Air and Space this Week

Item of the Week

TWO IMPORTANT FIRST FLIGHTS, TWENTY-TWO YEARS APART

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*September 21 is a red-letter day in flight test. Two important aircraft made their first test flight on that date, one in 1942, and the other in **1964, sixty years ago this week**. One was highly successful, the other, not so much.*

Boeing Model 345, the first of three prototypes of what would become the B-29 bomber, made its first flight on 9/21/1942. The huge aircraft was a quantum leap in aircraft design and construction, and would play an important role at the end of WWII and on into the early days of the Cold War.

*The Strategic Air Command began looking for a long-range supersonic replacement for the B-52 in the mid-1950s. The winning design proposal was for North American's XB-70. By the time construction began, the aircraft was already obsolete, vulnerable to anti-aircraft missiles even at high altitude and Mach 3. Only two prototypes were built, intended to be high-altitude aeronautics research platforms. The first-built (AV-1) made its first test flight on **9/21/1964**, a hop between Palmdale and Edwards AFB. It was inauspicious, and did not bode well for the future; one of its six engines failed just after take-off and the undercarriage malfunctioned, preventing the landing gear from being raised, which limited the planned speed significantly. The left-side main landing gear locked on landing, blowing its tires and starting a fire. The fate of the second prototype was much worse…*

WWII: THE NEED FOR A VERY LONG-RANGE HEAVY BOMBER

WWII was truly a global conflict, making the ability to project power over great distances very important. This need was critical for success in the European Theater of Operation (ETO), but since Germany could be attacked from different directions and military targets in Germany and captured regions were very heavily defended by flak and fighters, bomber defensive capabilities and fighter escorts were the keys to successful strategic bombing. B-24s could carry a bomb load long distance, and the B-17 could better handle battle damage.

The war in the Pacific Theater of Operation (PTO) was primarily a naval war, where ship-borne bombers were much smaller. Yes, the Doolittle mission did launch medium bombers (B-25s) from the deck of the aircraft carrier *Hornet*, but that mission had much more of a propaganda and intelligence value than any benefit from the few bombs that were dropped. Long-range

heavy bombers flying from captured island bases would be needed, but capturing and utilizing such bases were not going to be available until later stages of the war.

President Roosevelt recognized the need for China to remain in the war, in order to divide Japan's military attention and assets. The two countries had been fighting long before Pearl Harbor, and China was losing. Japan had occupied much of the eastern portion of China, the part they needed most for resources and defense, but the western portion remained free. FDR pledged to Chiang Kai-shek at the Cairo Conference in November, 1943, that the USA would finish the B-29 bomber, which the Boeing company had been developing since 1940, and deploy it to China by spring of 1944, with the mission of bombing the Japanese main islands from there. Pressed from the Pacific side by naval advances, and strategically-bombed from the China side (Operation Matterhorn), was hoped to be sufficient to keep China as an ally and end the war in the PTO.

DEVELOPMENT AND UTILIZATION OF THE B-29

DEVELOPMENT

The U.S. Army Air Corps released a request for proposals to build an advanced bomber on January 29, 1940 (the AAC would change its name to the U.S. Army Air Force on January 1, 1941). It required the new bomber to be able to fly much farther with a much heavier bomb load than any previous, including the B-17 and B-24, which required the new bomber to be much larger, and much more technologically-sophisticated than its predecessors. It also required the use of the largest engine then built, the Wright R-3350. Five companies responded: Boeing with the B-29, Lockheed with the B-30, Douglas with the B-31, Convair with the B-32, and Martin with the B-33. Boeing and Convair were selected to build two prototypes.

Boeing was already developing a heavy bomber, the Boeing Model 345. Numerous features were added/modified to meet the USAAC requirements. The sheer size of the aircraft needed was daunting enough, but many other upgrades had to be designed, tested, and refined. The aircraft would have to bomb from heights where conditions required crew protection from the cold and lack of air, defensive firepower would have to be increased, and more. The RAF's experience in the Battle of Britain showed the value of self-sealing fuel tanks and armor protection for vital components. No wing then in existence had enough lift for the mammoth plane required; a new one would have to be designed from scratch.

All five companies knew that the only engine then available that would meet the USAAC specifications was the Wright R-3350. Wright was already producing smaller engines, the R-1820 and R-2600, and did not have the capacity or inclination to reduce their output of the smaller two in order to develop the R-3350 properly. The design of the first R-3350s build was inadequate; the cooling system for the engine was underfit; the lubrication system, especially to the cylinders in the upper portion of the engine, was much less than needed; the reduction gearing in the engine was prone to failure; and the carburetor system was inadequate. Engine weight was a problem, so designers had used magnesium instead of aluminum, for many

engine parts. *Flammable* magnesium (it is put in fire starters to make sparks that last – don't you watch *Survivor*?). An overheating engine with flammable parts; what could go wrong?

Political pressure was intense. Orders for B-29s would pour in while the aircraft was still in the prototype phase. Much of flight test would take place under combat conditions, a decision that killed a lot of crews, even before they reached combat.

Boeing's Chief Test Pilot, Eddie Allen, had a stellar reputation. He made the first flight of the first B-29 prototype and was intimately involved in the aircraft's development. On February 18, 1943, he took off with a crew of 10 (some sources say 14), for what should have been another relatively routine test flight. The aircraft crashed and burned, killing the entire crew, including two who had attempted to bail out. The B-29 hit a packing plant owned by Frye & Company, killing 19 employees. The death toll there would have been much higher, but the crash occurred at lunch time and many employees were eating elsewhere in the packing company facility. Prompt action by first responders also kept the death toll down.

The initial report was that the B-29 suffered an engine fire (not uncommon), but post-crash analysis showed lots of evidence of fire, but no conclusive evidence of an engine fire. However, pieces of the leading edge of the wing were missing; some were found miles from the crash site. The most likely cause was a fire, but in the complicated fuel system that allowed fuel to leak and accumulate behind the wing's leading edge, where it blew and took chunks of the edge with it. A moot testimony to Allen's excellent flying skills was that he almost made the runway before his main wing spar burned through.

The demand for the Wright Company's engines overwhelmed their management and manufacturing capability. The skill level of workers building the B-29 and its components needed to be much higher than for other aircraft, and Wright and Boeing and their suppliers were struggling to acquire the necessary manpower with the necessary expertise. To give an example of the problem, 1.4 million man-hours was required to design the B-29, and (initially) 150,000 man-hours of skilled labor was required to build each aircraft! All while the armed forces and other critical industries were strapped for manpower.

The Wright engine situation was so bad that a government committee investigated the situation. It was led by Congressman Harry Truman, who made a real name for himself during the inquiry. The upshot of their findings put the blame on Wright management for emphasizing their construction of their smaller engines and on the USAAC for unrealistic demands to shortcut engine development time.

UTILIZATION

AAF General "Hap" Arnold, reserved command of the newly created 20th Air Force for himself, aiming to make it a prototype organization for what he hoped would be a separate service after the War. He had selected BGen Kenneth B. Wolfe to run the B-29 Special Project Office to streamline and coordinate production in 1943, and turned to Wolfe again, putting him in charge of the 20th Bomber Command.

The B-29s were deployed in two groups. The elements of the 20th Bomber Command in India used them on the first mission to bomb targets in Bangkok (June 5, 1944), and it was a fiasco. Ninety-eight B-29s were dispatched. Only two dozen or so of the many-more bombs dropped hit the targets at which they were aimed, fourteen B-29s aborted soon after launch, 42 made alternate fields, and five crashed on landing at their base of origin.

Ten days later they made their first raid against the Home Islands, attacking the steel mill complex at Yawata. The results were even worse. Sixty-eight B-29s took off, one crashed on take-off, six more were lost in "accidents," and one was taken out when a defending fighter collided with it. Not one single bomb hit its target.

Five bases in India would ultimately be built. Supply was a problem, because the "Burma Road" was the only road from India to China. The Ledo Road would be completed later, but India and Chinese bases would have to be supplied by air. Supply planes, like the C-46 , could carry some fuel, bullets, and bombs, and the B-29s themselves were often pressed into supply duty. The altitudes needed to fly "Over the Hump" (Himalayas) placed great strain on unreliable engines. Crews used gallows humor to describe their navigation technique, "just follow the aluminum highway (crashed airplanes) over the mountains." Seven round trips by each B-29 over the Hump were required to bring in enough gasoline for one B-29 combat mission! In addition to the bases in India, four bases in China were also constructed (building the long runways needed without much in the way of earth-moving equipment required 50,000 Chinese laborers for each)!

General Arnold replaced Wolfe with LeVerne Saunders. China-based B-29s had dropped 11,000 tons of bombs with little to show for it, and India-based bombers did little better. Meanwhile, the 21st Bombardment Group, under General Hansell, had moved to the island of Tinian in the Marianas Group as soon as it and nearby Guam were captured by Marines. Hansell got his B-29s up and running quickly, using naval supply lines, but with little to show for the effort.

The first sortie from Tinian on October 28, 1944, a warm-up mission to bomb Truk, already a backwater. Five more similar missions followed, then, after a week-long weather delay, the 20th was ready to take on strategic targets in the Home Islands that were intended to wreak havoc with Japan's war industries. The problem was that the bombing was being conducted from very high altitude to avoid defending flak and fighters, who were willing to use ramming tactics to bring down the B-29, as one did on the first Home Island attack. The AAF had limited experience with high-altitude winds, particularly the Jet Stream, and bombing accuracy suffered accordingly.

General Arnold was impatient, and replaced Hansell with General Curtis LeMay in January, who at first has similar negligible results. Follow-up missions were similarly ineffective. With his reputation on the line, LeMay did some serious thinking about the problem of bombing Japan from a remote and difficult to supply base. He knew that the plane, the bombs, and the crew were not the problem, the height from which the bombing was conducted was the problem.

LeMay's next move shocked the B-29 crews. Instead of bombing at high altitude, LeMay ordered his bombers to leave their aerial gunners at home, dismount the gun turrets, load up

with incendiary bombs, and attack from low altitude (5,000 - 8,000 feet) at night. The bombers would be well within range of Japanese flak. Crewmen were resigned to being shot down over highly-enemy territory.

LeMay wanted to make a statement to Japanese (and American) leadership that further resistance was futile. The acid test of LeMay's tactics came on the night of March 9/10. It was called "Operation Meetinghouse."

Incendiary bombs had been developed earlier in the War, and had been used on some targets more prone to fire damage than others, in both Theaters. The famous firestorm that burned out Hamburg in July, 1943, was caused by blanket bombing with incendiaries; the resulting fires merged and created a strong updraft that caused hurricane-force winds that fanned the flames into an uncontrollable conflagration.

The M-69 incendiary bomb was going to be the star of Meetinghouse. Each bomb contained a cluster of 38 hexagonal pipes, 3 inches across and 20 inches long. Each pipe was filled with napalm and a small explosive charge. The cluster would open at about 2000 feet, spreading the hexagonal bomblets. When they hit, the charge exploded, blowing flaming sticky blobs up to 100 feet from the impact site.

Early March had been unseasonably warm and dry, and March 9/10 was windy, perfect conditions for a fire-bomb attack. Tokyo's fire-fighting capability was miniscule for a city its size. Two hundred seventy-one B-29s took off at sunset. It was the 40th B-29 attack to date.

A few Pathfinder B-29s came in first. Their mission was to mark the target for the B-29s following. They laid their fire bombs in an X-pattern, directly on target. Following B-29s dropped 1660 tons of firebombs, creating a firestorm that burned out 16 square miles of Tokyo, killing at least 100,000 people. It was arguably the most devastating single attack of the War, and that would include two famous ones that would follow.

The low-level fire-bombing attacks continued for the next three months. Most Japanese cities suffered severe damage. The Japanese had very limited means to defend themselves, let alone go on any sort of offensive. After the atom bombs fell, dropped by B-29s, the Emperor capitulated.

After V-J Day, the B-29 was the USAAC's primary strategic weapon; atomic, then hydrogen weapons were too heavy for any other aircraft, and missiles large enough to carry them had not yet been developed. When the Korean Conflict came, B-29s were used to good effect to prevent the North Koreans from building airfields from which they could attack the South. Then Russian MiG-15s made their appearance. B-29s had dominated the field for seven years, but they stood no chance against a jet fighter with a heavy cannon. The jet age had begun.

THE NEED FOR A LONG-RANGE SUPERSONIC BOMBER

Let's fast forward some two decades from VJ-Day. The B-29 had been replaced by the B-52 as the U.S. Air Force's very heavy bomber early on. The B-52 was a very good design (as witnessed by it still being on active duty!), but its ability to perform a deep-penetration nuclear attack on

the USSR was being degraded by improved aerial defenses, especially the SA-2 anti-aircraft rocket (the one that brought down Francis Gary Powers' U-2 in 1960).

The Strategic Air Command had been established in 1946, and began preparing to put the B-36 into service. The "Peacemaker" was even larger than the Superfortress, too large to be practical; plans were made for a larger version of the B-29, the B-50. The nascent SAC was absorbed into the then-new U.S. Air Force on September 26, 1947, with General George Kenny commanding. A war exercise held the following May went so badly that Kenny was removed, and replaced by, wait for it, General Curtis LeMay.

The successful test of an atomic bomb by the USSR on August 29, 1949, and subsequent experiences in Korea, set off an arms race. The B-58 Hustler became the USAF's medium range (nuclear) bomber and the B-52 the USAF's super-heavy bomber. Realizing that the B-52 was too slow for deep-penetration strikes led those who believed in bombers more than missiles to begin to plan the next generation of bombers, one that could carry a heavy load at supersonic speeds, too fast and too high for intercepting aircraft.

Aviation companies continued to conduct research into high-speed flight. Progress was made on improved engine design, high-powered fuels, skin friction issues, and many more engineering problems. In 1955, the USAF issued General Operational Requirement No. 38 for a new bomber, desiring an aircraft with the Mach 2 speed of the Convair B-58 Hustler and the payload and range capabilities of the B-52. Six companies bid for developmental funding, and on November 8, 1955, Boeing and North American Aviation were awarded contracts for Phase 1 planning. The initial designs they came up with in mid-1956 were quite similar, and both were summarily rejected by General LeMay. The Air Force told them to try again.

Aviation technology was making great strides in the mid-1950s, with or without the new bomber. Designers were finding great benefit in a delta-shaped wing, rather than the short trapezoid that worked so well for the F-104 Starfighter. Engine designers were amazed to discover that a high-speed engine would actually be more efficient (in terms of miles flown per unit of fuel consumed) at Mach 3 than it was at subsonic speeds.

The second try by Boeing and NAA again produced similar designs, at least for a long fuselage and a delta wing. Boeing put its six engines in pods slung under the wing, like the Hustler's. However, NAA had searched NACA research records and found a way to use the fuselage shape to provide extra lift, so they put the engines behind a large triangular air intake beneath the wing. They also made the tips of the delta wing movable; dropping the tips at high speed provided more lift and more stability. NAA also had a better solution to skin heating than Boeing.

The best way to find the best plane design was to hold a competition between the two, which was announced on August 30, 1957. The final operational requirements were for a bomber capable of cruising at Mach 3.0 – 3.2, with an over-target ceiling of 70,000 feet, a range of 10,500 miles, and be capable of using facilities already built for the B-52.

North American Aviation's design won; on December 23, 1957, they were awarded a Phase 1 development contract. Two months later, the proposed bomber was given the designation XB-70, and the Air Force held a contest to determine the new bomber's name, which became "Valkyrie." The Air Force wanted NAA to build testable prototypes on an accelerated basis, but that effort went unfunded. NAA was also developing the F-108 supersonic interceptor at that time, and found they could save time and money by using the F-108's engine design, escape capsule, and other systems for the XB-70. The first news of the XB-70 was made public in early 1960.

Anti-aircraft artillery was no match for a high-flying Mach 3 bomber. But high-speed interceptors, and air- and ground-launched anti-aircraft missiles were another matter, or could/would be in the near future, a fact that worried Air Force officials. Missiles were the bigger problem, since they could be held at immediate readiness and a super-sonic interceptor could not. The problem was underscored almost immediately after the XB-70 info was made public, when the USSR used an SA-2 missile to down Powers' U-2 at a height USSR interceptor aircraft could not reach.

Additional blows to the XB-70 came when it was determined that the fuels it would use caused high engine wear and were highly-toxic, which made servicing the engines difficult and dangerous. Use of that fuel was discontinued. Further, the F-108 program was cancelled, which negated the savings NAA was using for the XB-70.

Declining utility and increasing costs led the Joint Chiefs to recommend a scaling-back of the XB-70 program, and President Eisenhower was even more pessimistic about the Valkyrie's future value. The program faced complete cancellation. Then 1960 election politics got involved. JFK's campaign criticized Eisenhower as being "weak on defense" and for allowing a "missile gap" to develop. The Air Force amped up their funding for the XB-70, with a contract for a prototype and 11 YB-70s in August, 1960. Nixon followed suit.

After JFK was inaugurated, he learned that the missile gap was a myth and that the XB-70 program was "unnecessary and economically unjustifiable," because the concept of a supersonic manned bomber was made obsolete by ICBMs. He did, however, support continued high-speed, high-altitude aeronautical research.

General LeMay became the Chairman of the Joint Chiefs in July, 1961, and immediately began advocating for the XB-70, which got him cross-wise with Secretary of Defense McNamara. Machinations followed, but the upshot remained, the XB-70 program was cancelled. Two, then three, then two again, prototypes were approved, to be used for research. The first, XB-70 (AV-1) was completed on May 7, 1964; the second, XB-70 (AV-2) was completed on October 15, 1964. AV-2 would be slightly more advanced, incorporating what was learned in building and flying AV-1.

The first test flight of the XB-70 occurred before AV-2 was completed, on September 21, 1964, **sixty years ago this week and twenty-two years to the day after the first test flight of the XB-29**! From propellers and pistons to Mach 3 in just 22 years!

FLIGHT TEST AND LOSS OF THE XB-70A VALKYRIE (AV-2)

The first test flight of the Valkyrie was inauspicious. One engine failed immediately after take-off and there was a warning of an undercarriage failure, too, forcing the pilot to keep the landing gear down for the flight, which limited the top speed attained to less than 400 MPH. After a brief flight, the AV-1 landed, the wheels on the left gear locked, tires blew, and a fire started. The AV-1 went supersonic for the first time on the third test flight (10/12/64). On October 14, 1965, AV-1 made it to Mach 3. A weakness in the wing assembly caused separation of panels on two subsequent occasions; AV-1 was never allowed to exceed Mach 2.5 again.

Flight test of AV-2 was delayed until the problems encountered with AV-1 could be corrected. It made its first test flight on July 17, 1965. Subsequent flights showed that it could meet the performance standards of speed, duration, and height originally expected. Sonic booms had become a problem, and AV-2 was fitted with instruments that would help provide data to mitigate booms (work continues on that problem even today!).

On June 8, 1966, AV-2 made a publicity flight for General Electric, builder of its engines. It was accompanied by an F-104 Starfighter, piloted by NASA's Chief Test Pilot, "Cowboy" Joe Walker, and several other aircraft, all with GE engines. Walker tucked in close for the photo-op, and then his F-104 quickly flipped up and over the Valkyrie, shearing most of the latter's vertical fins. Walker was killed instantly. The pilot of the Valkyrie managed to get into his escape pod and survived with injuries; the co-pilot didn't make it out of AV-2. The photo flight had not been authorized, and a few of those involved were reprimanded, IMHO light punishment for two deaths and the lost of a billion-dollar-or-so aircraft. For more on this tragic turn of events, see the Item of the Week about it here.

AV-1 continued for a while as a test bed, making a total of 83 flights. Its last supersonic flight was on December 17, 1968, and its final flight was on February 4, 1969, when it flew to Dayton, Ohio, and its permanent home at the Museum of the U.S. Air Force, where it resides today.

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