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BACKGROUND PAPER

ON

THE HISTORY OF AIR REFUELING

From the earliest days of aviation, the problem of range extension for aircraft was contemplated. Range extension would allow aircraft to transit large distances or bodies of water without the problem of landing for services. In a military application, it would allow the bomb-laden aircraft to take off with heavier weapons loads, and reach targets much further than normally possible. A solution to range extension, by air-refueling, surfaced very early in the history of aviation, however it wasn't until the 1950's that it reached a practical level of application. Immediately upon its military inception, enlisted men, and eventually women, were a critical part of this operation. Of course, enlisted personnel were involved in all aspects of maintaining and supporting these new, air refueling, weapons systems. But KB-29's, KB-50's, KC-97's, and eventually KC-135's and KC-10's all carried enlisted people as crewmembers, initially as radio operators, flight engineers, hose reel operators, and boom operators. Today, flight engineers and boom operators are the only enlisted crewmembers still carried on USAF primary tanker aircraft, the KC-135 and the KC-10.

Allow me at this point to insert a disclaimer. Initially, when I selected this topic for research, I had visions of discovering some of the early hose reel and boom operators. Although I am sure there were many who were instrumental in turning it into the successful program we have today, it takes a better researcher than this one to find them. In almost every case, even on historic air refueling missions, the pilot, or the test team engineer is mentioned, but the enlisted crewmember is not. I do not mention this as sour grapes, or to try and create an aura of self importance. It is that I am sure at the time of these developments and events the people involved saw little purpose in putting their name into the records. Therefore, today, we should all assess what impact our actions may have on future Air Force issues and record our stories properly. The enlisted story is an important one and we need to provide all the information we can so that in the future the world can read and learn of our contributions.

But I veer from my purpose, which is to take us from the early days of air refueling, of stuntmen jumping from plane to plane, through the procurement of the KC-135. In between these events, there were many people and programs instrumental in the development of air refueling as we know it today. Let us start with the pioneers of aviation.

Following World War I, aviation suffered stagnation, primarily due to lack of support from the general public. Up until this point, because of the limitations involved in flying, there was little potential seen in it. To develop aviation to its full potential would require public support and interest. The actual physical problems with aviation were limited range and payload. Although engineers were working on improved engine and airframe designs to correct this prob-

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lem, military and civilian pilots were not satisfied, and pursued other avenues to extend range. This is where inflight refueling came from. For the military, it extended range for reconnaissance and weapons delivery. For the civilians, it was another trick to do at "Flying Circus's".

Although stuntmen were performing various feats with aircraft at the time, the first an aircraft was refueled in flight is generally attributed to Lieutenant Godfrey L. Cabot of the United States Naval Reserve and Lieutenant Harris of the United States Navy on October 3, 1920.(8:1) On this day, using a Huff-Doland aircraft, trailing a rope with a grappling hook attached, they retrieved a five gallon can of gasoline from a raft floating on the Potomac River in Washington, D. C. This event marked the birth of in-flight refueling, for it was the first time that an aircraft was able to extend it's range without stopping for ground servicing. While the amount of fuel was pretty insignificant, it did demonstrate the ability to extend range of aircraft through inflight refueling. This event seemed to peak the interest of many people in the aviation business, so much so that on 12 November, 1921, Wesley May, with a five-gallon can of gasoline strapped on his back, was transferred from the wing of a Lincoln Standard biplane onto the wing of a Canadian JN4 plane, and proceeded to pour the fuel into the JN4's fuel tank. Obviously, neither one of these two methods represent a practical method of fuel transfer, however Lt. Cabot did present a paper to the Army Air Corps Command recommending transatlantic delivery of aircraft using his grappling hook method of retrieving fuel. The Command was apparently not impressed.

During WWI, there were two officers concerned about the loiter time of their Spad aircraft, Captain Lowell Smith and Lieutenant John Richter. Lt. Richter complained that he had to fly nine sorties on one day, when he could have flown just one with some other means of obtaining fuel. They wished they could somehow refuel without returning to their bases. In 1923, they were stationed together at Rockwell Field, San Diego, Ca., and they decided to do something about this. They received approval from their base commander, Major H. H. Arnold, to proceed. Lieutenant Richter had been an engineer with the railroad prior to the war, and was good with tanks, valves, and gauges. Two airplanes were fitted with 50 foot hoses which could be lowered to the receiver airplane. The first test flight was flown on 20 April, 1923. Even though the tanker hose was connected to the receiver for over 40 minutes, they elected to transfer no fuel. During May and June, numerous test flights were flown, culminating in an endurance record on June 27, 1923 of 6 hours and 39 minutes. As all these flights were conducted over a circular course, they weren't considered true range extension. Lieutenant Richter and Captain Smith were determined to prove that air refueling worked, so they planned a longer range event. On 25 October, 1923, they flew from Lomas, Washington, nonstop to Tiajuana, Mexico. This flight took over 12 hours to complete, using the air refueling equipment developed earlier. This flight proved air refueling had military applications far beyond performing stunts.(8:-)

On November 18, 1923, the first air refueling fatality occurred. Lieutenants Wagner and Peck tried to refuel inflight during an airshow at Kelly Field, Texas. The hose pipe of the tanker aircraft became tangled with the propeller of the receiver, causing it to crash. This seemed to take the interest out of this maneuver, and little was done

in regards to air refueling until late in 1928.

During the winter of 1928 Captain Ira Eaker called his good friend Major Carl Spaatz to see what he thought of trying to break the existing endurance record. He valued Major Spaatz's opinion because he worked in the office of the Chief of the Air Corps and also because if a plan didn't make sense, Major Spaatz would be the one to say so, but if it did, he would become a major supporter. Captain Eaker's plan relied on the 1923 air refueling techniques developed by Captain Smith and Lieutenant Richter. (8:-)

Major Spaatz liked Captain Eaker's plan, and with his support, the War Department approved of the record attempt, with one provision. Nothing was to be left to chance. Any special equipment must be tested and proved operable before any record attempts could be made. The War Department's lack of faith in the plan was proven when no public announcement of the attempt was made.

A Fokker trimotor monoplane named the "Question Mark" was selected to be the receiver airplane. It was modified with a large funnel to allow fuel to be transferred into the fuselage tank. Two Douglas C-1 aircraft were to be the tankers, each carrying two additional 150 gallon gas tanks and a 40 gallon oil tank. A 50 foot hose would be lowered to the receiver, through which fuel would be transferred.

On January 1, 1929, the "Question Mark" took off from Van Nuys, California. Major Spaatz and Capt Eaker were joined in the Question Mark by Lieutenants Halverson and Quesada, and finally, our first enlisted man, Staff Sergeant Roy W. Hooe. During refueling operations, Major Spaatz would stand on a platform on the Question Mark, catch the hose lowered from the tanker, and place it into the funnel. Forty-two contacts were made with the tankers, transferring 245 gallons of oil and more than 5,600 gallons of gasoline. Staff Sergeant Hooe was responsible for the inflight maintenance and for transferring the unloaded fuel by hand pump from the fuselage tank to the wing tanks. After being airborne for 120 hours, the crew thought that the flight may be coming to an end. The left engine was misfiring and the right engine was not running very smoothly. Sergeant Hooe worked on the engines and was able to improve them for a while, causing Major Spaatz to decide to continue the flight as long as they had sufficient power. Finally, after one engine had failed, he decided to land. The flight had lasted 150 hours, 40 minutes and 15 seconds, more than doubling the previous record, having covered more than 11,000 miles. The "Question Mark" had flown further and remained airborne longer than any lighter-than-air machine in history. For their efforts, the crew was presented with the Distinguished Flying Cross. The citation presented to Major Spaatz read: For extraordinary achievement while participating in an aerial flight. On January 1-7, 1929, he commanded the airplane "Question Mark" on a refueling flight, at and near Los Angeles, California, which remained in the air for a total of 150 hours, 40 minutes, and 15 seconds, a period of continuous flight longer than any previous flight ever accomplished. By his endurance, resourcefulness and leadership, he demonstrated future possibilities in aviation which were heretofore not appreciated and thus reflected great credit upon himself and the Army of the United States.

Many years later, in an interview, General Eaker said this flight accomplished several things. They found out what parts on aircraft

were prone to failure and needed improvement and improved lubrication. Likewise, they had demonstrated the possibility of extending the range of military aircraft by refueling in flight. It actually appeared possible to transfer bomber and fighter aircraft overseas by refueling in flight. Their report to the War Department went unused for many years. It wasn't that they didn't like the idea, but they felt that basically, technology in general and power plants in particular, were not up to the task of extremely long distance flights.(2:-) In fact, even though Jimmy Doolittle addressed air refueling in a letter to General Arnold just prior to WWII, very little was done in the United States until after WWII.(3:-) As Russia's ambitions became evident, and the USAF became concerned about its ability to conduct long-range operations, the development of equipment and procedures for inflight refueling became a very high priority. In 1948, the Strategic Air Command decided it was time to test and improve world-wide capabilities.

The GEM program was initiated at Air Material Command (AMC) in March, 1948. It was a long range development program for Strategic Air Command aircraft studying winterization, air-to-air refueling, electronics and other special modifications. In early 1948, the air-to-air refueling program had received increased emphasis when it was dedicated as an A-1 priority. The AMC was to have responsibility for the technical side, while the Strategic Air Command (SAC) picked up responsibility for all operational suitability tests. At this point in time, the United States had no air refueling capability. Although studies were being done here, the world's only operable system had been developed in Britain by Flight Refueling Limited.(2:-)

The Flight Refueling system was a cumbersome, high risk, program using trailed lines and grappling hooks. The receiver aircraft trailed a weighted line, while the tanker approached from behind. As the tanker caught up, it fired a line across the receiver cable, and hooked it. The receiver hauls both lines in, and attached to the tanker line is the refueling hose. As the receiver retrieves these lines and cables, the cable attaches itself to the receiver fuel system and allows fuel transfer. Piece of cake, right?

As troublesome as this was, it was the only system available, so AMC procured enough equipment from Flight Refueling Ltd. to outfit 100 B-29's into receivers and 60 B-29's into tankers. Initially, Eighth Air Force was charged with all refueling training, and during 1948 a few successful hookups were made.(2:-) The most historic refueling using this system was the non-stop around the world flight by the "Lucky Lady."

After WWII, the United States found itself with the atomic bomb, but not necessarily a vehicle to deliver it to its new adversary, Russia. The aircraft of the time could certainly carry it, but not with enough range to reach Russian targets. This is where the emphasis came from for air refueling. In 1948, after procuring the British system, an order arrived at SAC Headquarters from the Pentagon, ordering them to start immediate preparation for a non-stop, around the world flight. Their front line bomber, the B-50, would be the plane to do it, with KB-29 tankers, providing the fuel. An additional incentive to this flight was the explosive world situation. The Berlin airlift was in full swing and the cold war was becoming a very real concern. An around the world flight would do much to demonstrate American capabil-

ities.(5:-)

The air refueling portion of the round the world mission was the most critical part. Rendezvous equipment was not very refined and the air refueling system was still the primitive British system described earlier. It is easy to see why educated guesses gave it a 25 per cent chance of success. In fact, the "Lucky Lady" barely got to make the trip.(5:-)

The primary B-50 chosen for the flight was the "Global Queen" with the "Lucky Lady" as the ground spare. The "Global Queen" took off at 1130 AM on 22 February, 1949. As she had taken off okay, the "Lucky Lady" was put back in the hangar. Suddenly, in the middle of the night, the "Global Queen" lost an engine, and the "Lucky Lady" was put back in the line-up. At 1120 the following day, she rolled down the runway enroute for her rendezvous with infamy. Approximately four days of flying lay ahead of her, with four air refuelings to keep her airborne. With the primitive system in use, each air refueling would take approximately two hours, as the fuel was transferred at a rate of only 100 gallons per minute.(5:-)

Air refuelings were scheduled over the Azores, outside of Saudi Arabia, off the coast of the Phillipines, and off the coast of Hawaii. All refuelings were uneventful, but one tanker's return to base was not. While returning to Clark AB, it let down through an overcast too soon, hit about ten feet below the top of a mountain and exploded, killing all nine members of the crew. (5:-)

Anyway, 94 hours and 1 minute after takeoff, the "Lucky Lady" touched down at Carswell AFB, Texas. Secretary of the Air Force Stuart Symington, Chief of Staff General Hoyt Vandenberg, and CINCSAC General Curtis Lemay greeted the history-making crew.

Tremendous value was placed on this flight. The citations to accompany the award of the Distinguished Flying Cross read in part: "The successful execution of this historic flight demonstrated the feasibility of aerial refueling to extend the operating range of military aircraft." The Mackay Trophy awarded to the crew paralleled these thoughts: "These inflight refuelings resulted in a graphic demonstration that the range of the modern military aircraft is unlimited."

Another thing this mission proved was that the cable system of air refueling was not effective enough for widespread use. Thanks, in part, to the troubles associated with air refueling on this mission, the Air Force realized it needed a different system. The British system, while workable, was unwieldy and difficult to use and had the additional disadvantage of using components manufactured overseas. A possible alternative was the flying boom system developed by Boeing Aircraft Company in 1948.(7:-)

The flying boom was actually designed by a German scientist, B. A. Holman, working for Air Material Command. The flying boom was a telescoping aluminum tube that could be flown up, down, or side to side and was controlled by the enlisted crewmember forever known as the boom operator. It offered many advantages over the hose system. It was free from weather interference. It was stable at the higher speeds associated with the newer generation bombers. It had better lighting capability, and allowed easier separations in an emergency.

It could pass up to 500 gallons per minute verses the 100 gallon per minute from the British system. The first flight test of the flying boom was 16 September, 1948. After the flight of the "Lucky Lady", it was decided that further procurement of the British system was undesirable, and the flying boom became standard SAC equipment with receptacles to be installed on all future bombers. Boom equipped KB-29's actually started arriving in September of 1950.(1:-) A wonderful thing to ponder is the speed of development of new technology during this era. The flying boom method was first thought of in 1948, yet by the fall of 1950 there were three bombardment wings with KB-29 flying boom tanker aircraft and by December 1951 there were 14 tanker squadrons.

When it became apparent that the command would receive B-47 aircraft, an immediate requirement arose for an a tanker capable of hauling larger loads of fuel higher and faster. To meet this requirement, the C-97 was converted to the KC-97 tanker. KC-97 tankers although first flown in August of 1950, did not start air refueling training until April of 1952. This was primarily due to a shortage of boom and tank assemblies. Also, initially there was a severe shortage of boom nozzles. Apparently, early receptacles on the receiver aircraft were very difficult to refuel, causing a tremendous number of nozzles to fail. Simultaneous with all these developments, the fighter community was looking for its own tanker system.(7:-)

As the United States Air Force was pursuing the flying boom system, it also asked Sir Alan Cobham of Flight Refueling Limited to come up with a better refueling system for fighter aircraft. By 1949 it had developed the first probe and drogue system, similar to what is still used today. Colonel Dave Schilling, a WWII fighter ace, was assigned to the Pentagon to supervise a fighter refueling program. He went to England to see Sir Alan's probe and drogue system, and felt that it had great potential. He improved the design by using three drogues to refuel three fighters at a time.(6:-)

Successful tests were run on the new equipment. A final test was a flight across the Atlantic by Colonels Schilling and Ritchie. It was two F-84's to fly nonstop across the Atlantic, using air refueling. Colonel Ritchie's aircraft fuel probe froze, and it crashed 19 miles from Goose Bay, Labrador. Colonel Schilling was forced to land at Bangor, Maine because of poor weather. Despite Colonel Ritchie's mishap, the value of air refueling fighters had been proven.(6:-)

In 1952, the USAF decided to give probe-and-drogue refueling a full scale operational test under combat conditions in Korea. F-84E's of the 116th Fighter Bomber Wing were equipped with probes and the KB-29's were equipped with drogues on their wingtips and tails. The first combat mission was flown by Colonel Harry W. Dorris, Jr. He flew five combat missions for a total of 14 hours and 15 minutes without landing, setting a new endurance record for single-engine fighters. He also proved that a human could stand long hours in a single-engine airplane. This was to prove valuable for deployment of aircraft over long distances.(6:-)

TAC had proven their need for air refueling, but they did not receive their own tankers until receiving two squadrons of B-29's in 1954. In 1956, they started receiving KB-50s equipped with probe and drogue equipment. By 1961, fighter refueling had become routine. Between 1957 and 1960, TAC had made over 5,200 transoceanic deploy-

ments requiring inflight refueling. But TAC was still using all propeller driven airplanes. Nothing revolutionized air refueling like the KC-135 Stratotanker.

The first flight of the KC-135 was 15 July, 1954. All of a sudden the Air Force had a true high altitude, high speed tanker. Taking off at gross weights up to 297,000 pounds, it could carry over 30,000 gallons of fuel, any or all of which could be offloaded to the receiver aircraft, or burned for its own use. It could refuel down to speeds of 180 knots or as fast as 355 knots, fast enough for anything in the inventory. At the same time, it could carry upwards of 83,000 pounds of cargo or as many as 250 passengers in an emergency situation, although 54 is the current maximum peacetime amount.

The KC-135 has ended up being one of the military bargains of the 20th Century. Currently flown by the USAF, the Air National Guard and the Air Force Reserve, it is still the primary USAF tanker. It played a vital part in Vietnam, by refueling fighters and bombers involved in the air campaign. There is more than one story of the tanker going far into North Vietnam to "tow" a battle damaged fighter back to safety. These planes have been and will be a part of every air combat or airlift operation, from Grenada to Panama, from Iraq to Somalia to Bosnia. By modifying them with CFM-56 engines, producing almost twice the thrust while reducing noise and fuel consumption, these planes have become indispensable and a vital tool for furthering US policy, wherever that may be projected around the globe.

Although we ended up dwelling more on the aircraft side of air refueling than the people involved, I want to reiterate that it is the people who get the job of air refueling done. Whether it is Staff Sergeant Hooe on the "Question Mark", or the line operators on early B-29's. Be it hose reel operators on KB-50's, or boom operators on KC-135's, there is a proud tradition of enlisted crewmember involvement in the air refueling business. It has been said that being a boom operator is such a wonderful job. Where else do you get three officers and a multi-million dollar airplane to take you to work? But this statement makes light of a job that is, in fact, a vital part in getting that airplane to do what it was designed to do. As boom operators, we are lucky to get to see the fruits of our labor, the receiver going on his way, the C-5 heading to Somalia to provide famine relief, the F-16 trying to maintain peace over Bosnia, or simply a local pilot maintaining his currency. But never should we forget that there are many people, probably working harder than us, preparing that airplane for flight, handling our flight plans, or assisting our passengers. Without all the support agencies, we wouldn't be able to do our job.

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