 43d Air Refueling Squadrons at Fairchild became the "Fightin' 135th," since adding the numbers of the two units together totaled 135--also the number of the aircraft they flew.

The strategic deterrence mission at Fairchild was interrupted in the 1960s by the war in Southeast Asia. The 92d Bombardment Wing's first tanker deployed to the Philippines in 1964, following the Gulf of Tonkin incident. Later, additional tanker crews deployed to the Pacific to support Operations Young Tiger and Arc Light. Young Tiger involved the refueling of tactical fighters, while Arc Light supported B-52 bombing missions. Throughout the Vietnam Conflict, wing tanker crews were credited with 30 "saves," meaning their air refuelings prevented receiver pilots from either ejecting or having to crash land.

After the Vietnam Conflict ended in 1973, the KC-135s at Fairchild transitioned back to their primary role of providing strategic deterrence through 24/7 ground alert

with their B-52 counterparts. SAC had a “hard crew” policy, meaning the assigned aircraft commander, copilot, navigator, and boom operator always flew together, took leave together, deployed together, and pulled alert together. SAC ground-alert operations normally consisted of one week on alert, followed by three and one-half days of Combat Crew Rest and Recovery--CCR, or “C-squared” as it was known. The three and one-half days was calculated as a half day off for each day on alert. Since alert-crew changeover was normally on Thursday mornings, crews often felt cheated because part of their C-squared fell on the weekend. Crews then had two weeks--actually only 10 working days after C-squared--to accomplish flight training and ground training before the next alert tour began. There were also times when crews had to pull the dreaded back-to-back tour, meaning one week on, one week off, and then back on for another week tour.

As one former tanker crewmember recalled, “Looking back at SAC alert, and knowing what we know now, it was not a bad way of life. It certainly had predictability and stability, two things we strive for with today’s AEF [Air and Space Expeditionary Force] construct.” While on alert, crewmembers could accomplish a good deal of their ground training, including flight simulators, and also work on their professional military education, as well as advanced civilian degrees. In addition, crews could visit with family members, either at the alert visitation center or at several facilities located close enough to allow sufficient response time. For Fairchild, some of those facilities included the Base Exchange, the theater, the gym, and the recreation center. It was always a sad time for crews when they were in “restrictive alert,” usually because the road conditions did not permit excursions from the alert facility.

Alert duty was also a time for fitness. Racquetball and basketball were popular alert activities at Fairchild, and crews often headed out to the gym late at night to participate. Late-night fitness was usually a safe bet, because SAC didn’t normally initiate alert exercises in the middle of the night. Everyone feared getting caught in the shower at the gym when the klaxon--the loud, unmistakable siren--sounded, requiring an immediate report to the aircraft. Other popular activities while on alert included playing cards and board games, and, of course, watching TV. Playing poker for money was taboo while on alert, but alert crewmembers would often hear announcements at night for meetings of the “Fairchild Tea and Social Club.” Soon after the “club” meeting convened, poker games would mysteriously materialize in the chow hall.

At Fairchild, as at most SAC bases, bomber and tanker crews lived together. The different crews were unofficially known as the A Team and the B team, respectively. On a more informal level, the tanker crewmembers were known as “TOADs” to the bomber guys, and tanker folks simply called their bomber brethren “Pukes.” The common understanding was that TOAD stood for “Take Off And Die,” a reference to the tanker requirement to give all of its available fuel to the B-52s if they needed it to complete their mission. TOAD could also have referred to the KC-135A’s serious lack of performance. The A model--also known as “steam jet” or “water wagon”--was grossly underpowered during high-temperature, heavy-gross-weight takeoffs.

The KC-135A used water injection to increase its thrust during heavyweight takeoffs. Above 20 degrees Fahrenheit, demineralized water was injected into the air inlet and diffuser section of each engine, increasing the density of inlet and combustion air, which resulted in an added thrust of about 2,000 pounds for each engine. Water injection not only produced incredible noise heard for miles around, it also produced a cloud of black smoke that looked like a small thunderstorm on the runway. Everybody on base and in the local community knew when a KC-135A was taking off.

Besides pulling SAC ground alert, throughout the 1970s and 1980s, Fairchild's tankers had a regular commitment to support Tanker Task Force (TTF) operations around the world. TTFs were located in the Pacific (Andersen Air Force Base, Guam), Alaska (Eielson Air Force Base), and Europe (Royal Air Force Mildenhall and Royal Air Force Fairford, England). These deployments were a treat for tanker crews, as they were able to get a break from alert and spend 30 to 45 days at some "exotic" location. The missions often involved the refueling of reconnaissance and fighter aircraft from bases where a permanent air refueling capability was not available. It was always a special time for crewmembers when the squadron leadership released the new TTF schedule. Just about everyone wanted Pacific first, Europe second, and Alaska hardly at all. Crewmembers seeing an Alaska TTF on their schedule often hoped for a crew change before the deployment, so they could join a crew with a better destination.

The decade of the 1990s opened with Fairchild tankers deploying to support Operation Desert Shield and, later, Operation Desert Storm during the first Gulf War. At about the same time--August 1990--the wing received its first KC-135 R-model. The R-model modification solved the performance problem with the KC-135A, as the tanker received new, more-powerful engines that were also much quieter and cleaner. The modification also included a number of other sub-system upgrades, including new auxiliary power units. Today's KC-135 includes a glass cockpit and other major avionics upgrades that allow it to remain viable in today's aerospace environment.

As the Cold War ended in the early 1990s, Fairchild took on a much different look. SAC inactivated, and the B-52s came under the new Air Combat Command. Although KC-135s remained at Fairchild, they became part of the 453d Operations Group, an Air Mobility Command (AMC) geographically separated unit. This organizational structure, however, only lasted a few years at Fairchild. In 1994, the B-52s departed, and on 1 July, the 92d Bombardment Wing redesignated as the 92d Air Refueling Wing, assigned to AMC. For the first time in their history at Fairchild, tanker crewmembers became the "A team." The number of air refueling squadrons in the 92d Air Refueling Wing would expand to five, making it the largest tanker wing in the Air Force at the time.

Since 1994, the 92d Air Refueling Wing has been involved in virtually every major contingency operation around the world. Throughout the 1990s, the wing's tankers regularly deployed to support Operations Northern and Southern Watch, the

missions to keep Iraq's Saddam Hussein in check. In 1999, wing personnel deployed to various locations worldwide to support Operation Allied Force, the mission to stop Serb aggression in Bosnia. Following the terrorist attacks on our nation in 2001, the 92d began Combat Air Patrol support operations and placed aircraft and aircrews on alert for homeland defense--Operation Noble Eagle. Deployments began shortly afterwards for Operation Enduring Freedom (OEF), and they continue today not only for OEF but also for Operation Iraqi Freedom.

Recently, the air refueling mission at Fairchild began a new and significant chapter in its history. On 1 October 2007, the 92d Air Refueling Wing and the 141st Air Refueling Wing (Washington Air National Guard) entered into a classic association arrangement, the first of its kind for active-duty/Air National Guard KC-135 wings. The classic association means the two wings share the same aircraft as a cost-saving measure. The 141st had established its own outstanding reputation in air refueling expertise, ever since it began flying the KC-135E-model at Fairchild in 1976. Due to Base Realignment and Closure directives, the 141st Air Refueling Wing KC-135s moved to another Air National Guard unit, resulting in the classic association on base. Over the years, Fairchild Air Force Base's tanker crews have prided themselves on always being there when needed--always enabling their receivers' missions to complete successfully through professional air refueling operations. With Fairchild now past the half-century mark of air refueling experience, the future looks bright as the 92d Air Refueling Wing and the 141st Air Refueling Wing team up to continue the base's legacy of air refueling excellence.



A 92d Bombardment Wing KC-135A provides the signature black smoke of a "wet" takeoff.



The 92d Air Refueling Wing's flagship tanker--tail number 58-0092--sets on the ramp near the large hangar complex at Fairchild Air Force Base, Washington.



On 1 October 2007, Colonel Thomas J. Sharpy, 92d Air Refueling Wing Commander, (left) and Colonel Gregory Bulkley, 141st Air Refueling Wing Commander, unveiled the new aircraft markings during a ceremony commemorating the classic active-duty/Air National Guard association between the two wings.



While deployed to the US Central Command theater in support of Operation Enduring Freedom, a B-1B Lancer takes fuel from a 92d Air Refueling Wing tanker.

Air Refuelers in the Vietnam Conflict

Air refueling played an important role throughout the air war over Southeast Asia. With distances of 7,100 nautical miles from Travis Air Force Base, California, to Andersen Air Force Base, Guam, and another 2,251 nautical miles to Saigon, South Vietnam, all tactical aircraft sent from the United States to Southeast Asia required air refueling. Even the B-52 Stratofortress received a precautionary refueling on its way to Guam. The destruction of five B-57 Canberra bombers in November 1964 taught Airmen the hard lesson of basing large, vulnerable aircraft in Vietnam. Therefore, during the course of the conflict, Strategic Air Command (SAC) based its tankers in Guam, Okinawa, the Philippines, Thailand, and Taiwan.

In early 1964, SAC deployed its first four KC-135A Stratotankers to Clark Air Base, the Philippines. Dubbed "Yankee Team Task Force," this group of tankers was intended to serve on a temporary mission. On 9 June 1964, Yankee Team performed its first combat air refueling of the war, servicing eight F-100D Super Sabres on a mission to strike Pathet Lao antiaircraft emplacements in northern Laos. Although SAC withdrew the task force by 22 June, the Joint Chiefs of Staff reestablished the Yankee Team at Clark on 5 August, following the Gulf of Tonkin Incident. By late September, the KC-135 force, renamed "Foreign Legion," began regularly supporting fighters engaged in combat. With air refueling contributing direct support to combat aircraft, Vietnam was the "first tanker war."

As the conflict continued to escalate, so, too, did the number of tankers assigned to the theater. Due to the number of aircraft, basing locations also continued to grow. SAC established a new wing at Kadena Air Base, Okinawa, in January 1965, with a new nickname, "Young Tiger." This new moniker soon came to represent all air refuelers in the theater for the next eight years.

On 12 February 1965, 38 KC-135s supported the deployment of 30 B-52s to Andersen Air Force Base, Guam, in preparation for bombing operations over Southeast Asia. Arc Light missions focused B-52 bombing missions against Viet Cong jungle strongholds. Tankers from Kadena made it possible for the heavily loaded bombers to complete the roughly 2,000-mile round-trip. Arc Light commenced on 18 June 1965 when 30 KC-135s refueled 27 B-52s on their way to Viet Cong targets.

In addition to combat air refuelings, tanker crews began to receive credit for saving tactical aircraft. One of the earliest incidents occurred on 22 November 1965, when an F-105, after releasing its ordnance, began to experience a rapid loss of fuel. A Kadena KC-135, commanded by Captain Ross C. Evers, rushed over North Vietnamese territory to provide fuel. Perhaps the best known "save" occurred on 31 May 1967. Major John H. Casteel's crew was engaged in a routine refueling of two Air Force F-104Cs over the Gulf of Tonkin when US Navy aircraft dangerously short of fuel arrived. This KC-135, equipped with a boom-drogue adapter to support the

F-104s, refueled two Navy KA-3 tankers, two Navy F-8s, two Navy F-4s, as well as its assigned F-104s. In order to save the aircraft, a brief tri-level refueling occurred with the KC-135 feeding a KA-3 while the KA-3 passed fuel to an F-8. Without the KC-135's help, the Navy aircraft would probably not have reached their carrier. This KC-135 crew earned the MacKay Trophy for the most extraordinary aerial flight of 1967--the first time the award went to a tanker crew.

There were two important events in Southeast Asia in early 1968. First, a Korean crisis arose after North Korea seized an intelligence vessel, the USS *Pueblo*, on 23 January. Second, North Vietnam and Viet Cong forces launched a series of attacks, known as the Tet Offensive, throughout South Vietnam on 30 January. In response to the *Pueblo* crisis, SAC deployed additional KC-135s and B-52s to the region under Operation Port Bow. KC-135s also supported the deployment of tactical aircraft to the Far East, called Operation Combat Fox. Under Operation Commando Royal, KC-135s supported tactical aircraft patrols of the Korean Demilitarized Zone with an average of five refueling sorties per day.

With the Tet Offensive ongoing, and, in particular, the Siege of Khe Sanh underway in South Vietnam, the Joint Chiefs of Staff authorized the Operation Port Bow tankers and bombers to support Arc Light missions. To support Operation Niagara, relief operations for Khe Sanh, authorized tanker sorties increased from an average of 53 per day to 66 in February. The increased tanker and bomber missions helped to break the siege, and this tanker rate remained authorized afterwards. However, on 1 April 1968, before the daily rate could achieve that authorized level, President Lyndon B. Johnson ordered a halt to all bombing north of 19 degrees. On 1 November 1968, he further stopped all bombing of North Vietnam and the demilitarized zone.

Although combat operations over North Vietnam were suspended after November, tankers, although nowhere near the numbers of 1968, continued to support operations in South Vietnam and Cambodia during the "Vietnamization" of the conflict. By the end of 1971, South Vietnamese ground forces had largely taken over the ground war, but aircraft of the US Air Force and US Navy continued to provide tactical support. When intelligence reported a likely increase in hostilities in early 1972, the United States sent more aircraft to Southeast Asia. SAC's KC-135s supported the deployment of additional bombers under Operations Bullet Shot I and II and tactical aircraft under Operations Constant Guard I, II, and III. As the expected North Vietnamese spring invasion began, SAC also reintroduced large numbers of KC-135s to Thailand and the Philippines to support Operation Linebacker from May to October 1972.

As the offensive faltered, intense negotiations ensued for a permanent ceasefire. In an attempt to show good faith in the negotiations, President Richard M. Nixon again restricted operations over North Vietnam. When negotiations stalemated, Nixon authorized Operation Linebacker II as an intense series of coordinated strikes of B-52 and tactical aircraft against strategic military targets in North Vietnam, primarily against the previously off-limits Hanoi-Haiphong area. Throughout this 11-day offensive (18 to 29 December 1972), KC-135s enabled the operation of a variety of bombing, strike, fighter, and electronic warfare aircraft. Although a ceasefire

agreement was signed within a month after Linebacker II, KC-135s continued to support combat operations in Southeast Asia for another seven months.

The last combat air strike over Cambodia on 15 August 1973 marked the end of the air war in Southeast Asia. KC-135 combat operations lasted 110 months, with the tankers flying 194,687 sorties, transferring approximately 1.4 billion gallons of fuel during 813,878 air refuelings. SAC lost only four KC-135s in Southeast Asia, two during take-offs and two during landings. In addition to enabling a wide range of operational possibilities in warfare, the efforts of the tanker crews saved an untold number of their fellow Airmen's lives, as well as a large number of aircraft.



One of a formation of F-5A Freedom Fighters, armed with 500-pound bombs, refuels from a KC-135 tanker somewhere over Vietnam in February 1966.



A KC-135A boomer's eye view of a "plugged-in" B-52D carrying MK82s destined for an Arc Light mission in Vietnam in 1966.

Air Refueling and Airlift

Since the early air transport aircraft depended heavily on equipment developed for commercial uses, the airlift force was not equipped for air refueling. Even the development of the C-130 Hercules did not bring air refueling to the airlift force, since planners did not see the C-130 as an intercontinental carrier. Contracts for the C-141 Starlifter and C-5 Galaxy called for aircraft that could fly 4,000 nautical miles. This distance would allow these intercontinental carriers to fly from McGuire Air Force Base, New Jersey, to Rhein Main Air Base, Germany, a distance of 3,390 nautical miles, while still allowing for strong headwinds or minor rerouting for weather. Planners also realized that payloads could be increased with refueling stops in Newfoundland or the Azores.

The C-141A was, therefore, constructed without an air refueling capability. While the C-5A had an air refueling receptacle, the Military Airlift Command (MAC) did not train many aircrews to refuel for three reasons. First, the large mass of the C-5 tended to create a bow wave of air that pushed the KC-135 Stratotanker away. Second, a defect in the C-5's original wing construction limited the aircraft's lifespan. Planners were concerned that the additional stress placed on the C-5 by the abnormal angles required to air refuel would shorten the lifespan even further. Additionally, budget constraints meant only a few C-5 aircrews could be trained for a dangerous maneuver that was seen as having, at best, a limited application. Military planners soon witnessed the shortsightedness of this.

On 6 October 1973, Egypt and Syria simultaneously attacked Israel, in violation of the tenuous 1967 Arab-Israeli War ceasefire agreement. Israel lacked adequate air transport for large quantities of cargo, especially oversized cargo such as helicopters and tanks. The crisis further intensified when the Soviet Union began a resupply airlift to Egypt and Syria on 10 October. In response, President Richard M. Nixon directed an American military sealift and airlift to resupply Israel--Operation Nickel Grass.

Beginning on 14 October with a C-5 carrying 186,000 pounds of cargo, MAC's C-141s and C-5s flew steadily from various locations in the United States to Lod International Airport in Tel Aviv for the next 32 days. The average distance of these stateside locations to Lod was 6,450 nautical miles. Given the diplomatic sensitivities resulting from the overriding dependence on Arab oil, all European nations, except Portugal, denied landing and overflight rights to MAC's aircraft. Portugal allowed MAC to use the facilities at Lajes Air Base in the Azores. From the first mission on 14 October until the last on 14 November 1973, MAC's C-5s flew 145 missions, and the C-141s flew 421 missions, transporting 22,318 short tons of cargo.

The 1973 Arab-Israeli War demonstrated that America's strategic airlift forces needed an air refueling capability. Without Lajes, only the C-5 could have made the

flight from McGuire Air Force Base to Tel Aviv with any useful payload--which would have been greatly reduced to about 33 tons, as compared to the 73-ton loads possible with Lajes. Plus, the lack of training for C-5 aircrews would have meant little to no air refueling. Using the lessons of Operation Nickel Grass, General Paul K. Carlton, Commander of MAC, pointed out that if air refueling had been available, MAC would have accomplished the same results with 57 fewer C-141 missions and 44 fewer C-5 missions, and saved about 48.5 million pounds of fuel (about 25 percent). These arguments persuaded policymakers and Pentagon planners to reverse the trend of not air refueling transport aircraft.

As General Carlton later explained, "One of the things that people don't understand is that air refueling also economizes on fuel use. It is real hard to make people understand that you bring a second airplane up and refuel and you can actually do it with less gallons of fuel than if you just ran the one airplane through ground stops, but it is a fact. It utilizes the airplane better. So we were able to, largely with the help of the Israeli airlift, convince many audiences that we have got to get with refueling."

On 30 August 1974, Strategic Air Command (SAC) began an air refueling training and qualification program for MAC C-5 aircrews. The accelerated program lasted until 19 December, allowing time for 257 C-5 training missions. This program qualified an initial cadre of 72 C-5 aircrews. Additionally, Lockheed corrected the C-5 wings and upgraded the aircraft. From 1986 to 1989, Lockheed delivered 50 C-5Bs capable of carrying a 145-ton load 2,950 nautical miles without air refueling. With tanker support, the C-5B had a virtually limitless operating range.

MAC planners also relooked at the C-141s. The contract to upgrade the C-141 included adding 23 feet to increase its cargo capacity and air refueling receptacles to increase its operating range. Between 1976 and 1981, all of the Air Force's C-141As were modified and redesignated as the B-model. Training and operational use of the C-141B's refueling capability ensued immediately. On 21 June 1982, tanker operations set two new records, which cemented the combination of airlift and air refueling as a worldwide force. While establishing the mark for the southernmost air refueling, just 750 miles north of the South Pole, the KC-10A Extender transferred a record 67,400 pounds of aviation fuel to the C-141B conducting airdrop operations to resupply Antarctica's South Pole station.

With these lessons in mind, planners also insisted that any new intercontinental airlift aircraft include an air refueling capability. Boeing designs for the C-17 Globemaster III, therefore, included the plumbing necessary for air refueling. With a payload of 169,000 pounds and a cruise altitude of 28,000 feet, the C-17 has an unrefueled range of about 2,400 nautical miles. However, air refueling provides the C-17 with a global range.

Planners also applied these same lessons when replacing the two VC-137C, Air Force One, aircraft. In addition to the age and expense to maintain, the original justification for the replacements included the fact the VC-137Cs lacked sufficient range to reach many major world capitals with ease. When the Boeing Corporation

delivered the replacements in 1990, the VC-25As (modified 747s) included receptacles to give the aircraft an air refueling capability.

The lessons of Operation Nickel Grass highlighted the benefits air refueling presents to the airlift mission, most notably a more rapid worldwide response, heavier cargoes, and reduced requirements for overseas base support. Under the Air Force's reorganization in 1992, the creation of Air Mobility Command brought airlift and air refueling even closer together. Combining the air refueling capability with the airlift capability under one command strengthened a bond necessary for the US Air Force to have a truly global reach. The events of the early twenty-first century, more than ever, prove this need for a robust air refueling capability.

Unloading a helicopter from a C-5 at Lod Airport, Israel, during Operation Nickel Grass in October 1973. Operation Nickel Grass highlighted the need for air refueling support of airlift missions.





A high-angle front view of a C-5A approaching a KC-135 tanker for refueling, as seen from the boom operator's position during a non-stop mission to Clark Air Base, Republic of the Philippines, on 30 August 1974.



The rollout of the YC-141B, with the capability of inflight refueling, on 8 January 1977.

Air Refueling and Special Operations

Within the Air Mobility Command community, when air refueling is discussed in modern times, the majority think of the KC-135 and KC-10 tankers. However, another facet of refueling involves the less-familiar C-130 tankers and the special operations helicopters and tilt-rotor aircraft they support.

The Sikorsky R-4, first flown in January 1942 and the first operational helicopter of the US military, was a fascinating piece of machinery, but only had an operating radius of 60 miles. Nonetheless, military aviators viewed the helicopter as an instrument to rescue individuals from predicaments in difficult-to-reach areas.

As the Air Force matured, planners determined the helicopter would be better utilized if its range could be extended. In 1964, the Air Rescue Service submitted a requirement for air refueling of helicopters. At first, engineers assumed helicopter air refueling would be extremely dangerous due to the helicopter's whirling and delicate blades and the downwash from the refueling tanker. Their initial recommendations had the helicopter trailing a drogue that a tanker would plug into and pump its fuel to the helicopter. A few others, however, thought differently.

Since the Air Force lacked probe-and-drogue tankers, an appeal was made to the Marines for use of one of their Lockheed KC-130 tankers. The Marines used these aircraft to refuel their A-4 Skyhawk jet fighters. On 17 December 1965--the 62d anniversary of the Wright brothers' first powered flights at Kitty Hawk--a US Air Force CH-3 helicopter flew behind a KC-130 as the KC-130 reeled out a drogue. The CH-3 plugged in, proving the concept of helicopter inflight refueling. The date of 17 December now would also mark the Kitty Hawk of helicopter air refueling (HAR). That moment changed the general scope of helicopter operations forever.

Initially, HAR assisted the Air Rescue Service in plucking downed Airmen from the jungles of Vietnam. The refueling extended the rescue helicopter's range and endurance necessary for successful operations. However, others envisioned the use of helicopters in covert operations.

In mid-May 1970, intelligence indicated US prisoners of war (POW) had been located in a camp on the outskirts of the city of Son Tay, 23 miles northwest of Hanoi, North Vietnam. The intelligence included reconnaissance photographs from SR-71 Blackbirds and Buffalo Hunter drones showing US POWs had hung their laundry out to dry in a pattern suggesting search and rescue. This intelligence led to Operation Kingpin, the raid into North Vietnam on 20 November 1970 to rescue the American POWs.

The combination of aircraft used for Operation Kingpin included A-1E strike aircraft, HH-3 and HH-53 helicopters, and C-130E cargo aircraft. Also included in this mix were two US Air Force HC-130P tankers. The plan called for the C-130Es to perform pathfinder duties and lead the flight of helicopters to the target location.

However, before the aircraft could reach their final target, the HC-130Ps refueled the helicopters over Laos, prior to their entering North Vietnamese airspace. Although a small part of the operation, without air refueling, this rescue mission would have never happened. Despite intense planning and preparation, the operation failed in the sense that the POW camp was empty. Later intelligence revealed the POWs had been moved approximately four months prior to the raid.

Using C-130 aircraft for HAR proved useful throughout the Vietnam Conflict. However, 10 years after the Son Tay raid, planners opted for ground refueling during the Iranian hostage rescue attempt, in order to minimize the rescue force footprint. Conversely, this mode of refueling proved fatal. After the decision was made to abort the mission due to mechanical issues and morning twilight approaching, the helicopters began ground refueling for the flight out of Iran. During this time, a Navy helicopter collided with an Air Force C-130, killing five Air Force crewmembers and three Marines. One can only speculate if the rescue attempt may have been a success had HAR been the means of refueling. Since then, US Air Force and Army special operations missions have depended greatly on air refueling as part of mission planning.

Operations Enduring Freedom and Iraqi Freedom have been special operations-centric vice conventional air operations. As such, US special operation missions rely heavily on helicopter support. To ensure these aircraft successfully complete the mission, MC-130E Combat Talon (prior to their retirement), MC-130H Combat Talon II, and MC-130P Combat Shadow aircrews provide the tanker support. Although their missions are not as glamorous as their gunship counterparts, they do play a very important role in a mission's success.

The future of Air Force Special Operations Command helicopter and tilt-rotor refueling operations is the MC-130H Air Refueling System. The MC-130H Combat Talon II has been equipped with a state-of-the-art, digital, refueling pod that has a variable-speed drag drogue. This variable-speed drogue not only permits refueling of slower-moving US Army helicopters, but also the newly fielded high-speed CV-22 Osprey tilt-rotor. With this system, special operations inflight refueling has been taken to the next level.



A CH-3, with a dummy probe, conducts an air refueling concept test with a KC-130 tanker.



A US Air Force HH-60 helicopter refuels from a HC-130 aircraft during search and rescue operations in Galveston, Texas, on 13 September 2008, as part of Hurricane Ike humanitarian assistance operations led by the Federal Emergency Management Agency. (US Air Force photo by SSgt James L. Harper, Jr.)



Major Robert Lewis mans the navigation console aboard an MC-130 aircraft during Exercise Solid Shield '87. (US Air Force photo by SSgt Joseph Fallon)

Operation El Dorado Canyon

Numerous terrorist-related incidents led to the retaliatory strikes against Libya by United States Air Forces in Europe (USAFE) and the United States Navy (USN) on 14 and 15 April 1986. This complex joint operation pulled in US Air Force aircraft from Royal Air Force (RAF) bases in England as well as aircraft based in the United States and those aboard the USN carriers in the Mediterranean.

In January 1986, President Ronald W. Reagan proclaimed economic sanctions against Libya by invoking the International Emergency Economic Powers Act. By March, the United States Sixth Fleet had sent two Navy carriers, the USS *Coral Sea* and the USS *America*, to the Mediterranean.

The arrival of the carriers did not put an end to terrorist attacks, as just a couple of weeks later, on 2 April 1986, a bomb detonated on board Trans World Airways (TWA) Flight 840 en route from Rome, Italy, to Athens, Greece. There were approximately 115 people on the TWA flight that day. The explosion occurred in midair over Argos, Greece, and created a hole in the fuselage, which caused suction to pull from the aircraft four US civilians, including a baby, to their deaths. While five others were injured, the remaining passengers survived the blast, and the aircraft was able to land safely at the Hellinikon International Airport in Athens.

That act of violence was followed just a few days later by another bombing, this one at the “La Belle” discotheque in West Berlin, a club known to be frequented by United States military men and women. On the evening of 5 April, the explosion destroyed the disco--more than 200 people were injured, and a service member and a civilian were killed.

Just five days later, on 10 April, President Reagan ordered retaliation when intelligence sources intercepted message traffic that placed responsibility for these terrorist activities on Colonel Muammar Qadhafi, president of Libya, and supporters loyal to his cause. Thus began Operation El Dorado Canyon, which culminated in the bombing of multiple suspected terrorist targets in Tripoli and Benghazi, Libya. At the outset, Admiral William J. Crowe, Jr., the Chairman of the Joint Chiefs of Staff, advised the President this operation should be conducted jointly with the US Air Force and the US Navy. Several possible plans had been put together, and when the time came for implementation, the decision was made to have Air Force fighters hit targets in Tripoli and Navy fighters hit targets in Benghazi simultaneously.

Strategic Air Command KC-10 Extenders were flown from the United States and were joined by KC-135 Stratotankers to support this operation. Most of the tankers came from over a dozen stateside wings as well as from bases in Europe. The tankers, USAFE F-111s, and US Navy A-6 Intruders and A-7 Corsairs teamed up to become primary players participating in this joint effort that spanned two continents, with the Navy operating from the Mediterranean and the Air Force from the United Kingdom.

From the beginning, this operation faced major obstacles. The political climate at that time was one of trepidation among the European nations, particularly concerned that retaliation would lead to an increased level of terrorism. Therefore, the US was denied overflight rights by France and Spain, forcing the aircraft to fly around the Iberian Peninsula and through the Strait of Gibraltar to get to their targets. This detour added approximately 1,300 nautical miles to the trip each way, making the round trip over 5,000 nautical miles and adding 6 to 7 hours of flying time.

Approximately 28 tankers departed from RAF Mildenhall and RAF Fairford at 1713 Greenwich Mean Time (GMT) on 14 April and arrived at their fighter drop-off location at midnight GMT to begin the attacks. Twenty-four F-111s left the British base at Lakenheath, while five EF-111s, along with five tankers, came from RAF Fairford a short time later. After departing England, the tankers refueled the F-111 strike force four times under complete radio silence on the way to the targets, with the first of those refuelings taking place near Land's End, England. That was not as easy a task as it might sound when you consider that at that time the KC-10 was a rare sight in Europe, as they were quite new to the inventory, and there were none stationed in Europe. This meant that few of the F-111 pilots had ever taken fuel from a KC-10, and one pilot had never even seen that aircraft prior to this operation. Now, here they were, not only taking fuel from them, but doing so at night and in complete radio silence!

Land's End was also about the point where the KC-135s began their refueling of the KC-10s. The focus of the KC-135s was to keep the KC-10s fueled so the KC-10s would then have the range necessary to enable the attack aircraft to make it to their destination, deliver weapons on target, and return safely to England. This operation was planned using the strengths of each type of aircraft, taking into consideration that the KC-135s, by refueling the KC-10s, were providing the extended range the KC-10s would need in order to conduct their part of this complex mission effectively and also realizing that the KC-135s were not capable of being air refueled. The KC-135 could deliver 127,700 pounds of fuel, while the KC-10 could only deliver 98,500. However, the KC-10 had a range of 3,000 nautical miles, compared to the 1,500 nautical miles of the KC-135. This demanded a team approach, optimizing the extra fuel capacity of the KC-135s to keep KC-10 fuel tanks full. When the Stratotanker crewmembers reached the Strait of Gibraltar, having accomplished their segment of the mission as planned, they returned to England, feeling confident that the KC-10s were now able to get the F-111s safely to their targets and back.

The Navy and Air Force fighter aircraft reached Benghazi and Tripoli and began the bombings. The elapsed time of the attack totaled less than 12 minutes, but it sent a strong message. With Air Force and Navy forces working together, operating over 100 aircraft, the mission was a resounding success, and for a time after this operation, Libyan-sponsored terrorism declined.

The mission's long duration was tough on the F-111 and KC-10 crews. Having to add all those miles by going around the Strait of Gibraltar made what would have been a seven-hour-long mission almost twice that. There were two casualties when

what was most likely a Libyan surface-to-air missile shot down an F-111 and its two-man crew over the Gulf of Sidra.

Once again, tankers proved their worth by adding the global reach that was invaluable in this operation and in those soon to follow in the Middle East.



An F-111 aircraft is refueled by a 912th Air Refueling Squadron KC-135R Stratotanker during a refueling mission over the North Sea. (US Air Force photo by MSgt Patrick Nugent)



Right-side view of a KC-10A Extender aircraft (tail section) refueling an F-111 aircraft in flight.

Extraordinary Air Refueling Effort: The Persian Gulf War

While Vietnam could be called the “first tanker war” because of the volume of air refueling missions providing direct support to combat aircraft, the Persian Gulf War confirmed that airpower was critically dependent on air refueling. The deployment and containment phase, Operation Desert Shield, lasted from 7 August 1990 until 16 January 1991. Operation Desert Storm, 17 January to 28 February 1991, included one of the most intensive air refueling operations of all time.

After Saddam Hussein’s Iraqi forces invaded Kuwait on 2 August 1990 and concerns arose that they might continue into Saudi Arabia, the US and its allies initiated Operation Desert Shield. The 1st Fighter Wing deployed the first tactical aircraft, 24 F-15s, of hundreds to help defend Saudi Arabia and pressure Iraq to withdraw from Kuwait. To speed their deployment, 7 to 8 August, these initial F-15s received 12 air refuelings on their 6,000-nautical-mile journey from Langley Air Force Base, Virginia, to Dhahran Air Base, Saudi Arabia. As the buildup of forces continued, Strategic Air Command (SAC) also deployed an increasing number of tankers along the route at such places as New England, the Azores, Egypt, and Guam. Desert Shield’s air refueling bridge required nearly 100 tankers operating from 9 countries to move more than 1,000 bomber and fighter aircraft to the Persian Gulf theater. As well as supporting deploying aircraft, many air refueling missions supported tactical aircraft monitoring the Iraqi border and flying combat rehearsals. Altogether, during Desert Shield, US Air Force tankers flew 4,967 sorties, offloading 28.2 million gallons of fuel.

In addition to air refueling, SAC’s KC-135s and KC-10s contributed critical support with their organic airlift capability. Tankers transported 74 percent of SAC’s passengers and 56 percent of the command’s own cargo. From mid-August 1990 until Desert Storm began, SAC released an average of seven KC-10s to operate in a dedicated cargo-transport role. In this strategic airlift role, the KC-10s flew 379 missions, transporting 1,111 passengers and 19,905 short tons of cargo. The air refueling demand of fighters and other tactical aircraft, combined with the lesser cargo capacity, kept the KC-135 fleet unavailable for such a dedicated strategic airlift mission--KC-135s, however, still supported airlift missions when they could.

In theater, the first 10 KC-135Rs arrived at Seeb, Oman, on 26 August. By the time the conflict started on 17 January 1991, SAC had 262 KC-135s and 46 KC-10s operating from 21 locations in 10 countries. At the peak of Operation Desert Storm, 81 percent of the US Air Force’s KC-10 fleet and 44 percent of its KC-135s were committed. In addition to those of the US Air Force, air refueling aircraft of the US Navy, US Marines, and coalition partners (including Great Britain, Canada, France, and Saudi Arabia) conducted tanker operations during the war. It is also important to note that the US Air Force activated some 5,200 Air National Guard and Air Force

Reserve men and women to support tanker operations. This confirmed the critical wartime role of these air refueling forces.

Once the war began, the daily Air Tasking Orders (ATOs) identified 160 unique air refueling tracks; however, only 19 of those accounted for approximately 80 percent of all tanker sorties. While these tracks were placed along the routes taken by combat aircraft from their bases to Iraq and Kuwait, insufficient airspace to support all of the allies' air refueling requirements became the most limiting factor. Limited airspace was a problem not just over Saudi Arabia, but also in the refueling areas along the Turkish/Iraqi border and over the Mediterranean Sea. During the most intense periods of flying activity, airspace congestion also prevented using additional tankers.

Still, the ATOs scheduled an average of 300 air refueling sorties per day. Generally, planned offloads only accounted for about half of the KC-135R's and KC-10's potential available fuel. Planners scheduled less than half of the available fuel from the KC-135A/Q and KC-135E because of their smaller fuel load and operating efficiency. This offload allowed tanker sorties to fly longer or at lower altitudes. The contingency planning also facilitated emergency offloads and solved problems as they emerged. During the 43 days of Operation Desert Storm, US and coalition tankers flew 15,434 sorties, offloading 110.2 million gallons of fuel. As a US Air Force fact sheet of the time put it, "more than enough fuel was offloaded to fill the gas tank of every private and commercial and publicly owned automobile in Texas and Oklahoma."

The concept of the air bridge, developed fully during Operations Desert Shield and Desert Storm, proved invaluable in the postwar expeditionary Air Force. Operation Restore Hope, the peacetime deployment of 25,000 US troops to Somalia to ensure the distribution of food from 9 December 1992 to 4 May 1993, demonstrated that air refueling could sustain airlift over long distances, but only if staging bases were closer to the main area of operations. While ensuring the timely delivery of personnel, supplies, and equipment to the far-flung corners of the world, tankers played a major role in the new era of contingency operations.

Tankers remained at the fore for every major air operation. During Operation Provide Comfort, 6 April to 24 July 1991, expeditionary KC-135s flew 905 sorties and delivered 4.5 million gallons of fuel to aircraft involved in the protection of Kurds in Northern Iraq. During Operation Deny Flight, the international response to the civil war in Bosnia-Herzegovina 12 April 1993 to 20 December 1995, the US Air Force deployed tankers to Italy and France. These KC-135s and KC-10s, along with allied tankers, flew set air refueling tracks, most over the Adriatic Sea, much like they had during Operation Desert Storm. Concurrently, air refueling made possible Operation Southern Watch, the enforcement of the no-fly zone over Iraq.

Such air refueling lessons, training, and capabilities continued to pay strong dividends through the end of the decade. On 3 September 1996, air refueling made possible Air Combat Command's B-52 participation in Operation Desert Strike, in response to Saddam Hussein's Iraqi Force threatening the Kurds of Northern Iraq.

Two B-52s from Barksdale Air Force Base, Louisiana, flew 13,683 nautical miles to fire 13 conventional air-launched cruise missiles against targets in Iraq. The 34-hour, non-stop, bombing mission required the support of 15 KC-135s and KC-10s, offloading nearly 1.4 million pounds of fuel. In another example, during Exercise Centrazbat, 14 to 15 September 1997, 9 KC-10s and 11 KC-135s refueled 8 C-17As, making it possible for them to set an airdrop distance record of 7,897 nautical miles from the United States to Kazakhstan. Again and again, in a variety of combat and humanitarian operations and exercises throughout the 1990s, tanker aircrews continued to demonstrate that air refueling enabled the Air Force's "Global Reach."



A KC-135E refuels US Navy F/A-18s during Operation Desert Shield.



A 22d Air Refueling Wing Welcome Home--First Lieutenant Steve Nichols, 6th Air Refueling Squadron, is welcomed home to March Air Force Base, California, by his wife in March 1991.

Air Refueling's Ongoing Role in the War on Terror

Following the terrorist attacks on the United States in 2001, KC-135 Stratotankers and KC-10 Extenders were among the first aircraft launched as part of the homeland defense mission under Operation Noble Eagle. The quick response by active-duty Air Force, Air Force Reserve Command, and Air National Guard crews enabled the initiation and sustainment of combat air patrols all over the United States, including those flown by the US Navy and US Marine Corps, and provided a massive, effective demonstration of the "total force" concept.

Operation Enduring Freedom--literally on the other side of the globe--provided more superlative examples of total force support to joint operations. Members of the 319th Air Refueling Wing, Grand Forks Air Force Base, North Dakota, jumped into the world of bare-base operations and deployed to the US Central Command area of responsibility on 23 September 2001. Despite the conditions at its operating location, the wing's deployed aircrews quickly flew 459 sorties and air refueled 1,617 receivers, including a Navy F-14 Tomcat experiencing an inflight emergency.

The rapid reactivation of the air bridge concept played a major role in this operation. Air Force KC-10As deployed to Guam in less than 30 hours to support B-52H Stratofortress and B-1B Lancer deployments, then refueled the bombers pre- and post-strike. Additional KC-10s and KC-135s deployed to locations such as Qatar, Japan, and Diego Garcia to support bombers, airlifters, reconnaissance, and other Services' aircraft. Tanker operations in the vicinity of Afghanistan included direct support of special operations aircraft during the first strikes on Taliban leadership and the refueling of aircraft involved in rescuing the aircrew of a downed MH-53J Pave Low III during the fall of Masar-e-Sharif.

One key point quickly stood out: the KC-10 Extenders, with their receiver capability, proved particularly valuable. Overall, by the end of major combat operations in Afghanistan, Air Force tankers provided over 1 billion pounds of fuel to over 42,000 receivers through 13,000 sorties and 96,000 flying hours.

Tankers were also part of the team at the initiation of Operation Iraqi Freedom. On the first mission, KC-135s refueled two F-117 Nighthawks and five support aircraft on the way to their targets and then the F-117s on their way back. Other tankers played a critical role in the 33-hour B-2A Spirit bombing missions from Whiteman Air Force Base, Missouri. The 319th Air Refueling Wing deployed 10 KC-135Rs fitted with the Multi-Point Refueling System, the wing-mounted hose and drogue pods. This system allowed the KC-135s to support all aircraft, including US Navy and coalition probe-equipped planes. As the threat subsided, the tankers moved into the combat area. At one point, a 22d Air Refueling Wing KC-135R flew over Tikrit, Iraq--one of the most heavily defended and dangerous cities in-theater--to support six aircraft involved in a search and rescue mission for a downed F-15E Strike Eagle crew.

The reestablishment of the air bridges--such as the primarily Maine and New Hampshire Air National Guard-manned Northeast Tanker Task Force--enabled Air Mobility Command (AMC) to support direct delivery to the theater. By the time the air bridge mission ended on 11 September 2003, the Northeast Tanker Task Force alone had flown over 1,700 sorties and offloaded more than 130 million pounds of fuel. In the end, Air Force tankers provided 68 percent of the overall inflight refueling capability during the combat phase of Operation Iraqi Freedom, flying 7,665 sorties and offloading over 476,000 pounds of fuel to 32,714 receivers.

On 18 June 2003, Brigadier General Paul J. Selva, Vice Commander of the AMC Tanker Airlift Control Center, summed up the operations this way:

There are some unsung heroes in this whole process. The Northeast Tanker Task Force, which was almost entirely Guardsmen and Reservists, flew almost every single day. The nominal number was 12 a day, refuelings for airlifters and other assets going across. Without that, they would have had to stop. In the case of the airlift community, this adds a four-hour block of time on the ground, waiting for gas, and getting moved. If you multiply that out over a couple of days, every three or four days, just by utilizing air refueling, you gain another day of operations. That velocity, again, in the system is one of the things that allowed us to be as successful as we were.

As in Operations Desert Shield/Desert Storm, the cargo and passenger capacity of the KC-135s and KC-10s also provided a critical support role to the airlift operations. In addition, on 21 March 2007, a KC-135 departed Bagram Air Base, Afghanistan, on the first non-stop medical evacuation flight of non-critical patients from Afghanistan to Ramstein Air Base, Germany. Previously, C-130s had flown non-critical patients without life-threatening injuries to a central airfield in the theater, where they typically waited a day or two for a medical evacuation flight to Ramstein on a retrograde C-17. Better security at this staging airfield and the availability of in-theater tankers by early 2007 enabled the 618th Tanker Airlift Control Center to schedule frequent KC-135 aeromedical evacuation missions and for routine patients to be moved from Afghanistan to Germany in just 10 hours. This new policy transformed a former aeromedical evacuation "spoke" activity performed by C-130s and C-17s into a "hub" system supported by KC-135s operating in an aeromedical evacuation role.

Still, air refueling remained the tanker's primary role. By the end of December 2008, AMC's tanker aircrews (active-duty, Air Force Reserve Command, and Air National Guard) had built an impressive record. Since Operation Noble Eagle's beginning, they had flown 11,154 sorties and offloaded over 420 million pounds of aviation fuel supporting the operation. Over the same period, tanker crews flew 37,140 sorties and offloaded nearly 1.5 billion pounds of aviation fuel in support of Operations Enduring Freedom and Iraqi Freedom, not counting those sorties flown in the theater of operations. Tankers under the operational control of the US Air Forces

Central, during this same period, flew another 91,382 sorties, offloading more than 5.7 billion pounds of fuel.

Despite such a continuously high operations tempo demanded by Operations Noble Eagle, Enduring Freedom, and Iraqi Freedom, the other missions of the tanker force did not slow down. These missions included joint exercises, humanitarian relief operations, Phoenix Banner presidential support, detainee transfer missions, and aircraft deployment support.



With 117th Air Refueling Wing (Birmingham, Alabama, Air National Guard) KC-135 Stratotankers as a backdrop, personnel of the 117th Security Forces Squadron are given flightline post briefings during Operation Noble Eagle. (US Air Force photo by MSgt Ken Johnson)



As part of the preflight checklist, Airman 1st Class Jason Somrak, serving with the 379th Expeditionary Aircraft Maintenance Squadron, muscles the KC-135 Stratotanker aircraft refueling pod off of the stand on the flightline of an undisclosed airfield in Southwest Asia, 10 September 2008. (US Air Force photo by TSgt Michael Boquette)



Technical Sergeant Sonya Kidd and Captain Keith Larson, both from the 445th Aeromedical Evacuation Squadron, Wright-Patterson Air Force Base, Ohio, load medical supplies into a KC-135 Stratotanker aircraft at Ramstein Air Base, Germany, on 7 October 2008, for transport to Bagram Air Base, Afghanistan. (DoD photo by A1C Grovert Fuentes)

The Invisible Aircrews

In January 1929, the flight of the Question Mark proved the endurance capabilities of an aircraft and crew. It also illustrated that any such endeavor would require air refueling. For the Question Mark, it took two Douglas C-1 single-engine transports with 150-gallon tanks installed and a refueling hose passed through a hatch cut in the floor. Captain Ross G. Hoyt, First Lieutenant Auby C. Strickland, and Second Lieutenant Irwin A. Woodring flew Tanker Number 1, while First Lieutenant Odas Moon, Second Lieutenant Joseph G. Hopkins, and Second Lieutenant Andrew F. Salter manned Tanker Number 2. After the famous flight, the Question Mark's crewmembers each received the Distinguished Flying Cross. The crews of the tankers had to wait many years before letters of commendation were added to their files. And, it was not until 1976 that Hoyt and Hopkins, the only surviving tanker crewmembers, received Distinguished Flying Crosses at a small ceremony in the Pentagon.

In his book, *75 Years of Inflight Refueling*, Richard K. Smith noted the Question Mark "inadvertently established a precedent. Hereafter, in any operation involving inflight refueling, all accolades would be heaped on the crews of the receivers; only anonymity awaited the refueler crews who made the operation possible--and successful." In many respects, these words remain true. In just one example, a C-5 Galaxy rushed the first of two US Navy "Super Scorpio" submersible vehicles and crews to Kamchatka to assist in the August 2005 rescue of a Russian mini-sub crew. Few recall that to make this mission from California to Kamchatka timely, the C-5 received four air refuelings: one from an active-duty KC-10 Extender from Travis Air Force Base, California; one from an Air Force Reserve Command KC-135 Stratotanker from Portland, Oregon; and two from Air National Guard KC-135s from Eielson Air Force Base, Alaska.

Fortunately, this has not always been the case. Since 1949, at least 10 flights receiving the MacKay Trophy, for the "most meritorious flight of the year" by a US Air Force member or organization, relied on air refueling. For instance, Captain James G. Gallagher and the aircrew of the Lucky Lady II required four air refuelings from KB-29s to complete the first around-the-world nonstop flight and earn this prestigious recognition in 1949. Even among the "invisible" aircrews of air refueling operations, a few have stood out, crewmembers of four tankers having received the MacKay Trophy.

The first tanker crew to earn this recognition did so through a "save" in Vietnam on 31 May 1967. The crew, consisting of Major John J. Casteel, Captain Dean L. Hoar, Captain Richard L. Trail, and Master Sergeant Nathan C. Campbell, performed the first multiple air refueling between a KC-135 and a US Navy KA-3 tanker which simultaneously refueled a Navy F-8 Crusader operating with an emergency fuel shortage. Interestingly, before receiving the nomination for the MacKay Trophy, the

crew almost faced a court martial for having offloaded so much fuel that day that they had to land at Da Nang Air Base, South Vietnam, despite the restrictions against large, vulnerable aircraft. Still, this crew's decision ensured the safety of two KA-3s, two F-8s, two Navy F-4s, as well as its assigned Air Force F-104s.

The next tanker crew to earn the MacKay Trophy--Captain Robert J. Goodman, Captain Michael F. Clover, Captain Karol F. Wojcikowski, and Staff Sergeant Douglas D. Simmons--did so in 1983. On 5 September, a US Air Force F-4E Phantom transiting the North Atlantic lost power to one engine and was forced to reduce power to the second. Even after jettisoning the centerline fuel tank, the fighter lost critical altitude and speed. A KC-135A assigned to the 42d Bombardment Wing, Loring Air Force Base, Maine, provided escort and four critical air refuelings, at times having to use the boom to tow the crippled F-4. The crew's extraordinary actions enabled the fighter to land safely at Gander International Airport, Newfoundland.

On 21 June 1985, Lieutenant Colonel David E. Faught, a KC-135 instructor pilot of the 97th Bombardment Wing at Blytheville Air Force Base, Arkansas, earned the MacKay Trophy for saving the lives of his seven crewmembers and preventing the Stratotanker's loss. After a six-hour training mission, the nose gear on the KC-135 failed to extend. While the weather deteriorated and the fuel supply diminished, Faught led his crew in several unsuccessful attempts to extend the nose gear. In the meantime, the KC-135 received several air refuelings from an EC-135 and a KC-10. After 13 hours in the air, Faught brought the KC-135 in to Blytheville with a successful nose-up landing.

The citation for the 1986 MacKay Trophy reads, in part, "the KC-10 aircrew of Gold 11 actions meant "valuable aircraft and priceless lives were saved by their superior airmanship, prompt action, and humanitarian regard for their fellow airmen." Arriving at Lajes Air Base, the Azores, on 5 March, the 68th Air Refueling Wing KC-10 crew, comprised of Captain Marc D. Felman, Captain Thomas M. Ferguson, Master Sergeant Clarence Bridges, Jr., Master Sergeant Patrick S. Kennedy, Master Sergeant Gerald G. Treadwell, Technical Sergeant Lester G. Bouler, Technical Sergeant Gerald M. Lewis, Staff Sergeant Samuel S. Flores, Staff Sergeant Scott A. Helms, and Staff Sergeant Gary L. Smith, and the three US Marine A-4 Skyhawks they were escorting across the Atlantic, found the airfield closed for unexpectedly poor weather conditions. Diverting to an airport on the island of Santa Maria, the KC-10 had to lead the A-4s through the thick clouds and low overcast to help them land. It took three tries to get the KC-10 and Skyhawks on the ground.

In the meantime, the second part of the mission, another KC-10 with six A-4s, followed close behind and was also diverted to Santa Maria. To assist, a Marine KC-130 launched from Lajes to take over refueling responsibilities of three of the A-4s. Like Gold 11, the KC-130 led the Skyhawks through the overcast to land. The first two were successful, but the third went off the runway, scattering debris along the end of it, forcing air traffic controllers to close it to any further landings. The crew of Gold 11 quickly took on 100,000 pounds of fuel and launched on a shortened

runway in near zero visibility. They then provided fuel for the other KC-10 and the three remaining A-4s, allowing them to divert to Rota Naval Air Station, Spain.

In addition to the MacKay Trophy, tanker crews have earned recognition in the Strategic Air Command Bombing and Navigation competition, as well as at Air Mobility Command's Air Mobility Rodeo competitions. They've earned other recognitions as well, including the General Carl A. "Tooey" Spaatz Trophy, Brigadier General Ross G. Hoyt Award, and Senior Master Sergeant Albert L. Evans Award (see Appendices 1, 2, and 3, respectively). Such tanker missions, laudable enough to earn special trophies and awards, are only a small representation of the thousands of air refueling crews contributing in a large, but often under-acknowledged, way to accomplishing the various Air Force missions. In describing his own career view, General Arthur J. Lichte, Commander of Air Mobility Command, summed up the feelings of air refueling crews from the Question Mark forward, "I think the tanker guys always felt that the mission was very important, and it wasn't until many years later that the rest of the Air Force said, you know without tankers we can't do any of the things we do. As a tanker guy, I've felt fulfilled as I've gone through my career in the tankers."



In January 1929, Lieutenant Odas Moon, pilot of refueling plane #2 supporting the Question Mark, paints a gas tank on the side of his Douglas C-1.



From left to right, Major John J. Casteel, Captain Richard L. Trail, Captain Dean L. Hoar, and Master Sergeant Nathan C. Campbell, the first tanker crew to earn the MacKay Trophy, use models to demonstrate their tri-level refueling mission.



General T. Michael Moseley (left), USAF Chief of Staff, presents the Distinguished Flying Cross to (left to right) Major Brian Neitz, Captain Nathan Howard, Captain Tricia Paulsen-Howe, and Technical Sergeant Jim Pittman. On 7 April 2003, this 22d Air Refueling Wing KC-135 crew put themselves in harm's way to help the crew of a downed F-15E. The KC-135 crew flew into hostile airspace north of Baghdad, Iraq, to refuel aircraft involved in the rescue, some of which were critically low on fuel.

Appendix 1

General Carl A. “Tooey” Spaatz Trophy

The Spaatz Trophy, established in 1975 to honor the memory of General Carl A. Spaatz, the first United States Air Force Chief of Staff and a pioneer in the field of air refueling, was originally awarded by Strategic Air Command (SAC) to the best air refueling unit. Donated by Tactical Air Command in appreciation for SAC’s air refueling support of its fighter fleet, the trophy was awarded on a calendar year basis. After its activation, Air Mobility Command continued presenting this trophy to the best air refueling unit, beginning in 1993.

1975	11th Air Refueling Squadron (July 1974–June 1975)	Altus AFB OK	KC-135
1975	22d Air Refueling Squadron (July–December 1975)	March AFB CA	KC-135
1976	41st Air Refueling Squadron	Griffiss AFB NY	KC-135
1977	306th Strategic Wing	Ramstein AB GE	KC-135
1978	912th Air Refueling Squadron	Robins AFB GA	KC-135
1979	307th Air Refueling Group	Travis AFB CA	KC-135
1980	452d Air Refueling Group	March AFB CA	KC-135
1981	305th Air Refueling Squadron	Grissom AFB IN	KC-135
1982	46th Air Refueling Squadron	K. I. Sawyer AFB MI	KC-135
1983	42d Bombardment Wing	Loring AFB ME	KC-135
1984	906th Air Refueling Squadron	Minot AFB ND	KC-135
1985	906th Air Refueling Squadron	Minot AFB ND	KC-135
1986	43d Air Refueling Squadron	Fairchild AFB WA	KC-135
1987	32d Air Refueling Squadron	Barksdale AFB LA	KC-10
1988	909th Air Refueling Squadron	Kadena AB JA	KC-135
1989	32d Air Refueling Squadron	Barksdale AFB LA	KC-10
1990	<i>Cancelled for Operation Desert Shield</i>		
1991	<i>Cancelled for Operation Desert Storm</i>		
1993	9th Air Refueling Squadron	March AFB CA	KC-10
1994	384th Air Refueling Squadron	McConnell AFB KS	KC-135
1995	911th Air Refueling Squadron	Grand Forks AFB ND	KC-135
1996	911th Air Refueling Squadron	Grand Forks AFB ND	KC-135
1997	905th Air Refueling Squadron	Grand Forks AFB ND	KC-135

1998	99th Air Refueling Squadron	Robins AFB GA	KC-135
1999	99th Air Refueling Squadron	Robins AFB GA	KC-135
2000	99th Air Refueling Squadron	Robins AFB GA	KC-135
2001	32d Air Refueling Squadron	McGuire AFB NJ	KC-10
2002	9th Air Refueling Squadron	Travis AFB CA	KC-10
2003	384th Air Refueling Squadron	McConnell AFB KS	KC-135
2004	906th Air Refueling Squadron	Grand Forks AFB ND	KC-135
2005	6th Air Refueling Squadron	Travis AFB CA	KC-10
2006	384th Air Refueling Squadron	McConnell AFB KS	KC-135
2007	912th Air Refueling Squadron	Grand Forks AFB ND	KC-135
2008	349th Air Refueling Squadron	McConnell AFB KS	KC-135

Appendix 2

Brigadier General Ross G. Hoyt Award

The Hoyt Award was established by the Air Force Association in 1994 to honor the memory of Brigadier General Ross G. Hoyt, a pioneer in the field of air refueling. The award is presented annually by the Air Force Association to the best air refueling crew (active-duty, Air National Guard, or Air Force Reserve Command) in the United States Air Force.

1994	380th Operations Group	Plattsburgh AFB NY	KC-135
1995	905th Air Refueling Squadron	Grand Forks AFB ND	KC-135
1996	384th Air Refueling Squadron	McConnell AFB KS	KC-135
1997	909th Air Refueling Squadron	Kadena AB JA	KC-135
1998	911th Air Refueling Squadron	Grand Forks AFB ND	KC-135
1999	2d Air Refueling Squadron	McGuire AFB NJ	KC-10
2000	67th Special Operations Squadron	RAF Mildenhall UK	HC-130
2001	349th Air Refueling Squadron	McConnell AFB KS	KC-135
2002	8th Special Operations Squadron	Hurlburt Field FL	MC-130
2003	9th Special Operations Squadron	Eglin AFB FL	MC-130
2004	711th Special Operations Squadron	Eglin AFB FL	MC-130
2005	79th Rescue Squadron	Davis-Monthan AFB AZ	HC-130
2006	8th Special Operations Squadron	Eglin AFB FL	MC-130
2007	67th Special Operations Squadron	RAF Mildenhall UK	HC-130
2008	67th Special Operations Squadron	RAF Mildenhall UK	HC-130

Appendix 3

Senior Master Sergeant Albert L. Evans Award

The Evans Award was established in 1980 by the Strategic Air Command to recognize the best air refueling operator section each year. The award is named to honor the memory of Senior Master Sergeant Albert L. Evans, an air refueling boom operator killed in a KC-135 accident on 19 September 1979. Air Mobility Command reestablished this award in 2001.

1980	920th Air Refueling Squadron	Wurtsmith AFB MI	KC-135
1981	46th Air Refueling Squadron	K. I. Sawyer AFB MI	KC-135
1982	906th Air Refueling Squadron	Minot AFB ND	KC-135
1983	71st Air Refueling Squadron	Barksdale AFB LA	KC-135
1984	906th Air Refueling Squadron	Minot AFB ND	KC-135
1985	41st Air Refueling Squadron	Griffiss AFB NY	KC-135
1986	43d Air Refueling Squadron	Fairchild AFB WA	KC-135
1987	32d Air Refueling Squadron	Barksdale AFB LA	KC-10
1988	909th Air Refueling Squadron	Kadena AB JA	KC-135
1989	6th Air Refueling Squadron	March AFB CA	KC-10
1990	305th Air Refueling Squadron	Grissom AFB IN	KC-135
1991-2000	<i>Not awarded during these years</i>		
2001	384th Air Refueling Squadron	McConnell AFB KS	KC-135
2002	6th Air Refueling Squadron	Travis AFB CA	KC-10
2003	9th Air Refueling Squadron	Travis AFB CA	KC-10
2004	99th Air Refueling Squadron	Robins AFB GA	KC-135
2005	6th Air Refueling Squadron	Travis AFB CA	KC-10
2006	9th Air Refueling Squadron	Travis AFB CA	KC-10
2007	99th Air Refueling Squadron	Robins AFB GA	KC-135
2008	6th Air Refueling Squadron	Travis AFB CA	KC-10

Back Cover: This stencil, "check the oil and clean windows please," was found on the receptacle of a 92d Strategic Aerospace Wing B-52 when it went into Boeing's Wichita Plant for modifications in 1964.

CHECK
THE OIL
AND CLEAN
WINDOWS
PLEASE

