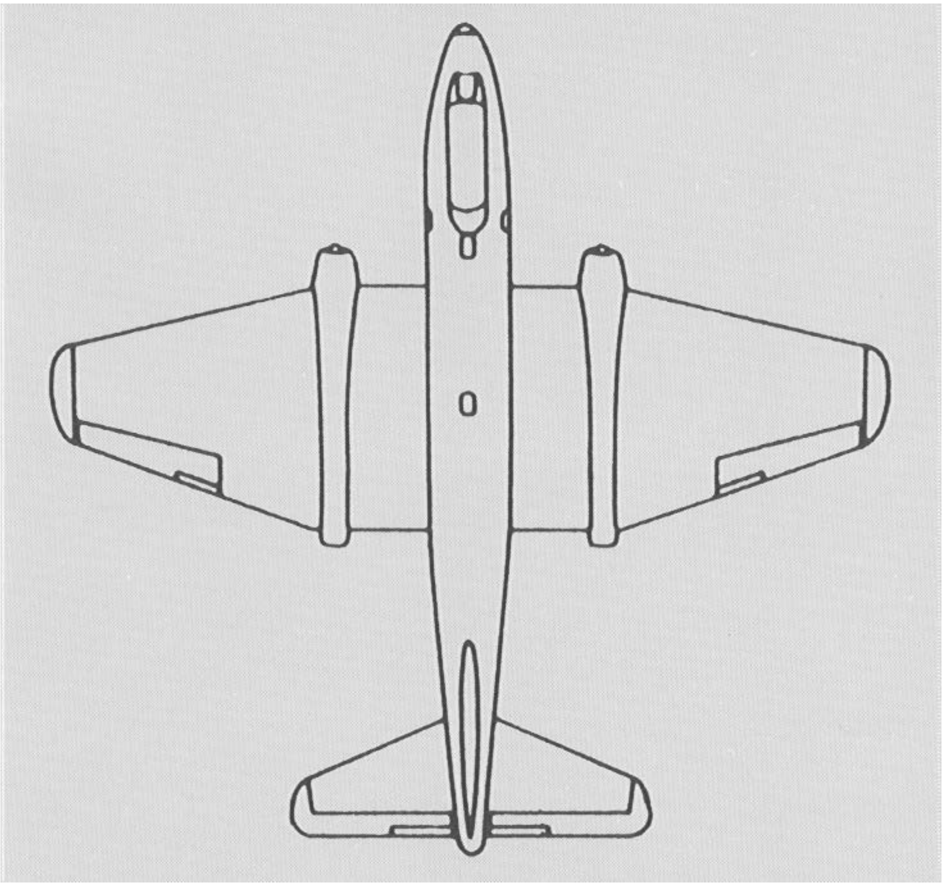
B-57 Canberra

The Glenn L. Martin Company



B–57 Canberra
Martin

Manufacturer's Model 272

Overview

The beginning of the Korean conflict on 25 June 1950 and the shortcomings of the weary Douglas B–26, a World War II production originally known as the A–26, accounted for the urgent procurement of a light tactical bomber. The new bomber became the Martin B–57, a by-product of the English Electric Canberra, the first British-built jet bomber, initially flown in 1949.

Adaptation of a foreign-made aircraft to American mass production methods, as well as the use of different materials and tools, could present many difficulties. Another problem, perhaps more critical, centered on the Wright J65 turbojets, due to replace the Canberra's 2 Rolls Royce Avon turbojet engines. The J65 was the U.S. version of the Sapphire, a British hand-tooled production currently scheduled for manufacturing by the U.S. Curtiss-Wright Corporation. The Air Force was fully aware of these potential pitfalls, but had no better option. It had an immediate requirement for a light jet bomber, with a 40,000-foot service ceiling, a 1,000-nautical mile range, and a maximum speed of 550 knots. The new bomber had to be capable of operating from unimproved airfields, at night and in every kind of weather, with conventional or atomic weapons. High altitude reconnaissance was another must. For such purposes, the B–45 was too heavy; the Navy AJ–1, too slow; and the Martin experimental B–51's range too short.

As a result of the outbreak in Korea, the Air Force reached a final decision. The desire for a night intruder was so strong that it took just a few days to set in motion the informal production endorsement of February 1951. Because of its experience with the XB–51, the Glenn L. Martin Company was recognized as the most qualified contractor to assume the domestic production of the British aircraft and to deal with the likely engineering difficulties involved in manufacturing a high-performance tactical bomber.

While the Air Force did not expect the B-57 venture to be free of problems, it did not foresee their magnitude. Testing of the 2 imported Canberras revealed design faults that could affect the safety, utility, and maintenance of the future B-57. Then, one of the British planes crashed; Martin's subcontractors could not meet their commitments; and the J65 prototype engines consistently failed to satisfy USAF requirements. In June 1952, further test flights had to be postponed for a year because of continuing engine and cockpit troubles. As a result, the Korea-bound B-57 did not fly before 20 July 1953, just 7 days before the conflict ended. Production of the crucial RB-57 was also delayed. The reconnaissance version entered service in mid-1954, after testing again confirmed that the more powerful J65 engines, added equipment, and other improvements had increased the aircraft's weight, in turn reducing the speed, distance, and altitude of both the B-57 and the RB-57.

Even though the Douglas B/RB-66s, on order since 1952, were expected to satisfy the tactical bombardment and reconnaissance requirements of the near future, the Air Force handled the disappointing B/RB-57 program with caution. The program was reduced, but there was no talk of cancellation. In keeping with procedures that unfortunately appeared to have become almost customary, steps were taken to ensure that the deficient B/RB-57s would be operational. This turned out to be expensive; later and considerably improved models still carried flaws, but in the long run the program's retention proved sound. In 1955, the B/RB-57s justified their costs when they served overseas pending the B/RB-66 deliveries which, as predicted, had fallen behind schedule. In 1956, much-needed RB-57Ds joined the Strategic Air Command, and various configurations of this model satisfied important special purposes.

Delivered too late for combat in Korea, the RB-57 in May 1963 and the B-57 in February 1965 began to demonstrate under fire in Southeast Asia the basic qualities justifying the Canberra's original selection. In 1970, other reactivated and newly equipped B-57s, known as Tropic Moon III B-57Gs, were deployed to Southeast Asia, where they made valuable contributions until April 1972. Finally, WB-57Fs, either modified RB-57Fs or former B-57Bs, were still flying high-altitude radiation sampling missions in 1973. Concurrently, EB-57Es, and related adaptations of the versatile B-57, continued to play significant roles, with no immediate phaseout in sight.

Basic Development — 1945

The Glenn L. Martin Company's B-57 Canberra was derived from the first British-built jet bomber. This high-altitude radar bomber was developed by the English Electric Company, Limited, in answer to specifications B 3/45, as issued by the British Ministry of Supply in 1945.[1] The first 2-man prototype of the English Electric Canberra was flown in May 1949 at the Wharton airdrome. In September, it was revealed to the aeronautical world at the Farnborough flying display of the Society of British Aircraft Constructors. The plane, like the several variants subsequently developed from its basic design, demonstrated superior characteristics. Not only could the new bomber take off and land in combat configuration on short and easily constructed runways, but it maneuvered well at low and high speeds. The United States, through the Martin Company, eventually bought off-the-shelf 2 B.Mk.2s, English Electric's first true production of the Canberra. The B.Mk.2, in contrast to the May 1949 prototype, carried a crew of 3—a pilot, navigator/plotter, and observer.

Preliminary Requirements — 16 September 1950

Soon after the outbreak of hostilities in Korea,[2] the USAF Board of Senior Officers began discussing how to replace quickly the weary Douglas B-26 Invader with a modern tactical bomber, specifically geared for night operations. To this end, the preliminary requirements of September 1950 called for a light jet bomber with a service ceiling of 40,000 feet, a cruising speed of about 400 knots, a maximum speed of 550 knots, and a range of almost 1,000 nautical miles. The needed aircraft also had to be capable of operating from unimproved airfields, of searching for targets at low speed and low altitude, and of destroying mobile or stationary targets at night or in bad weather, with conventional or atomic weapons. High-altitude reconnaissance was another requirement.

Initial Candidates — October 1950

Few aircraft, either under development or in operation, could be adapted to satisfy the requirements of September 1950 without excessive delay. Hence, the list of U.S. and foreign candidates was short. Specific possibilities were the Douglas B-26 (an improved version of World War II

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[1] Britain's first jet bomber was actually conceived in 1944 by W. E. W. "Teddy" Petter, who later designed the Lightning and Gnat interceptors.

[2] The Korean conflict lasted from 25 June 1950 until 27 July 1953.

vintage), the Martin XB-51, the North American B-45 and AJ-1, the Canadair CF-100, and the English Electric Canberra. Much was already known about the new Canberra, but not quite enough. It had favorably impressed the USAF staff officers who had witnessed its first flight at Wharton airdrome in 1949.[3] In the summer of 1950, a committee headed by Brig. Gen. Albert Boyd, Commander of Edwards AFB, had given the plane an "expedited" and "limited evaluation." Therefore, the committee's report of 28 September was not conclusive. It deemed the Canberra suitable for all-weather fighter, tactical reconnaissance, and medium-altitude bomber operations. Yet, the report said the plane had little potential as a ground attack fighter-bomber because it was unstable during close support maneuvers. In the same cautious vein, the committee found that the British plane's tactical utility and ease of production warranted its "consideration" for the Mutual Defense Assistance Program.[4] On the other hand, the Canberra should not be used in the United States Air Force before "rigorous evaluation" of at least 1 aircraft and accelerated service testing of several prototypes. If eventually procured, the plane would require at least 25 changes. Even then, to benefit from the Canberra's design, the Air Force would have to accept the initial airframe, performance, and load capacity.

Subsequent to this appraisal, the Board of Senior Officers organized another committee. It was chaired by Brig. Gen. S. P. Wright, Deputy Commander of the Air Proving Ground, and included several representatives from Air Materiel Command (AMC) and Tactical Air Command (TAC).

Tentative Selection — December 1950

With the Boyd report on hand, the Wright Committee measured the Canberra's performance against that of the 4 remaining candidates, a

[3] The Canberra flight of 1949 underscored Great Britain's spectacular post-World War II advancements and her superiority in jet propulsion development. It gave credence to the British claim that production of thousands of Canberras was the factor which alone could best provide the tactical airpower necessary to counterbalance Soviet predominance in ground troops.

[4] W. Barton Leach, Special Consultant to Secretary of the Air Force W. Stuart Symington and to Secretary Thomas K. Finletter, Mr. Symington's successor, was among those who visited England in 1949 and 1950 for the primary purpose of reviewing the British jet propulsion accomplishments. Upon his return, Leach discussed the British Canberra proposal with John A. McCone, Under Secretary of the Air Force. While thinking that there might be disadvantages in diverting American production "heavily" to an aircraft of the Canberra type, Leach recognized that such a proposal could not be dismissed lightly, because the whole basic structure of strategic planning was involved. The discussion was to prove academic, since the Martin B-57 production never even reached the 500 mark.

comparison that did not help the North American B-45 and AJ-1. The B-45 was ruled out because it was too heavy; the Navy AJ-1, because it was too slow. While noting that neither the XB-51 nor the Canberra fully met the Air Force's night intruder requirements, the Wright Committee endorsed both. It proposed the immediate purchase of British Canberras for 2 light bombardment groups and future procurement of sufficient B-51s to equip 2 other groups. The Wright Committee's suggestion aroused scant enthusiasm among the Air Staff members. The Board of Senior Officers, after studying the Air Proving Ground Command's latest evaluations, found itself liking the Canberra's performance. In contrast, it seriously doubted that the B-51's range could ever match the Canberra's radius of action.[5] Although aware that the Canberra would need modification for the night intruder role, the board asked Lt. Gen. Kenneth B. Wolfe, Air Force Deputy Chief of Staff for Materiel, to ascertain if the British could furnish enough Canberras and still satisfy Royal Air Force orders. Nonetheless, as recommended by General Boyd, the board felt that no determination could be made until a borrowed Canberra became available. Going several steps further, the board then decided not only to await the plane's arrival, but to make on-the-spot comparisons with every initial aircraft candidate. This evaluation, it believed, together with a review of the night intruder's future role, should ensure the best solution to the present dilemma.

Final Endorsement — 26 February 1951

After hinging for weeks on divergent opinions, the Air Force decision to get a facsimile of the English Electric Canberra was nearly unanimous. As negotiated with the British government, a Royal Air Force Canberra B. Mk.2, bearing USAF insignia, left Northern Ireland on 20 February for Gander Field, Newfoundland. It landed in Baltimore, Maryland, on 21 February—the first jet aircraft to complete an unrefueled flight across the Atlantic Ocean—and arrived at Andrews AFB 2 days later. Ensuing flight demonstrations and ground inspections of the Canberra sealed the fate of other candidates. On 26 February, the Senior Officers and USAF Weapons Boards picked the British plane as the best interim aircraft available for the night tactical intruder role. General Vandenberg, Air Force Chief of Staff,[6] and Secretary Finletter swiftly agreed.

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[5] Martin's 2 XB-51s, under contract since May 1946, did not fly until October 1949. Costing a total of $12.6 million, both aircraft eventually crashed.

[6] General Vandenberg succeeded Gen. Carl Spaatz as Chief of Staff of the Air Force on 30 April 1948.

Program Go-Ahead — 2 March 1951

The Air Force wanted a night intruder so badly that it took just a few days to set in motion the informal production decision of 26 February. Since General Wolfe had found out that the British could barely take care of their own Canberra needs, the Air Staff directed AMC on 2 March 1951 to arrange for the aircraft's domestic production. Martin became the chosen contractor. The Air Force was convinced that the XB-51 had given that company a sound background for dealing with the potential problems of a high-performance tactical bomber.

Production Restrictions — 2 March 1951

Procurement Directive 51-135, issued by the Air Staff on 2 March, reflected the urgency of bringing into service an American version of the Canberra. The B-57, as the aircraft was to be known, was to go directly into production, a decision tantamount to buying an off-the-shelf airframe with an off-the-shelf engine and installed equipment. Even though the resulting aircraft, 250 of them to begin with, might not be exactly what was needed, configuration changes would be kept to a bare minimum—under the strict control of the Board of Senior Officers.

Testing Agreement — 16 March 1951

The British Canberra, exhibited at Andrews AFB, reached the Martin Company on 10 March. This permanent assignment grew out of a Combined Test Project Agreement, formalized with the Royal Air Force on 16 March. Under the same agreement, Martin received a second British Canberra several months later. Although the 2 planes acquired USAF serial numbers (51-17352 and 51-17387), they were carried in the Air Force inventory as Canberras, not as B-57s.

Contractual Arrangements — 24 March 1951

The informal production decision of 26 February 1951 was finalized on 24 March by Letter Contract AF 33(038)-22617. This production letter contract asked Martin to deliver 250 B-57s between November 1952 and October 1953. The schedule was predicated on Martin's attaining a peak production rate of 50 airplanes per month.

Other Negotiations March/May 1951

The production letter contract of 24 March covered more than the procurement of 250 B–57s. It authorized Martin to acquire the Canberra manufacturing rights, and gave the company a $6 million advance payment to take care of its most pressing expenditures. The license agreement finally worked out by the British and American firms was signed on 8 May 1951. Martin eventually built 403 B–57s of one kind or another; the English Electric Company, Ltd., in time received royalties topping $3.5 million. Another $1 million was paid for the 2 Canberras secured by Martin during the spring and summer of 1951. The Air Force reimbursed Martin the full cost of the 2 imported planes.

B-57A

New Features

As an intended replica of the English Electric Canberra B. Mk.2, the B-57A featured no outstanding innovations. Nonetheless, because of the American mass production methods, standards, and uses of different materials, tools, gauges, wiring, and techniques, the plane differed from its British pattern in several aspects. The B-57A had a slightly modified cockpit and canopy that afforded better visibility and more room for the crew (reduced from 3 to 2). Two Wright Aeronautical J65 turbojet engines were substituted for the Canberra's 2 Rolls Royce Avon turbojets. Other changes included the addition of wing tip tanks (to increase loiter time) and replacement of the British "clam shell" type bomb-bay doors. Developed by Martin for the B-57A, the pre-loaded revolving bomb-bay door rotated 180 degrees and eliminated the drag caused by an opened bomb-bay compartment during the bombing run.

Pre-Production Planning — 1 July 1951

Although the Wright J65 Sapphire engine,[7] due to power the B-57, and some equipment the Air Force wanted on the airplane would be furnished by the government, the urgent delivery schedules specified by the production letter contract of March 1951 presented difficult tasks. As a result, Martin began immediately to plan ahead and on 1 July subcontracted 60 percent of the actual production work. Its principal subcontractors were the Kaiser Products of Bristol, Pennsylvania, for the wings and special weapons bomb-bay doors; and the Hudson Motors Corporation of Detroit, Michigan, for the aft portions of the plane.

Pre-Production Testing — 1951

Martin tested its first British Canberra from April to October 1951,

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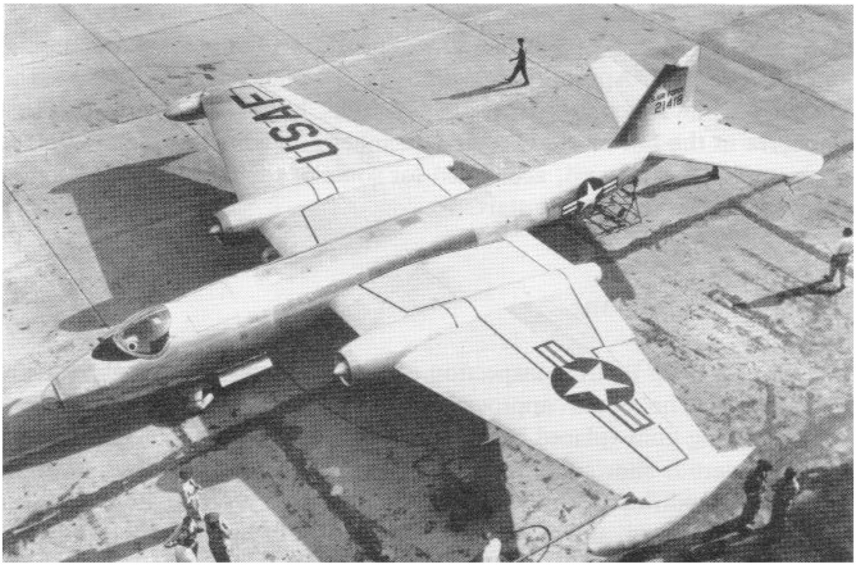
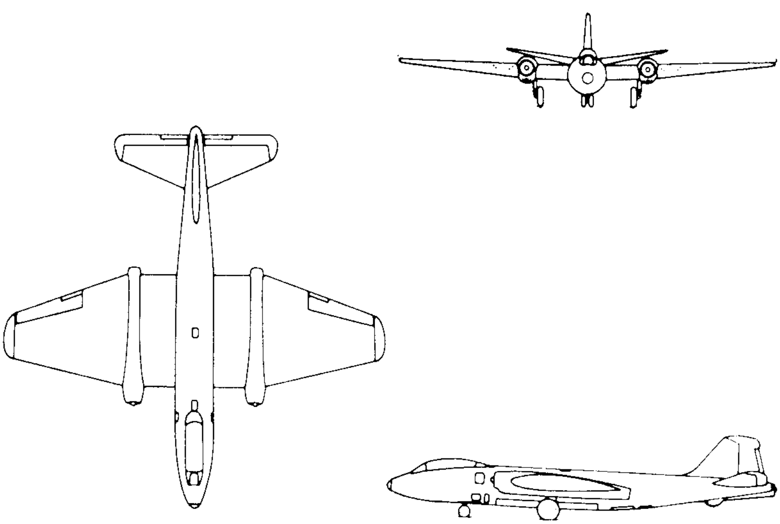
[7] The Sapphire was a hand-tooled production of the British firm Armstrong-Siddeley for which the Curtiss-Wright Corporation at Wood-Ridge, N. J., had acquired a manufacturing license. Production of the Wright YJ-65, as the Sapphire engine was redesignated, was not expected to begin before September 1951.



The B-57, an American version of the British Canberra, featured wing tip fuel tanks.



accumulating 41 hours of flying time in the process. The second imported plane reached Martin in September, was test flown not more than 4 hours, and disassembled. Appropriate sections of the plane were then shipped to Martin's main subcontractors.[8] USAF pilots began test flying the first Canberra in the fall of 1951. A 21 December accident, in which the plane was completely destroyed, accounted for some of the slippage that plagued the B-57 program from the start.

Mockup Inspection — 20 July 1951

The Mockup Board's inspection of the B-57A was not an overwhelming success. The board approved the location of the eight .50-caliber forward-firing guns (placed in the wings instead of the fuselage nose), but noted numerous shortcomings. It also pointed out that the aircraft would have to be modified to carry special weapons, that a compatible bombing system was required, and that pylons were needed to support external stores. Particularly dissatisfied with the B-57A cockpit, the board insisted that it should be redesigned.

Other Initial Deficiencies — August 1951

The Aircraft Laboratory of the Wright Air Development Center examined Martin's first B-57 specifications in August 1951. The laboratory was well-prepared for its chores. In January, it had thoroughly evaluated the Canberra and indicated that an Americanized production from the British drawings and data would not satisfy USAF requirements. In August, the laboratory's criticism grew. Besides sharing the mockup board's concern, it found fault with the aircraft's landing gear, the brake actuating system, the absence of winterization, and many other items. Moreover, the laboratory concluded that, as currently planned, Martin's tip tank installation, engine mounting, and nose gear swivel angle would be inadequate.

Problems and Controversies — 1952

In January 1952, Wright Air Development Center decided to challenge the B-57's production philosophy. So far, the center noted, the Board of

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[8] Eventually reassembled, this Canberra went to the Sampson AFB Museum, Geneva, N.Y., on 2 June 1954. It was scrapped 2 years later.

Senior Officers had approved the correction of only 6 deficiencies. Yet, some of the 35 design faults uncovered by the center's engineers could affect the safety, utility, and maintenance of the future B–57. In fact, the Royal Air Force (RAF) had refused to accept the Canberra from the English Electric Company until many of the very same flaws were eliminated. It therefore appeared inconsistent to carry any of these deficiencies into the American production of the plane. At first, Wright Center's position was not well-received. Air Materiel Command was quick to point out that the center previously had made no attempt to integrate its list of deficiencies into the production schedule of the plane, even though it made no sense to discuss one without the other. Any configuration changes adopted at this late date, AMC emphasized, would cause unacceptable production delays. Moreover, in the command's opinion, several of the corrections suggested by the air development center were superfluous, at least for the B–57A. The Air Materiel Command agreed, however, that the B–57 production guidelines ran counter to the USAF regulations calling for technical excellence. Another month of debate failed to alter the production restrictions of March 1951, but it did bring AMC around to support Wright Air Development Center's position. And, as events soon proved, the center's effort would have significant impact on the program.

Program Changes — 11 August 1952

On 11 August 1952, production of the B–57A's reconnaissance version, ordered earlier in the year, was reduced by one-third. More importantly, and to Wright Air Development Center's great satisfaction, procurement of the B–57A was virtually canceled. Only 8 B–57As would be built. Despite slight alterations, these aircraft would be recognized as direct copies of the Canberra. As actually recommended 2 years before by the Boyd Committee, the B–57A would be used for testing, thereby paving the way for production of a similar but better aircraft.

Production Slippages — 1951–1953

The unexplained Canberra loss of late 1951 and ensuing testing setback undoubtedly accounted for part of Martin's production slippage. But a major initial delay was caused by the government-furnished Sapphire jet engines that were due to power all B–57s. The Sapphire was a hand-tooled production of the British firm Armstrong-Siddeley for which the Curtiss-Wright Aeronautical Division at Wood-Ridge N.J., had acquired a manufacturing license. However, the J65, as the Air Force version of the Sapphire was designated, was perhaps more difficult to adapt to American specifications and manufacturing methods than the British plane. Although the Wright production had been set to begin in September 1951, the J65 prototype engines consistently failed to meet USAF requirements.[9] In June 1952, when the Air Force finally accepted the first 2 YJ65–W–1 engines, neither had yet completed the required 150-hour qualification test. Still, there were other problems of equal consequence. In April of the same year, a technical status report could only state that the B–57 manufacturer and subcontractors had begun the fabrication of "bits and pieces." In June 1952, while the B–57A basic engineering seemed to be completed, projected test flights were postponed to mid-1953 because of continuing engine and cockpit troubles.

First Flight (Production Aircraft) — 20 July 1953

The Martin twin-jet B–57A night intruder bomber at long last took to the air on 20 July. Company officials described the 46-minute flight as entirely successful. On 20 August, the plane underwent its official Air Force flight acceptance test at the Martin airfield at Middle River, Maryland. In attendance, among high-ranking Air Force officials, were General Twining, Air Force Chief of Staff since 30 June 1953; Lt. Gen. Edwin W. Rawlings, Commander of Air Materiel Command; and Lt. Gen. Donald L. Putt, Commander of Air Research and Development Command. Newspaper accounts of the B–57A performance were enthusiastic, more so than subsequent USAF appraisals.

Enters Operational Service

Relegated to the testing status, none of the B–57A productions entered operational service. Yet, 1 or 2 eventually participated in a few special projects.

Testing — December 1953

The Air Force accepted the first B–57A on 20 August, but lent it

[9] The new engine was also earmarked for the Republic F–84F. Due to the urgent need for improved fighter-bombers since the outbreak of the Korean War, the Air Force in December 1950 selected the Buick Division of the General Motors Corporation as the second source for the Sapphire engine.

immediately to Martin and never took delivery of the plane.[10] Hence, USAF testing did not start until December 1953, when all other B–57As were delivered. Once underway, however, testing was extensive. USAF pilots test flew the second B–57A (Serial No. 52–1419) for no less than 101 hours, reached in 80 flights. While testing would go on for years, by late 1954 the Air Force knew without doubt that the B–57A was somewhat superior to the original Canberra. Yet the overall improvement carried a price. Added equipment and the more powerful J65 engines had increased the aircraft's empty weight by 3,700 pounds, in turn reducing speed, distance, and altitude.

Total B–57As Accepted 8

Acceptance Rates

All B–57As were received in FY 54. The Air Force accepted—but never physically possessed—the first B–57A in August 1953. It took delivery of the remaining 7 in December.

End of Production December 1953

Flyaway Cost Per Production Aircraft $9.3 million

Airframe, $8,937,886; engines (installed), $349,357; electronics, $20,780; ordnance, $7,442; armament and others, $33,704.[11]

Subsequent Model Series B–57B

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[10] This plane (Serial No. 52–1418) remained with the Martin Company from its completion until 19 June 1957, when it was transferred to the National Advisory Committee for Aeronautics. The contractor received the airplane under Bailment Contracts AF 33 (038)–32001 and AF 33 (600)–2407 of 6 August 1953 and 21 February 1956. Martin test pilots flew the plane 292 hours in 284 flights.

[11] The high cost of the B–57A was explained by the fact that only 8 of them were built, and that Martin's initial and one-time manufacturing costs were prorated among those first few aircraft. But for rare exceptions, the higher the production, the lower the cost. Although only 67 RB–57As entered the inventory, the reconnaissance B–57A showed a significant price decrease. And despite important improvements, the unit cost of the subsequent and more numerous B–57B was still cheaper.

Other Configurations RB-57A

Phaseout 1961

Attrition, conversions, and special projects gradually absorbed the few B-57As. By mid-1961, the aircraft no longer appeared in the Air Force inventory.

Other Uses 1957

Early in 1957, the Air Force lent the second B-57A to the Weather Bureau of the Department of Commerce. Following modification, the plane participated in the National Hurricane Project.

RB-57A

Manufacturer's Model 272A

Weapon System 307L

New Features

Cameras, installed aft of the bomb-bay, constituted the main difference between the reconnaissance B-57A and the B-57A test-bomber. The cameras—P-2s, K-17s, K-37s, K-38s, or T-17s—could be interchanged, according to the aircraft's missions, which were many and included day and night, high and low, and visual and photographic reconnaissance besides day combat mapping. Unlike the B-57A, the RB-57A was totally unarmed and painted with a high gloss black paint that minimized detection by searchlights. In common with the B-57A, the plane carried only a 2-man crew—1 pilot and 1 photo-navigator, the latter replacing the B-57A's navigator-bombardier.

Basic Development — October 1951

As in the B-57A's case, the decision to develop a reconnaissance version was prompted by the Korean conflict. Increasingly effective enemy air defenses underscored USAF reconnaissance shortcomings. Hence, in an October meeting, the Air Staff and representatives of AMC and Wright Air Development Center defined the RB-57A configuration. So few changes were outlined that it would only take a minimum of effort to return the future RB-57A to service as a bomber—an occurrence that never came to pass in view of the B-57A's fate.

Program Reduction — 1952

The Air Force at no time seriously considered canceling the B-57, but nearly deleted the reconnaissance counterpart. Early in January 1952, as a result of the past October meeting, AMC prepared to order 99 RB-57As.

Within a few weeks, however, a whole new situation arose. The Air Staff not only spoke of procuring only 87 RB-57As, but also ventured that eliminating the entire order might be best. Assuming the RB-26s could somehow be equipped with night photographic equipment and made to work until the Douglas RB-66 became available, about $30 million could be saved in doing away with the RB-57s. Because delivery of the first RB-66 could not be expected before 1954, and successful modernization of the RB-26s was questionable, the Air Staff finally decided against any drastic change. Nevertheless, after dropping the requirement to 87 planes, the RB-57A procurement underwent a final cut on 11 August 1952, when it was reduced to 67. Despite ensuing RB-57A problems, the decision proved wise. In the midst of the Korean War, the RB-26s steadfastly demonstrated the difficulty and occasional futility of fitting old planes with modern, sometimes unproven, components. Also, consistent with almost traditional production patterns, delivery schedules for the RB-66 slipped significantly.

Production Slippage 1952-1953

On 24 April 1952, the Air Research and Development Command asked Martin to give priority to the RB-57A at the expense of the B-57A program—officially still practically intact at the time. The RB-57A production nonetheless slipped. But the command's directive served its purpose and worked in favor of the B-57B—Martin's first true Canberra bomber. Meanwhile, the contractor's problems kept on growing. Part of Martin's Baltimore plant remained occupied by the Army Signal Corps, and the late delivery of machine tools hampered reactivation of available facilities. To make things worse, in addition to avowed engine difficulties, Kaiser production of wing panels and nacelles had also begun to fall behind.

First Flight (Production Aircraft) October 1953

Flight of the first RB-57A came about 3 months after that of the first B-57A. Both flights were made from the Martin airfield at Middle River, and, ironically, the RB-57A flight occurred close to the date initially set for delivery of the 250th B/RB-57. By that time, the Air Force had reached several perplexing conclusions. First, the B/RB-57As would not meet USAF requirements; therefore, relatively small quantities would be built. On the other hand, regardless of their known shortcomings, the RB-57As remained urgently needed. However, speeding up Martin's new delivery schedules would be extremely costly. The Air Force, after weighing such conflicting factors, adopted what were most likely the best solutions. Testing was cut short, and most RB–57As were produced without benefiting from the usual "debugging" period that normally preceded operational use. But a major effort was made to improve subsequent models in the series—the B–57Bs and the unique RB–57Ds.

Enters Operational Service — July 1954

The RB–57As came into operational use in mid-1954. The Tactical Air Command earmarked the first few for transition training with the 345th Light Bomb Wing, Langley AFB, Virginia, and sent the next 22 to the 363d Tactical Reconnaissance Wing at Shaw AFB, South Carolina. The 363d reached an initial operational capability (IOC) in July.

Operational Problems — 1954–1955

The 363d's initial operational readiness was short-lived. Subsequent RB–57A deliveries were held up because the J65–BW–5 engines started burning oil and filled the cockpit with smoke. This matter taken care of, all 67 RB–57As were accepted by September 1954. However, the entire Canberra fleet was grounded in January 1955, this time for engine compressor failure. And while this problem was being solved, new deficiencies were uncovered. The RB–57A's control system required adjustment, and the wing-fuselage attachment fitting needed reinforcement.

Structural Modifications — 1954–1955

Modifications, referred to as Garden Gate,[12] strengthened the connection of the wings to the fuselage. All RB–57As had received the Garden Gate changes by November 1954, and these modifications later were incorporated into Martin's production line. However, new structural deficiencies came to light as cracks developed around the aircraft's nose cap.[13] Repair of the cracks limited the operation of the aircraft.

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[12] The term came from the "garden gate" shape of the fittings that linked the wings to the fuselage.

[13] Martin had already canceled a Hudson subcontract involving the manufacture of RB–57A nose sections.

Overseas Deployments 1955

The engine malfunctions, structural deficiencies, and many other ills that afflicted the RB-57As were compounded by the lack of equipment and spare parts to support the new planes. Hence, at home or overseas, the aircraft assignments were delayed, and the first 2 USAF wings in West Germany which transitioned from RB-26s to RB-57As did not keep their new planes very long. Both the 10th Tactical Reconnaissance Wing at Spangdahlem AB and the 66th at Sembach AB started converting to more efficient RB-66s in late 1957.

End of Production August 1954

Production ended with the August delivery of the last 5 aircraft.

Total RB-57As Accepted 67

Acceptance Rates

The Air Force accepted 49 RB-57As in FY 54—from December 1953 through June 1954. The last 18 were accepted in FY 55—13 in July 1954 and 5 in August.

Flyaway Cost Per Production Aircraft $1.66 million

Airframe, $1,240,051; engines (installed), $349,357; electronics, $4,096; ordnance, $9,324; special equipment, $58,485.

Average Maintenance Cost Per Flying Hour $191.00

Subsequent Model Series B-57B

Other Configurations RB-57A-1, RB-57A-2, and EB-57A

RB-57A-1s—Ten RB-57As, after elimination of their most serious deficiencies, were converted for high-altitude reconnaissance. The project, known as "Lightweight" and later renamed "Heartthrob," was handled by the Wright Air Development Center and Martin. Under Heartthrob, all equipment and items not absolutely essential for daylight photography were removed from the basic RB-57A. The plane's J65-BW-5s were replaced by higher thrust J65-W-7 engines, and the crew was reduced from 2 to 1. The RB-57A-1 was 5,665 pounds lighter than the RB-57A (43,182 to 48,847), and its altitude was increased by 5,000 feet. The Heartthrob modifications were successfully completed in August 1955. Six RB-57A-1s went to the 7499th Composite Squadron in United States Air Force in Europe; 4 to the 6007th Composite Squadron in Far East Air Forces.

RB-57A-2s—Two RB-57A-1s were modified under Hardtack, a project also referred to as Heartthrob, Jr. The modification removed some equipment from the airplanes to make room for the Convair-developed AN/APS-60 Startrack, a high-altitude radar that had been briefly tested on a B-57B. Martin undertook the project with reluctance, because the non-standard AN/APS-60 was highly sophisticated and its installation promised to be difficult—which in fact it was. The 2 Startack-equipped RB-57A-2s were delivered in September 1957—a 9-month delay.

EB-57As—In the mid-sixties, the Air Force endorsed the modification of 32 RB-57As. The work, done by Martin, essentially consisted of fitting a compartment, full of electronic countermeasures equipment, in the aircraft bomb bay. The first EB-57A (Manufacturer's Model 272R) flew in April 1966 and was immediately accepted by the Air Force. Martin completed the fairly complicated project in less than a year and the Air Defense Command[14] continued to use the EB-57As for electronic countermeasures training until the early seventies.

Phaseout 1970-1971

The original RB-57A received little praise. By 1958 ten RB-57As had already been lost in flying accidents. At the end of 1970 only 2 remained on the active USAF rolls. But the RB-57A, although scarcely satisfactory from the start, did pay its own way. The aircraft's numerous special configurations proved invaluable for many years. Twelve EB-57As were still in the operational forces in late 1971.

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[14] The Air Defense Command became the Aerospace Defense Command on 15 January 1968.

Other Uses

In early 1956 one RB-57A satisfied the special photographic requirements of the United States Air Forces in Europe. Known as the Sharp Cut RB-57A, the aircraft did not materialize as soon as expected. Revisions to the bomb-bay and instrument panels and the installation of special purpose photographic equipment (the F-11 camera in particular), took time. In 1957 the Air Research and Development Command lent an RB-57A to Northrop Aircraft, Inc., to study laminar-flow boundary layer control, a topic of crucial USAF interest. In the spring of 1958 the Air Force prepared a number of RB-57As for atmospheric sampler missions. The modification added special equipment to the aircraft, which were temporarily designated B/20 airplanes.

Other Countries

Two RB-57As, after modification, were turned over to the Republic of China under Project Large Charge.

B-57B

Manufacturer's Model 272

Weapon System 307A

Previous Model Series RB-57A

The RB-57A preceded the B-57B in the USAF inventory, but the B-model was the B-57's first production bomber as well as the major inventory model.

New Features

The most significant change featured by the B-57B was an entirely new design of the cockpit area. The reconfiguration placed the navigator-bombardier behind the pilot under a large bubble canopy similar to that of the T-33.[15] This arrangement improved visibility, afforded more space for the installation of equipment, and conformed to the Air Force-preferred tandem type of seating. Specifically, the B-57B pilot's seat was on the fuselage centerline. The navigator's back seat was slightly offset left of the center line to provide room for the Shoran receiver-indicator and the Swedish-designed M-1 toss-bomb computer unit. The B-57B also introduced a flatplate wind-shield allowing the installation of a gun sight, external wing pylons, improved defrosting, and fuselage dive brakes. The wing pylons mounted high-velocity aircraft rockets or bombs. Beginning with the 91st B-57B production, the eight .50-caliber forward-firing wing guns, first seen on the B-57A test aircraft, were replaced by 4 M-39 20-millimeter guns.

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[15] The Lockheed T-33 Shooting Star was an all-metal, full cantilever low-wing, 2-seat, high-performance aircraft used by the Air Force for the training of flight personnel.

Basic Development 1952

The B-57B development took shape in early 1952, when Air Materiel Command and Air Research and Development Command acknowledged the unacceptable deficiencies of the B-57A configuration. In March, they jointly presented the current problems to Air Force Headquarters. And as early as 17 April, the 2 commands gave the Air Council a list of minimum but mandatory changes for ensuring production of a sound airplane. Although not relinquishing production control, the Board of Senior Officers did endorse most of the proposed modifications.

Production Decision 11 August 1952

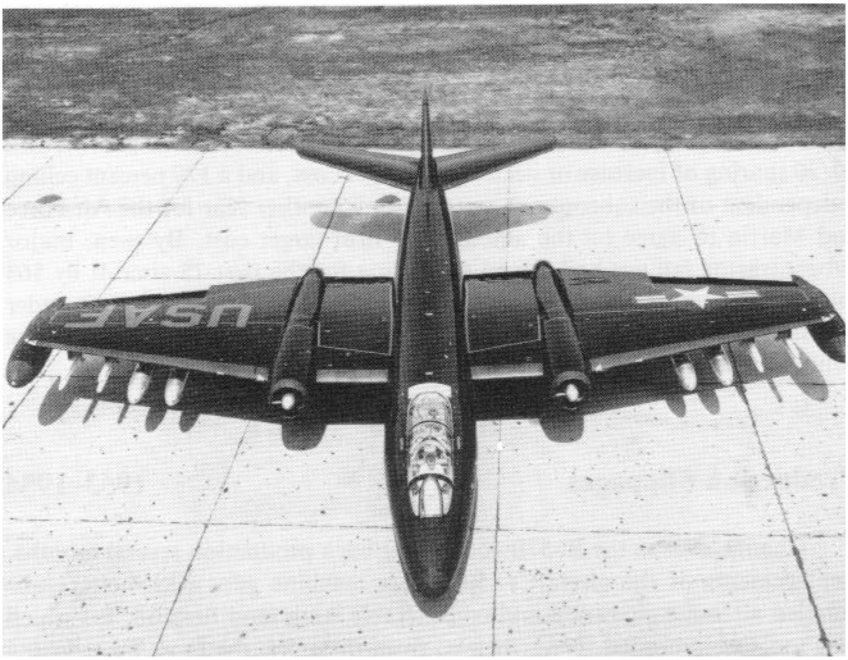
The B-57B production became official on 11 August, concurrent with the B-57A's virtual demise.

Mockup Inspection 2 October 1952

The B-57B mockup was officially inspected on 2 October. Of primary interest was the new cockpit arrangement and the single blister canopy. Deletion of the Shoran equipment, to provide space for a new type of radar, was discussed but not adopted.

Additional Procurement September/December 1952

Letter Contract AF 32(038)-22617 of March 1951 called for the production of 250 B-57s but was amended several times. In August of the same year, the number of B-57s on order stood at 209; in February 1952, at 177. On 11 August 1952, total procurement remained at 177, but 102 B-57Bs were substituted for 70 B-57As and for 32 RB-57As. The first follow-on fiscal year 1953 contract began with Letter Contract AF 33(600)-22208, which was issued 19 September 1952 and covered the additional procurement of 119 B-57Bs. An amendment on 18 December raised the FY 53 B-57B procurement to 191, bringing the cumulative B-57B future production to 293. This total, however, did not materialize. Affected by changes almost from the start, the B-57 program was revamped many times over. In some cases, obsolescence was the governing factor. On other occasions, special or ever-increasing operational requirements were the cause.



An armed B-57B, displaying the reconfigured cockpit which placed the pilot in front of the navigator-bombardier.

Revised Production Schedules 1952

Although frowned upon, the revision of production schedules was seldom avoidable. In August 1952, completion of the 177 B/RB-57s then on order was pushed back to August 1954, a date which proved highly optimistic. Also, Martin's production peak rate was reduced from 50 to 17 airplanes per month. The Air Force thought the B-57B would benefit from a slower production tempo. Still, it did not expect to wait until May 1956 for its full complement of new bombers—almost 3 years past the deadline set by the Board of Senior Officers back in 1951. Such complications, the program changes occurring during the interim years, and the new production schedules generated by such changes all proved costly. In the end, the B-57B's average unit price was double that first negotiated.

First Definitive Contract 1 August 1953

The Air Force finalized Letter Contract AF-33(038)-22617 in August

1953. Changes in quantity, type of airplane, and configuration explained the protracted negotiation period, and the contractor's hard bargaining played a part. Besides higher profits, Martin wanted to be amply protected against subcontractor failure and cost increase. The definitive contract was a fixed price incentive type, with reset. Martin received a 7.5 percent profit, with 80/20 sharing of increase or decrease of target cost, and a 120 percent ceiling independent of the subcontract costs. It took another year for the Air Force and Martin to agree on the amounts of firm target cost. By then, major subcontractor failings had upped the billing for the first 75 aircraft by $63 million. The target cost negotiations for the remainder of the aircraft under the same contract dragged on until April 1955. It was 1958 before the contract was completely closed out.

Production Slippages 1953–1954

Change-over to the B–57B cockpit set back production several months. Replacements of the aircraft's .50-caliber machine guns with better guns entailed airframe alteration and considerable wing modification, for which new tools were needed. Nevertheless, from the start, the most far-reaching production problem was Kaiser's failure to deliver B–57 wings on schedule. Martin asked for permission to cancel the Kaiser contract but was allowed to withdraw only part of it. The Air Force pointed to the exorbitant cost of dropping Kaiser, in money as well as time. In any case, Kaiser's difficulties could be traced to poor management, but the subcontractor still remained well-qualified to do the work. For that matter, Martin also posted a good record manufacturing the special bomb-bay doors pulled back from Kaiser. Yet, later events showed that the Martin engineering capacity could be overtaxed. In the long run, the price increase of the first 90 aircraft was chiefly due to the Kaiser muddle. Still, other alternatives undoubtedly would have been more expensive.

Program Changes 1954

The B–57B program, set at 293 aircraft, was reduced by 91. In early 1954, the Air Force pared the FY 53 B–57B procurement to 158 (a 33-aircraft cutback) and dropped the tentative purchase of 50 more B–57Bs. In the spring, 38 B–57Bs were canceled in favor of producing an equal number of B–57 dual-control trainers. A final change, a few months later, diverted 20 B–57Bs to the B–57D program of 1953. These aircraft were subsequently redesignated RB–57Ds.

First Flight (Production Aircraft) 18 June 1954

Following the B–57B's first flight, a few aircraft were delivered to the flight test center at Edwards AFB.

Enters Operational Service 1954–1955

B–57Bs were assigned to 2 Tactical Air Command light bombardment wings in late 1954 and early 1955. The 3-squadron wings in time received 18 aircraft per squadron—16 B–57Bs and 2 B–57 dual-control trainers. The initial recipient was the 424th Bomb Wing, Light, at Langley AFB. The 461st Wing, Blytheville AFB, Arkansas, acquired its first B–57B on 5 January 1955.

Operational Problems 1954–1955

Like the RB–57As, the B–57Bs prior to delivery suffered from engine malfunctions that filled the cockpit with toxic fumes. Following delivery, new engine problems required the grounding of B/RB–57s. Inspection of the engine compressor (the culprit) and lifting of the grounding order afforded short relief. Difficulties with the aircraft's stabilizer control system triggered another grounding in February 1955. The B–57Bs were released for flight the following month, but were restricted to a maximum speed of 250 knots pending modification of the horizontal stabilizer and the installation of a different stabilizer trim switch—yet to be accomplished by mid-year.

Testing 1954–1955

Fourteen of the first B–57Bs accepted by the Air Force never received the Garden Gate modification that was implemented on the production line. These planes were assigned permanently to testing, a program that started inauspiciously. Already delayed by Martin's production slippages, testing was continuously interrupted because the 14 test-bombers shared the deficiencies, groundings, and flight restrictions of other B–57Bs. Hence, an operational suitability test, conducted by the Air Proving Ground Command, was not completed on schedule. To make things worse, in February 1955 the command's interim test report generally confirmed TAC's expectations. After incomplete investigation, Air Proving Ground Command pointed out that the B–57B appeared in no way to satisfy the night intruder and close support requirements that had generated its production. The command gave several good reasons for its pessimism. The B-57B's target acquisition system was inadequate, the navigational range was too short, and the radio navigation could not recover the aircraft after strikes. The new bomber's armament also was deficient, the gun-bomb-rocket sight, the gun charging systems, and the external stores release being unreliable. Even the long-awaited M-39 guns could not be fired safely because the cartridge links hit the wing undersides. Moreover, the B-57Bs so far received still had no anti-icing and de-icing equipment. Nonetheless, the proving ground command tentatively concluded that the B-57B showed the potential of becoming an effective fighting machine. However, besides correction of the aircraft's present flaws, this would require the addition of proper internal equipment. Another obvious must was to increase range, which had shrunk in proportion to the aircraft's weight increase.[16]

Overseas Deployments 1955

Once underway, B-57B deliveries were almost uninterrupted. Thus, in 1955 two oversea light bombardment wings were equipped with B-57Bs. The 38th Bomb Wing, Light, at Laon AB, France, was the first, beginning in June. The other, the 3d Bomb Wing, Light, at Johnson AB in Japan, followed late in the year.

Improvement Postponement 1955

B-57B deployments, whether at home or overseas, did not signify that the Air Force was unaware of or accepted the aircraft's shortcomings underlined in the Air Proving Ground Command's interim operational suitability test report. In fact, these deficiencies were amply confirmed in the spring of 1955, when the AMC's Inspector General rated the new bomber nearly as low as the obsolete B-26 it was to replace. But the B-57B as received was quite flyable. The Air Force knew that, unlike the B-47, the aircraft could go directly to the tactical units and not make an immediate turn-around to a modification center. Moreover, money was scarce. The Air

[16] It would cost too much to modify the B-57 for air refueling, but there were other means to extend range. In principle, this had been taken care of in June 1954, with a purchase order for 54 external fuel tanks of the kind used by the old B-26s. Years later, however, TAC still experienced difficulties in getting enough long-range ferry tanks for the B-57s of its Composite Air Strike Force.

Force wanted to see how the faster B-66 fared, before endorsing a costly B-57 improvement program. Also, new equipment (radar, navigational, and other electronic systems) was either in short supply or still in the development or early production stages. In any event, the B-57's longitudinal control and stabilizer systems would be modified. But this could be postponed temporarily because, should the Air Force decide on other improvements, it would be cheaper to do all the work at once. Meanwhile, enforced (and not so unusual) flight restrictions would continue to ensure the aircraft's safety.

Post-Production Modifications 1955-1957

In September 1955 the Air Force decided to bring the B-57 to tactical standards. To this end, it organized a 3-phase combat readiness program. Phase I installed the low-altitude bombing system (LABS), the AN/APS-54 Radar Search, and the ALE-2 Chaff Dispenser. Phase II added the M-1 Toss Bomb Computer as well as the AN/APG-31 Tie-in-Equipment. This phase also involved so-called Class IV and V modifications to the longitudinal control and stabilizer systems and to the fuel control panels and special weapon bomb-bay doors. Phase III dealt with the AN/APN-59 Radar Beacon and a number of tentative engineering change proposals. Planning its 3-phase program carefully, the Air Force directed that it should be carried out by USAF personnel and contractor teams during the normal inspection and repair of each plane, as necessary. Some of the work was to be done at the Martin plant and some at the Warner Robins Air Materiel Area in Georgia. Like most planning, these arrangements were affected by circumstances. For example, modification schedules were altered by changes in programming and B-57 utilization. On occasion, Phases I and II were lumped together. Sometimes there were delays. The AN/APN-59's Phase III installation did not materialize. A Martin subcontract with the Swedish Airlines Services in Copenhagen, covering the modification of 55 United States Air Forces in Europe (USAFE) B-57s, was amended. The change decreased the number of aircraft involved by 20. Late in 1956, special USAFE requirements prompted TAC to part with 15 reworked B-57Bs. These aircraft, no longer under flying restrictions, remained on loan overseas while an equivalent number of USAFE B-57Bs underwent similar modifications. As for the Pacific Air Forces (PACAF) B-57s, they were modified at the Kawasaki plant at Gifu in Japan. Air Force personnel and teams from Land-Air, Inc. (another Martin subcontractor) handled the modification. The same Land-Air teams also helped in the United States. Even so, a great deal remained to be done in late 1957, as the aircraft's phaseout already appeared on the horizon.

End of Production — May 1956

Delivery of 2 last B-57Bs marked the end of production.

Total B-57Bs Accepted — 202

The Air Force accepted a peak number of 27 B-57s in June 1955—18 B-57Bs and 9 B-57Cs.

Acceptance Rates

The Air Force accepted 123 B-57Bs in FY 55, and 79 in FY 56.

Flyaway Cost Per Production Aircraft — $1.26 million

Airframe, $852,973; engines (installed), $257,529; electronics, $49,032; ordnance, $16,090; armament and others, $88,738.

Average Cost Per Flying Hour — $511.00

Subsequent Model Series — B-57C

Other Configurations — B-57G

Night strike operational problems in Southeast Asia led to a major reconfiguration of the plane that had been ordered many years before for another conflict. The B-57 night intruder, too late for combat in Korea and never totally successful in Southeast Asia, at least demonstrated under fire the basic qualities justifying its original selection. In 1967, after several trial projects involving the special equipping of different planes were delayed or proved unsuccessful,[17] the Air Force looked to the B-57 to begin satisfying

[17] Included in these many projects were the testing of a forward-looking infrared sensor, installed in an old B-26, and of a fairly similar but more sophisticated system, in a Fairchild C-123. These projects carried exotic names. One of them, Tropic Moon I, put low-light-level

increasingly tough requirements. As successively published in the late sixties, Southeast Asia Operational Requirements 35, 64, 77, and 117 called for a self-contained night attack jet aircraft. The plane had to carry every device needed to acquire and attack mobile ground targets and fixed anti-aircraft artillery sites, in any kind of weather and without any ground or airborne assistance.

The Air Force thought General Dynamics F–111D, as ordered in May 1967, would be the ultimate answer. Yet, production of such a high-performance, avionics-loaded weapon system would not be an easy task. For that matter, the less-ambitious reconfiguration of the already-proven B–57 would also be difficult, again because of the components earmarked for it. Pressed for time, the Air Force in March 1967 decided to equip 3 PACAF B–57Bs with an improved version of the Tropic Moon I low-light-level television already fitted in 1 A–1E. Referred to as Tropic Moon II, the new project was not allowed to linger. The Air Force notified all concerned commands on 12 April, and soon thereafter the Westinghouse Electric Corporation received the modification contract for the 3 aircraft that PACAF chose and ferried from Southeast Asia to Baltimore. Once modified, the Tropic Moon II planes were returned to Southeast Asia without delay. They actually reached Phan Rang AB in South Vietnam on 12 December 1967.

Meanwhile, the B–57's final reconfiguration was approved. Initially labeled Night Rider, this project centered on a General Dynamics proposal to equip 15 B–57s with low-light-level television, forward-looking radar, and infrared sensors. The B–57 appeared well suited for the Night Rider role. The aircraft was available, had room for several sensors, and could carry 9,000 pounds of bombs at speeds of 160 to 500 knots. TAC and PACAF supported the Night Rider project, but in May 1967 the Air Staff rejected it as somewhat risky and far too costly. Rising difficulties in Southeast Asia, where enemy night movement of troops and supplies continued unabated, caused the Air Staff to reconsider its disapproval. In mid-year, the Air Force not only decided to endorse the Night Rider concept, but also to speed it up. This gave way to Tropic Moon III, the conversion of B–57s to self-contained night attack configuration. Tropic Moon III received added impetus in August, when the Air Staff told the Air Force Systems Command[18] to skip usual managerial procedures, to develop a B–57G prototype "immediately," and to plan for simultaneous procurement of a full B–57G squadron. The

television in a McDonnell-Douglas A–1E Skyraider, but the plane was not expected to reach South Vietnam until the end of 1967.

[18] The Air Force Systems Command came into being on 17 March 1961, replacing the Air Research and Development Command that had been established in 1950.

Air Force wanted the Tropic Moon III prototype to be ready for testing by September 1968. It also wanted the 15 B–57Gs "to be deployed as soon as possible" to Southeast Asia.

Notwithstanding Tropic Moon III's urgency, money had to be found before anything could be done about it. By late 1967, the skimpiest Air Force estimates showed that it would take some $50 million to accomplish the project. But in early 1968, the problem seemed to be solved. Funds from lower priority programs had been shifted, $25 million had been added to the overall budget for fleet modification, and the Air Force was ready to inform industry of its requirements. Hence, on 8 March, Air Force Systems Command's Aeronautical Systems Division advertised for bids to modify government-furnished B–57Bs to a new "G" configuration by integrating government- and contractor-furnished equipment. The contractor guidelines, offered by the Aeronautical Systems Division, were quite explicit. Besides the basic airframe, the Air Force would furnish engines, electronic countermeasures equipment, and communications sets. The contractor would provide the weapons delivery and navigation systems as well as modify the airframes. Specific yardsticks were established for the B–57G's avionics. The Tropic Moon III forward-looking radar had to be highly sophisticated, certainly as efficient as the AN/APQ–126 of the Ling-Temco-Vought A–7D (the Air Force's forthcoming version of the Navy A–7 Corsair). The Tropic Moon III weapons delivery computer and navigation system were to be particularly accurate. Additional armor plate and new

Deployed to Southeast Asia, this B–57 Canberra completed a mission against Viet Cong troops in the province of Tay Ninh.

ejection seats had to be provided to increase crew protection. Also, other changes were required in order to enhance safety, including the mounting of self-sealing fuel tanks in the aircraft fuselage.

The Air Force's 1968 financial bliss did not last long. Bids submitted in April by General Dynamics, Ling-Temco-Vought, North American Rockwell, and Westinghouse topped the highest USAF estimate by $30 million or more. In May and June, the extra money actually needed could not be secured. It therefore became clear that the Air Force had only 3 choices, one of which was to forget the whole project, a possibility considered for a while. Less drastic second and third alternatives were to reduce the number of B–57Gs, or to trim some of the weapon system's costly requirements. Well acquainted with the state-of-the-art limits and the pitfalls of new components of the forward-looking radar type, the Aeronautical Systems Division fought for the third solution. The division[19] won its case, as Wright Air Development Center had years before when challenging the wisdom of the B–57A production. Reconfiguration of 16 lower-performance Tropic Moon III B–57Gs (prototype included) was officially approved on 29 June. The selected prime contractor, the Westinghouse Defense and Space Center of Baltimore, agreed on 15 July to do the work for $78.3 million—an amount still higher than hoped for. Two major subcontractors were involved. Westinghouse counted on Martin-Marietta to inspect and repair the elderly B–57Bs picked for reconfiguration. Texas Instruments was made responsible for the forward-looking infrared radar and laser ranger.

When dealing with new technology, the best plans could go astray. The Air Force wanted to put the Tropic Moon III B–57s into combat by April 1969, but this soon was changed to December. And this more realistic deployment date was not met, even though the modification at first proceeded smoothly. There were many reasons for every delay. In early 1969, Westinghouse category I tests fell behind schedule because the Air Force was late with the shipments of necessary ground equipment. To compound the problem, in August Texas Instruments' deliveries of forward-looking infrared sensors began to slip significantly, and the Air Force failed to deliver the electronic countermeasures equipment on time. In late 1969 investigation of recent crash of a B–57G, still being tested by Martin pilots, indicated that the aircraft's minimum speed was too slow for safety. Ensuing flying incidents, in February and May 1970, uncovered mechanical flaws which, although minor, had to be corrected.

Meanwhile, there were other setbacks. In 1968, the Tropic Moon II B–57's performance had proved disappointing, mainly because the low-light-level television system did not live up to expectations and the aircraft's

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[19] Aeronautical Systems Division was established on 1 April 1961, replacing WADC.

navigation system remained unreliable. In mid-1969, Westinghouse announced that the Tropic Moon III project would cost at least an extra $3.5 million. This additional expense was troublesome, but the Air Force was more disturbed by other events. Foremost were difficulties experienced with the weapon system's most crucial components which, besides delaying the program further, affected crew training and testing of new devices and munitions. As a result, the Air Force no longer thought of Tropic Moon III as a partial solution to a most urgent Southeast Asian problem. Rather, it had begun to consider the B-57G and F-111D as evolutionary steps toward the development of a high-speed, fully integrated, self-contained night and all-weather weapon system of the future.

In line with its new Tropic Moon III appraisal, the Air Staff in early 1970 insisted that the latest September deployment date would be met. The B-57G's category III tests, conducted by the Tactical Air Warfare Center between 29 April and 27 July, did not alter the Air Staff's decision. Overall, the results of category III testing indicated that, except for the forward-looking infrared radar, the aircraft's avionics equipment satisfied basic requirements. Concluding that the aircraft performance was nearing that originally specified, Gen. John D. Ryan,[20] Air Force Chief of Staff, ordered the 13th Bombardment Squadron to move to Ubon Air Base, Thailand, on 15 September. Only 11 of the remaining 15 B-57Gs were assigned to the squadron, leaving 3 aircraft at MacDill AFB to train replacement crews. A last B-57G also stayed behind to serve as a "test bed" for future improvements.

The Tropic Moon III B-57Gs were returned to the United States in April 1972. Despite the combined efforts of Texas Instruments and Westinghouse, the forward-looking radar proved deficient. Improved sets updated at a cost of $2 million and first combat tested in September 1971, also never worked completely well. But the B-57G airframe, with its new J65-W-5D engines, measured up to the planning criteria. The aircraft also got involved successfully in such projects as Pave Gat, which showed that sensor-slued guns could function effectively in a jet bomber.

Phaseout — 1958-1973

As programmed, TAC phaseout of its B-57B/C aircraft was fast. Started in April 1958, it was completed on 23 June 1959. To some extent, TAC deplored its loss. Despite limited speed, short range, and other

[20] General Ryan replaced Gen. John P. McConnell as Chief of Staff of the United States Air Force on 1 August 1969, and served in that position through 31 July 1973.

deficiencies, the B–57B had become a proven weapon system presenting few maintenance problems. A PACAF request for retention of its own B–57s fared better, and 2 squadrons remained at Johnson AFB, Japan, until 1965. These B–57 units, the 8th and 13th Bomber Squadrons, Tactical, then moved to Clark AB, in the Philippines for possible action in Southeast Asia. Small numbers of the aircraft soon flew missions from Bien Hoa and Da Nang Air Bases in South Vietnam. Combat attrition, accidents, and old age took their toll of the aircraft. Forthcoming Tropic Moon requirements also did not help, forcing PACAF to inactivate its last squadron in 1968. But this did not really spell the B–57B's end. As already noted, TAC reactivated the 13th Bombardment Squadron, Tactical, to fly reconfigured B–57B and B–57C aircraft. Known as B–57Gs, these planes stayed in Southeast Asia until 12 April 1972. Having been stripped of most of their Tropic Moon components, the B–57Gs went to the Air National Guard—like many of TAC's B–57Bs in the late fifties. The Guard flew the B–57Bs, that had been modified for reconnaissance, until 1966. However, its newly acquired B–57s were scheduled for storage at Davis-Monthan AFB in early 1974.

Other Uses 1956–1957

One B–57B was extensively modified for Operation Red Wing, a special weapons test held in the Pacific in 1956. To save time and money, the plane was modified while on the production line. Martin later restored this Red Wing B–57B to its regular configuration.

Six B–57Bs were modified during August and September 1956 to perform sampler roles in the Red Wing tests. In December 1957 four additional B–57Bs were also modified to monitor the type and rate of radioactive fallout in the upper atmosphere after a nuclear blast. Following completion of the Red Wing tests, these planes were all allocated to the Air Force Special Weapons Center at Kirtland AFB, New Mexico.

In late 1957, ten B–57Bs were modified under Project Stardust. This modification removed all armament equipment from the aircraft, but put in the latest flying instruments. These modified B–57Bs were used by high-ranking officers for proficiency flying and transportation.

Other Countries 1960

More than 50 B–57Bs, re-fitted with less-sophisticated components, were delivered to Pakistan under the auspices of the Military Assistance Program.

B–57C

Manufacturer's Model 272

Weapon System 307A

Previous Model Series B–57B

New Features

Rear cockpit flight controls and instruments were the only new features of the B–57C.

Basic Development 1953–1954

Development of a dual-control B–57B was spurred by an Air Training Command request in February 1953. In the ensuing months, TAC also insisted that a new trainer was needed to replace the T–33. Even the most seasoned pilots, TAC argued, needed to learn how to handle multi-engine jet bombers skillfully.

Go-Ahead Decision April 1954

Reduction of the B–57B program in favor of production of a dual-control version of the aircraft was officially approved in April 1954. At first, 34 B–57Bs on the fiscal year 1953 program were to be modified on the production line, but this number was almost immediately raised to 38. The modification, consisting mostly of installing government-furnished equipment in the aircraft's rear cockpit, was expected to cost less than $50,000 per aircraft. Although low cost was a factor, the Air Staff's decision stemmed primarily from Martin's assurance that the B–57B could be brought to the dual-control configuration without compromising its combat performance. In other words, no extra B–57Bs would be needed to replace those converted into trainers since the latter could still be used as bombers.

Additional Procurement — August 1954

Purchase of an additional 26 dual-control B-57s was included in the fiscal year 1955 program, in connection with the production of another B-57 type. In August 1954, however, the 26-aircraft order was canceled and the dual-control planes, formerly known as TB-57Bs, were redesignated B-57Cs.

Prototype Inspection — November 1954

The November inspection of the first B-57B modified for dual-control revealed no discrepancies.

First Flight — 30 December 1954

The B-57C made its first flight on 30 December 1954 and its second one on 3 January 1955. The Martin pilots who flight tested the plane were impressed by its performance and pointed out that they encountered no handling difficulties.

Enters Operational Service — 1955

Four B-57Cs, purchased to take care of attrition, were initially allocated to Air Training Command to support the B-57B transition training program. All other B-57Cs immediately went to tactical units. In fact, in the United States or overseas, 2 out of every 18 aircraft in a B/RB-57 squadron were B-57Cs.

Problems and Modifications — 1955-1957

Being practically identical, the B-57Bs and B-57Cs shared the same operational problems. Hence, most B-57B modifications were applied to the B-57Cs.

End of Production — May 1956

Delivery of 1 last B-57C in May 1956 marked the end of the dual-control production line modification.

Total B-57Cs Accepted — 38

Acceptance Rates

The Air Force accepted 18 B-57Cs in FY 55, and 20 in FY 56.

Flyaway Cost Per Production Aircraft — $1.21 million

Airframe, $916,279; engines (installed), $144,523; electronics, $46,128; ordnance, $20,340; armament and others, $84,685.

Subsequent Model Series — RB-57D

Other Configurations — None

Phaseout — 1958-1959

Phaseout of the small B-57C contingent followed the B-57B's pattern. Like the B-57Bs of the Tactical Air Command, most B-57Cs were brought up to the reconnaissance configuration in 1958, when they began reaching the Air National Guard. Three RB-57Cs were still listed on the Guard inventory in mid-1973.

RB–57D

Manufacturer's Model 294

Weapon System 307L

Previous Model Series B–57C

New Features

The single-seat RB–57D featured a substantially altered B–57B fuselage, new wings, more powerful engines, and components that varied, according to the aircraft's many specialized roles. Specifically, the fuselage bomb-bay was permanently closed off, the fuselage fuel tanks were removed, and 4 camera windows were installed forward of the nose wheel well. The RB–57D's large nose and tail radomes further lengthened the fuselage. The aircraft empennage incorporated a power-driven rudder and yaw damper. Fuel cells were integral with the RB–57D wing, which was of honeycomb construction—the first time that such a structural feature had been used in a piloted aircraft. The new wings, with their 105-foot span and their 1,500 square-foot area (replacing the 64-foot span and 960 square-foot area of the regular B–57), completely changed the appearance of the airplane. Two 1,000-pound thrust J57–P–9 engines (that took the place of the 7,200-pound static thrust J65s) had anti-icing equipment and could be used at altitudes over 70,000 feet. To increase range, all but the first 6 RB–57Ds were equipped for air refueling.

Basic Development 1952–1953

Martin's Model 294, which ultimately became the RB–57D, developed from a study concluded in December 1952 by the Wright Air Development Center. This study showed that it should be possible to develop "in a relatively short time period" a turbojet-powered special reconnaissance aircraft, with a radius of 2,000 nautical miles at altitudes of 65,000 feet. Anticipating a formal requirement for such an aircraft, the center established design Project MX-2147, which also specified that subsonic speed would be acceptable and that no defense armament would be required.

Requests for Proposals — April 1953

The advertisement of Project MX-2147 in April 1953 was followed by the award of 3 design contracts—to Bell, Fairchild, and Martin. The Martin study contract was initiated by a 29 June letter contract, amounting to $31,406. This document, as revised in October, bound Martin to submit reports on its design study by 11 December 1953 and allowed a $2,784 cost increase.

Production Decision — 21 June 1954

The Air Force decided in June that 6 of the B-57Bs currently on order would be built in the configuration of Model 294. The decision was based on several factors. Martin's high altitude design offered "relatively good performance, an operational date 12 to 18 months earlier, and lower costs" than Bell's X-16.[21] Martin's new planes, designated B-57Ds in August 1954, became RB-57Ds in April 1955—after the Air Force made it known that the airplanes would be used exclusively for strategic reconnaissance.

Additional Procurement — 3 January 1955

The Air Force increased the specialized reconnaissance B-57D program to 20 airplanes—the final total—and attached an overriding priority to the whole project. The forthcoming RB-57Ds, all destined for the Strategic Air Command, were ordered in 3 versions. The original 6, plus 6 of the additional 14, would be 1-man RB-57Ds carrying among other components 2 K-38 and 2 KC-1 split vertical cameras. One RB-57D, singled out as the RB-57D-1, would be equipped with the AN/APG-56 high-resolution, side-looking radar for day or night radar mapping reconnaissance. The RB-57D-1 would also carry a crew of 1. The remaining 6 RB-57Ds,

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[21] This did not mean the end of the X-16 Bald Eagle. The Bell design had actually been judged the best proposal and the Air Force endorsed the aircraft development concurrent with production of the Martin model. Just the same, the X-16 never reached the fabrication stage. Even though a significant number of Bald Eagles were ordered, the project was canceled in mid-1955 after Lockheed flew a U-2 which had been designed and built with company funds.

identified as RB-57D-2s, would be fitted with ferret electronic countermeasures equipment and would have a crew of 2—pilot and electronic countermeasures operator. All but the first 6 airplanes would be equipped for in-flight refueling by KC-97 tankers. Air-refueling would be done via a boom slipway door, aft of the canopy. The 20 RB-57Ds would have an autopilot and the D-1 and D-2s would feature the AN/APN-59 navigational equipment.

Contractual Arrangements 1954-1955

The Air Force intended to carry Martin's high-altitude B-57 on Contract AF 33(600)-22208, which followed the first definitive contract—AF 33(038)-22617—initiated by the letter contract of March 1951. However, negotiations for this second contract, like those of its predecessor, were complicated by the many changes that kept on afflicting the whole B-57 program. After discovering that less than 20 percent of the new aircraft's parts matched those of the B-57B, the Air Force had to alter its plans. The programmed quantity of B-57Bs was reduced by 20, and the 20 airframes (completed to the extent components were common to both B and D airplanes) were booked against contract AF 33(600)-25825, even though this document had been designed to cover nothing more than a pure development study. The stripped-down airplanes, transferred on paper as government-furnished equipment, were valued at $6 million. This sum, like subsequent costs for the D airplanes, was charged to the AF 33(600)-25825 development contract. This cost-plus-fixed fee agreement was allowed a high fixed fee rate of 7 percent, because of the program's urgency and the many imponderables faced by Martin in undertaking such a project. In early 1958 the total estimated cost of the entire D program was about $60 million—$1 million short of the final amount.

First Flight 3 November 1955

The high-altitude, daylight photo-reconnaissance RB-57D was first flown on 3 November. The flight lasted 50 minutes and the results were satisfactory.

Testing 1955-1956

Because of the urgency of the program for which the RB-57Ds were built, flight testing had to be limited and all tests ended in 1956. To begin with, Category II testing (a joint contractor-USAF effort) was not allowed to linger. Started on 29 November 1955, these tests were completed on 7 December. Just the same, RB-57D deliveries slipped to the spring of 1956.

Enters Operational Service 1956

It took until May 1956 for Strategic Air Command (SAC) to get its first RB-57Ds, even though the aircraft had been scheduled for delivery in late 1955. Strikes at Lear, Incorporated, which supplied the radars, caused delays in equipping the aircraft. Westinghouse, another main subcontractor, also had labor problems that created a shortage of autopilots. But the overall situation improved. By the end of September, SAC's inventory counted 11 RB-57Ds. Four B-57C trainers, brought up to the reconnaissance configuration, accompanied the new aircraft.

Operational Problems 1957–1958

Materiel deficiencies accounted for 20 of 22 unsatisfactory sorties, flown during June 1957 by the specialized RB-57Ds of the 4025th Strategic Reconnaissance Squadron. The Pratt and Whitney J57-P-9 engines, Westinghouse autopilots, and some of the more complicated electronic countermeasures systems did not function properly. In addition, it was difficult to obtain parts for the new electronic countermeasures components. The greatly enlarged wing also kept causing problems. First, the main wing spar had to be strengthened as did sections of the wing panels. Then, the Martin-developed "honey-comb" wing surfaces were subject to water seepage and wing stress. These shortcomings taken care of, the RB-57Ds served SAC's purposes well for several years.

End of Production December 1956

The RB-57D production ended in December 1956, but the Air Force did not take delivery of the last plane before March 1957.

Total RB-57Ds Accepted 20

Acceptance Rates

The Air Force accepted 12 RB-57Ds in FY 56 and 8 in FY 57.

Flyaway Cost Per Production Aircraft — $3.05 million

Airframe, $2,531,437; engines (installed), $313,974; electronics, $171,271; others, $39,750.

Subsequent Model Series — B-57E

Other Configurations — RB-57F and WB-57F

RB-57F—Most RB-57Fs were modified RB-57Ds even though a few B-57Bs were brought up to the same configuration. The modification, endorsed in the early sixties, was accomplished by the General Dynamics Corporation in Fort Worth, Texas. The first RB-57F flew in April 1964 and was accepted by the Air Force 2 months later. Still, it took until March 1967 to complete the last aircraft—a 2-year delay. The 16-aircraft project also proved to be much more expensive than expected. Each modified plane carried a price tag of $9 million—airframe, $5,958,530; engines (installed), $562,500; electronics, 1,573,750 others, $925,000. Moreover, some RB-57Fs, equipped for long-range oblique photography, cost an additional $1.5 million—for a unit cost close to $10.6 million. But the RB-57F, funded under a very special project, turned out to be an exceptional plane. Equipped with 2 Pratt & Whitney TF33-P-11A engines and 2 auxiliary J60-P-9s, the 2-seat (pilot, plus navigator or special equipment operator) RB-57F had a service ceiling of 68,500 feet, a cruising range of 3,690 nautical miles, a cruise endurance of 9.7 hours, and a cruising speed of 420 knots. Yet, the RB-57F's average cost per flying hour was only $886; the average maintenance cost, $407. Two RB-57Fs were allocated to the United States Air Forces in Europe and 2 others went to the Pacific Air Forces. The remaining 12 RB-57Fs were at Kirtland AFB, New Mexico, where they served with the 58th Weather Reconnaissance Squadron of the Military Air Transport Service.[22] These RB-57Fs were used to support Atomic Energy Commission and the Air Force Technical Applications Center's requirements until they were redesignated as WB-57Fs.

WB-57F—General Dynamics modified a few additional B-57Bs to give Military Airlift Command's Air Weather Service its 17 WB-57F contingent.

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[22] The Military Air Transport Service, responsible for furnishing rapid airlift for the armed forces of the United States and its allies throughout the world since June 1948, was renamed the Military Airlift Command on 1 January 1966.

The WB-57Fs, former RB-57Fs as well as newly reconfigured B-57Bs, retained the RB-57F's price—$9 million each. The redesignated aircraft stayed at Kirtland AFB, with the same squadron, for very similar purposes. Among other duties, the 58th Squadron for years continued to fly high-altitude radiation sampling missions to furnish data to the Defense Atomic Support Agency. In mid-1973, however, both the aircraft and the squadron neared their end. The Air Force planned to inactivate the 58th and to put all WB-57Fs out of the active inventory in mid-1974. Two of the aircraft were scheduled to go to the National Aeronautics and Space Administration, where they were expected to support further high-altitude sampling projects and the development of satellite systems.

Phaseout 1959–1960

SAC did not retain its RB-57Ds and few RB-57Cs very long. Only 6 of the aircraft remained with the command by December 1959. On 22 April 1960 SAC disposed of the last one, an RB-57C (Serial No. 53-3838) assigned to the 4080th Strategic Wing, Laughlin AFB, Texas. Four years before, the 4080th, then located at Turner AFB, Georgia, had received the command's first RB-57C (Serial No. 53-3842).

B-57E

Manufacturer's Model 272E

Previous Model Series — RB-57D

New Features

The 2-man (pilot and tow-target operator) B-57E featured a hydraulic power-boosted rudder (to improve directional stability) and target launching equipment. The B-57E differed externally from the dual-control B-57C in that it carried 2 target canisters (located on the lower rear fuselage), a modified tail cone, 2 rotating beacons, and a larger tail skid. The E-model had no armament and no bombing equipment, but either could be added without difficulty. The tow-target B-57E could easily be brought to the configuration of the B-57B bomber, because its target containers, internal cable reels and fittings, as well as cockpit towing controls were removable.

Initial Requirement — 16 March 1954

The Air Force asked the AMC to issue requirements for a modified B-57 that would be capable of acting as a tow-target aircraft and, like its predecessors, be suitable for rapid conversion to an operational bomber. The dual-control tow-target B-57 was expected to carry 4 tow reels and 4 banner targets per mission.

Go-Ahead Decision — January 1955

Although the Air Force was eager to replace its tow-target versions of the B-26 and B-45 airplanes, a firm decision on the B-57E program was not reached until January 1955. A number of factors accounted for the delay. Martin was slow in submitting specifications for the new configuration, and protracted program decisions as to quantities and types of airplanes did not help.

Contractual Arrangements February-December 1955

The last major B-57 contract—AF 33(600)-29645—was initiated under the fiscal year 1955 procurement program by a letter contract, signed on 21 February 1955. Contract negotiations started with a requirement for 68 B-57Es and 26 B-57Cs, but this order was subsequently canceled. This prompted a new round of negotiations and postponed signature of the definitive contract to 8 December—half-way through fiscal year 1956. To avoid a costly break in production scheduling (estimated at $16 million), previous programs were stretched. This raised the cost of the fiscal year 1955 program by $1.5 million (a comparatively low-cost alternative) and lowered Kaiser's workload, giving the wing subcontractor a chance to finally catch up.

First Flight (Production Aircraft) 16 May 1956

Martin first flew successfully a production B-57E with tow targets on 16 May—the first aircraft built for the Air Force specifically for this type of duty. The target launchers of 2 modified dual-control B-57Cs, used by Martin as B-57E prototypes, failed to work during earlier flights in April of the same year. But eventually, these problems were solved, and the 2 aircraft joined the B-57E fleet.

Program Change 10 July 1956

The Air Force canceled Strategic Air Command's requirement for conversion of 7 B-57E aircraft to the TRB-57E configuration. The Air Staff decided that, as planned, all but 4 of the 68 B-57Es would go to the Air Defense Command. The 4 exceptions, B-57Es without tow-target equipment, were allocated to the Air Force Flight Test School.

Enters Operational Service August 1956

A few B-57Es began reaching Air Defense Command in August and 18 more were delivered in September. However, Air Force Flight Test School did not receive its first aircraft until 24 October, and additional deliveries lagged behind schedule.

Program Slippage — March 1957

Because it started late, the B-57E program was accompanied by short deadlines and hurried production orders, all of which could spell trouble. But the program actually benefited from an odd combination of events. Already engrossed in the RB-57D program in February 1955, when the B-57E letter contract started, Martin found itself short of 600 engineers and of necessity subcontracted a good bit of the B-57E engineering. This turned out well. Hudson Motors was made responsible for the tow-target installation; Kaiser received an extension of its subcontract for the E wings; and excess parts, built by Martin for the high priority RB-57Ds, were transferred to the B-57E program. Nonetheless, there were a few setbacks. Late deliveries of government-furnished equipment, difficulties in getting the tow reel system to work with the B-57E without excessive airframe modifications, and other equipment problems held up the program for a time. Yet, much of the backlog was eliminated by the end of 1956. In the long run, the B-57E program's overall slippage did not exceed 1 month—a most rewarding accomplishment.

End of Production — 1957

Production ended in early 1957, and the last B-57E was delivered in March.

Total B-57Es Accepted — 68

Acceptance Rates

The Air Force accepted 2 B-57Es in FY 56—both in May 1956. All others were accepted in FY 57—beginning in August 1956 and ending in March 1957.

Flyaway Cost Per Production Aircraft — $1.01 million

Airframe, $847,534; engines (installed), $125,756; electronics, $22,377; others, $21,433.

Subsequent Model Series — None

Additional Procurement None

Rather than buying more B–57Es, the Air Force converted B–57Bs to the tow-target configuration. Some of these B–57Bs (such as those allocated in 1958 to TAC's lst Tow Target Squadron) came from USAFE, where they had received so-called "hard usage" modifications. Before undertaking their towing missions, these aircraft needed much more than modification. Fortunately, Warner Robins Air Materiel Area was able to do most of this work. The lst Tow Target Squadron flew its newly acquired aircraft for several years, transferring the last 14 to Air Defense Command on 1 July 1962. This marked the end of the B–57 weapon system in the TAC inventory.

Modernization 1965

In the mid-sixties, all B–57Es (converted B–57Bs included) were equipped with the external AF/A372–1 tow-target system.

Other Configurations EB–57E, RB–57E, and TB–57E

B–57E productions as well as B–57Bs converted to the E configuration underwent changes throughout the years. The Air Force at times used a few of these aircraft for training—modifying, adding equipment, and referring to the planes as TB–57Es. Many B–57Es, regardless of their origin, became RB–57Es after modification and the addition of reconnaissance equipment. Some of these planes still served in Southeast Asia in mid-1966, even though they were beginning to show signs of fatigue. The most gratifying change (from the economical standpoint) put electronic countermeasures equipment in the planes, which were redesignated EB–57Es. The sophisticated but relatively inexpensive EB–57Es, with a unit price of $2.02 million (electronic countermeasures equipment and modification costs included), provided electronic countermeasures targets to ground and airborne radar systems. In mid-1973, the Air Force active inventory counted an almost equal number of reconnaissance or electronic countermeasures-equipped B–57Es (19 RB–57Es and 23 EB–57Es), but the EB–57Es were expected to outlast every B–57 version.

Operational Status Mid-1973

Air Force rolls only listed 9 B–57Es by the end of June 1973, but various configurations of the versatile airplane continued to play significant roles, with no immediate phaseout in sight.

Program Recap

The Air Force accepted a grand total of 403 B-57s, all of which were produced in Baltimore, Maryland, by the Glenn L. Martin Co. Specifically, the B-57 program comprised 8 B-57As, 202 B-57Bs, 38 B-57Cs, 68 B-57Es, 67 RB-57As, and 20 RB-57Ds. Other B-57s, such as the B-57Gs, RB-57Fs and WB-57Fs, were the result of extensive post-production modifications. Production ended in early 1957, but at the close of the year USAF records showed that 47 of the 403 aircraft had been destroyed in major accidents. This came as no great surprise. Overall, the B-57 was not easy to fly. Moreover, prior to modification of its longitudinal control and stabilizer systems, the B-57 was uncontrollable if 1 of its 2 engines failed during takeoff or landing. In 1958, after completion of all possible modifications, the Air Force ascertained that 50 percent of the major accidents resulted from pilot errors, with 38 percent of the accidents occurring upon landing. Yet, while the number of B-57 accidents was high—129 major and minor accidents as of 1958, the rate compared favorably with that of the B-47 and some other aircraft.

TECHNICAL AND BASIC MISSION PERFORMANCE DATA

B/RB-57 AIRCRAFT

Manufacturer (Airframe)	The Glenn L. Martin Co., Baltimore, Md.
(Engines)	Wright Aeronautical Division of The Curtiss-Wright Corporation, Wood-Ridge, N.J., and Buick Division of The General Motors Corp.
Nomenclature	Light Tactical Bomber, Trainer, Target Tug, and Reconnaissance Aircraft.
Popular Name	Canberra

	B-57B	B-57C	B-57E	RB-57A	RB-57F
Length/Span (ft)	65.5/64	65.5/64	65.5/64	65.5/64	68.3/122.5
Wing Area (sq ft)	960	960	960	960	2,000
Weights (lb)					
Empty	28,793	28,793	34,789	26,380	37,020
Combat	38,689	38,689	37,300	32,448	49,500
Takeoff	56,965[a]	56,965[a]	54,072	57,000	61,500[b]
Engine: Number, Rated Power per Engine, & Designation	(2) 7,220-lb st (max) J65-W-5 or (2) 7,220 lb st (max) J65-BW-5	(2) 7,220-lb st (max) J65-W-5 or (2) 7,220-lb st (max) J65-BW-5	(2) 7,220-lb st (max) J65-W-5 or (2) 7,220-lb st (max) J65-BW-5	(2) 7,220-lb st (max) J65-W-5 or (2) 7,220-lb st (max) J65-BW-5	(2) 16,000-lb st (mil) TF33-P-11A & (2) 2,900-lb st (mil) J60-P-9
Takeoff Ground Run (ft)					
at Sea Level	5,000	5,000	5,050	3,400	2,600
Over 50-ft Obstacle	6,200	6,200	6,250	4,300	2,800
Rate of Climb (fpm)					
at Sea Level	4,320	4,320	3,825	4,800	2,725
Combat Rate of Climb (fpm) at Sea Level	6,180	6,180	370 (with target deployed)	7,100	7,600

Service Ceiling (100 fpm Rate of Climb to Altitude)	40,100	40,100	28,600 (with target deployed)	44,500	60,800
Combat Ceiling (ft) (500 fpm Rate of Climb to Altitude)	45,100	45,100	36,950 (with target deployed) at final towing weight	49,000	60,650
Average Cruise Speed (kn)	414	414	342 (initial towing speed)	355	411
Max Speed at Optimum Altitude (kn/ft)	520/2,500	520/2,500	403/25,000 (limited by banner shredding)	499/9,000	420/63,500
Combat Radius (nm)	824	824	2.50 hr (towing time)	250	1,280
Total Mission Time (hr)	4.13	4.13	2.68	3.12	6.12
Armament	4 20-mm M39[c]	4 20-mm M39[c]	Not Applicable	None	None
Crew	2	2	2	2	2
Max Bombload (lb)	6,000[d]	6,000[d]	N.A.	None[e]	None[f]

Abbreviations

fpm = feet per minute
kn = knots
max = maximum
mil = military
nm = nautical miles
st = static thrust

[a] Limited by space.
[b] Limited by wheel loading.
[c] Plus 16 underwing rockets.
[d] Bombloads could be made of various combinations—M117s MK82s, MK81s, CBU/SUU-30s, M14A frag clusters, fire bombs, flares, and the like.
[e] Several cameras (P-2s, K-37s, T-11s, K-17s, K-38s), plus flash bombs and photo flash cartridges.
[f] High-altitude weather photo reconnaissance equipment and special components for atmosphere sampling operations.

Basic Mission Note

All basic mission's performance data based on maximum power, except as otherwise indicated.

Combat Radius Formula:

B–57B and B–57C—Warmed up, took off, and climbed on course at maximum power. Cruised out at long-range speeds, increasing altitude with decreasing weight (external tanks being dropped when empty). Over target, descended to sea level and dropped bombs; external stores also, if carried. Remained in combat area for 5 minutes and climbed on course to cruise ceiling at maximum power. Cruised back to home base at long-range speeds, increased altitude with decreasing weight. Range-free allowances included 5-minute normal-power fuel consumption for starting engine and take-off; 5-minute sea level fuel consumption at power required for maximum structural limit speed; 20 minutes of maximum-endurance fuel consumption at sea level, plus 5 percent of initial fuel load for landing reserve.

Formula: Radius Mission II (High Speed)

Same profile and fuel reserve as for basic mission (Mission I), except all cruising was at normal-rated power.

Formula: Range Mission V (Ferry Range)

Warmed up, took off and climbed on course to cruise ceiling at maximum power. Cruised out at long-range speeds, increasing altitude with decreasing weight (external tanks being retained when empty). Range-free allowances included 5 minutes of normal-power fuel consumption for starting engines and take-off, 30 minutes of maximum-endurance fuel consumption at sea level plus 5 percent of initial fuel load for landing reserve.

B–57E—Formula: Towing Mission I

Took off and climbed on course at military power to normal-power service ceiling for banner extended configuration. Extended banner and cruise-climbed at speeds for maximum mile per pound in a race track pattern until only fuel for landing reserve remained. Cut banner and landed. Time-free allowances included 5-minute normal-power fuel consumption for starting engine and take-off, and 30 minutes of maximum-endurance fuel consumption at sea level plus 5 percent of initial fuel load for landing reserve.

B-57E—Formula: Towing Mission II

Same as Mission I, except towing was conducted at a constant altitude of 30,000 feet.

B-57E—Formula: Range Mission III

Took off and climbed on course to optimum cruise altitude at military power. Cruised out at maximum-range speeds, increasing altitude with decreasing weight, until all useable fuel (less reserve fuel) was consumed. Range-free allowances similar to time-free allowances of Mission I.

RB-57A—Formula: Radius Mission I

From sea level, took off and climbed on course to 24,000 feet with military thrust. Cruised at 24,000 feet at recommended cruise speed. Made an on-course normal descent to 5,000 feet. Flew at 5,000 feet, at 300 knots true airspeed, with no distance credit. Climbed on return course to 24,000 feet with military thrust. Cruise back at 24,000 feet at recommended cruise speed. Made normal descent to sea level on return course. Mission reserve fuel was 2,500 pounds.

RB-57F—Formula: Radius Mission

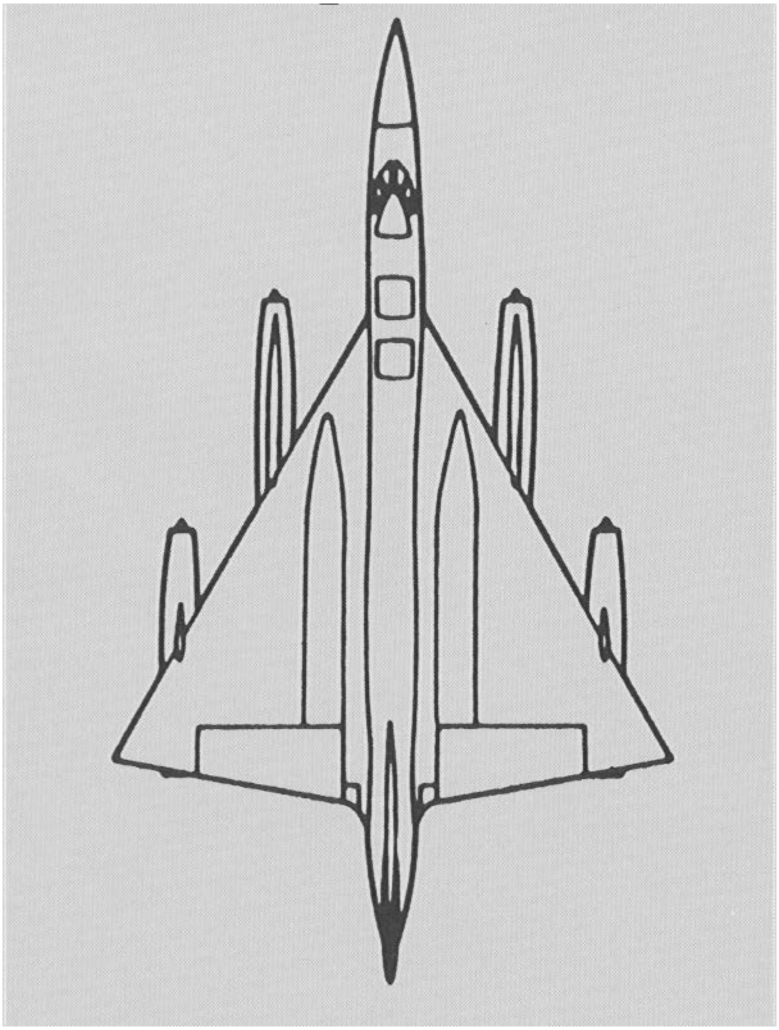
Took off and climbed on course at maximum allowable power to initial altitude of 60,000 feet. Cruised out at long-range speeds and at maximum altitudes to target at 63,200 feet. Returned to base at long-range speeds and maximum altitudes. Range-free allowances were fuel for 5 minutes at take-off power (70 percent of military-rated power) and 20 minutes at maximum-endurance speeds at sea level, plus 5 percent of initial fuel for landing reserve.

RB-57F—Formula: Ferry Range Mission

Took off and climbed on course at maximum allowable power to optimum cruise altitude. Cruised out at long-range speeds at optimum altitudes. Range-free allowances were fuel for 5 minutes at take-off power (70 percent of military-rated power) and 20 minutes at maximum-endurance speeds at sea level, plus 5 percent of initial fuel for landing reserve.

B-58 Hustler

Convair Division of General Dynamics Corporation



B–58 Hustler
General Dynamics

Manufacturer's Model 4

Weapon System 102A

Overview

Future aircraft "will move with speeds far beyond the velocity of sound," said renowned Hungarian-born aerodynamicist Theodore von Karman in 1945. Highly regarded by Henry "Hap" Arnold, Commanding General of the Army Air Forces (AAF), and by Maj. Gen. Curtis LeMay, the first Deputy Chief of Staff for Research and Development, von Karman, as the AAF's chief scientific advisor, most likely influenced LeMay's vigorous and diverse research and development program. Part of the program prompted the impressive 14 October 1947 test flight of the Bell X–1 rocket airplane, a flight which shattered both the sound barrier and the speculation that aerodynamic forces became infinite at Mach 1.

Development in the late 1940s of the single-place, air-launched X–1 was a major achievement. Nevertheless, as time would show, production of a 3-seater aircraft, capable of sustained speeds approaching the muzzle velocity of a 30-caliber bullet and of functioning effectively as a strategic bomber, would be a challenge of monumental proportions. The controversial B–58 program that ensued was to illustrate the dangers of untried technology versus the necessity of pioneering state-of-the-art developments. Where to draw the line between the two would remain open to question long after the costly B–58 ceased to exist.

A 1946 study by Consolidated Vultee Aircraft Corporation (Convair), a contractor noted for interest in the delta-wing configuration, marked the beginning of the B–58. The project was so complex, however, that a new study was requested and a second contractor, Boeing, became involved. Proposed in 1951, the initial Convair design, as recommended by Dr.

Alexander M. Lippisch, an eminent German scientist, foretold a delta-configured, 100,000-pound bomber; the Boeing design, a conventional, 200,000-pounder. Suggestive of the future B–58's tumultuous history, the 2 contractors followed totally different development approaches, and drastically opposed concepts emerged within the newly independent Air Force. USAF engineers kept asking for realistic military requirements, but the Air Staff decided that instead of accepting technology as the determining factor against which a mission could be fitted, mission objectives would come first and technology would be developed to satisfy them.

In late 1952, believing it promised the best means of achieving supersonic speeds with a weapon system of minimum size, the Convair design, already altered several times, was selected over that of Boeing. The choice was not unexpected. In a recent study, the Rand Corporation had clearly stated that by minimizing size, one reduced the radar reflectivity of a vehicle and, therefore, the probabilities of interception by surface-to-air missiles. Also, the Air Force's latest development directive had reemphasized the importance of minimum size, of high-speed and high-altitude performances and, finally, of the weapon system development technique, an objective with which Convair was familiar.

General LeMay, who by the fall of 1952 had been heading the Strategic Air Command (SAC) for 4 years, and who would remain in that position until promoted to Vice Chief of Staff in mid-1957, did not like the Air Staff's selection. Among other arguments, he pointed out that instead of fostering economy and reliability, combining unconventional design and operational techniques made "it entirely possible that the system might prove operationally unsuitable." General LeMay's objections did not prevail, which was unusual. Rejection of the more conventional, longer-range, supersonic bomber, proposed by Boeing and preferred by General LeMay, also was ironic, since it was LeMay who, back in early 1948, ensured that a new strategic jet bomber would be developed on the heels of the B–52.

Throughout the years, money had a great deal to do with the B–58's retention. By 1954, for example, after an investment of some $200 million, the B–58 project could show no tangible achievements. Cancellation at this stage, the Air Staff reasoned, would mean an unacceptable financial loss. Hence, despite production slippages, soaring costs, and General LeMay's continued opposition, the B–58 survived. Yet, the program that finally emerged was emaciated, in terms of numbers as well as military capabilities.

The Air Force bought 116 B–58s, less than half of the minimum initially planned. At long last operational in 1961, the B–58 still harbored deficiencies of varying importance. Its bombing and navigation system was unreliable, and the aircraft was unable to carry several kinds of new weapons. Although expensive, necessary modifications were accomplished between 1962 and 1964. However, significant problems remained. In the early 1960s, technological advances had radically altered the antiair defenses that the B-58 was expected to challenge. Defensive nuclear-tipped air-to-air and surface-to-air missiles appeared to preclude penetration of enemy airspace at high altitude. Since the B-58 structure incurred significant fatigue damage when flying at low level, and since the new bomber had no terrain-following radar, extensive modifications would be needed to permit effective low-level penetration. Such modifications did not materialize because of their prohibitive cost, and all B-58s were phased out of the Air Force inventory by early 1970, less than 8 years after the last ones rolled off the assembly line.

While the $3 billion price tag of the B-58 program did not help the manned bomber's cause, the aircraft did represent an important technological achievement. In its day the B-58 broke 12 world speed records and won almost every major aviation award in existence. The aircraft marked the first major departure from the monocoque riveted metal construction techniques of the 1930s and prompted the investigation of non-metallic composite structural methods. It brought about major technical advances, entailing technical uncertainties which remained until such an aircraft was flown. The Air Force took the risk, and the results may not have been cost-effective. Nonetheless, similar developmental risks again would have to be taken to assure progress in aerospace technology.

Basic Development — October 1946

Development of a long-range supersonic bombardment aircraft was officially initiated by a generalized bomber study (GEBO),[1] begun in October 1946 by Convair.[2] In requesting GEBO, the AAF called for determination of which design trends would be necessary to achieve unspecified, yet ambitious supersonic performances. Of necessity, the scope of the study was very broad, but "investigation of low aspect wings in general and Delta Wings in particular" was emphasized. Although already acquainted with the delta wing and, therefore, well suited for the work, Convair had to investigate countless configurations to determine the effects of wing area, aspect ratio, thickness and sweep, as well as the impacts of type (turbojet and turboprop), size, and number of engines on airplane speed, range, and gross weight. The GEBO findings were described in 3 reports,

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[1] Identified as GEBO I in June 1949, after the Air Force issued a contract for a second GEBO.

[2] The corporation subsequently became a division of the General Dynamics Corp. For details, see B-36, p 5.

which were completed in June 1948. Yet, this was only a beginning. Indicative of the magnitude of the project, in late 1948 the Air Materiel Command (AMC) Engineering Division of the now independent Air Force asked for a continuation of the GEBO study. The USAF engineers presented many valid reasons for their request, but their most telling arguments were that the findings so far obtained be used to show the "feasibility of military characteristics," and to assist in establishing "balanced characteristics and desirable design compromises." Meanwhile, pre-GEBO studies, conducted by Convair, had formed the basis of the winning interceptor design submitted by the company in 1946. Forerunner of the F-102, the ensuing rocket-propelled, XF-92 interceptor was extremely costly and highly impractical. Though the aircraft failed to earn a production contract, it proved to be an important step in the development of the delta wing, one of the future B-58's most striking features.

The delta wing itself, like many other aerodynamic innovations, had its inception in the German wind tunnels of World War II.[3] Although the National Advisory Committee on Aeronautics, independent of the German research, by 1945 had explained many of the delta configuration's theoretical advantages, the delta wing concept remained credited to Dr. Alexander M. Lippisch, leader of the German program.[4] In postwar years, U.S. governmental agencies and many of the American aircraft corporations studied extensively Dr. Lippisch's captured reports, with data on his never-flown, rocket-powered DM-1 glider and his spectacular, if not very successful, Messerchmitt-built Me-163B (the first operational liquid rocket-

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[3] While the word "delta" is inextricably linked to the work of Alexander Lippisch, a brillant aeronautical scientist, his work followed a path first taken by John Dunne, who developed such aircraft in Great Britain prior to the First World War. Actually, Dr. Lippisch's efforts paralleled those of G. T. R. Hill and the Westland company in Great Britain and that of John K. Northrop in the United States. For details, see Richard P. Hallion, *Lippisch, Gluhareff, and Jones: The Emergence of the Delta Planform and the Origins of the Sweptwing in the United States, Aerospace Historian,* Volume 26, No. 1 Spring, March 1979. Dr. Hallion, a former curator of science and technology at the National Air and Space Museum, joined the Air Force History Program in January 1982, becoming Chief of the Office of History of the Air Force Systems Command's Flight Test Center at Edwards AFB, Calif. He is currently an historian at Headquarters Air Force System Command, Andrews AFB, Md.

[4] Reportedly, Dr. Lippisch's scientific curiosity was first stimulated by observing Orville Wright's flight at Templehof Airfield in 1909. Eventually, Lippisch became assistant aerodynamicist with Zeppelin-Werke, which later became the Dornier organization. His interest in gliders, which had its roots in the Rhone Mountain glider movement of 1920, brought him in 1927 to the Forschungs Institut der Rhone-Rossitten Gesellschaft, an institute for the study of gliders, where he became technical director of the design section. Although he designed the "Fafnir," a high-performance glider, as well as numerous others, his primary interest lay in proving his assumption that aircraft could have the appearance of a "flying wing" and still be practical—a delta-wing aircraft from which came the modern delta supersonic design.

propelled interceptor), introduced by the Germans in August 1944. Yet, while Dr. Lippisch was not the inspiration that caused Convair to continue working on the 60-degree delta, his comments reinforced and encouraged Convair engineers to believe that the delta wing could solve most of the problems of supersonic flight.[5]

Initial Requirements 1947

The initial requirements for a new bomber were emphasized in 1947 by Maj. Gen. Curtis E. LeMay, Deputy Chief of Air Staff for Research and Development.[6] In May, General LeMay wrote directly to Lt. Gen. Nathan F. Twining, AMC Commander, to urge that studies be undertaken of a new jet bomber that could become operational in the late 1950s. This airplane, General LeMay stated, should have a combat radius of 2,500 miles, a cruising speed of at least 500 miles per hour, and a gross weight of about 170,000 pounds. No amount of modification to the B-50 or B-36 would bring these airplanes within the desired characteristics, General LeMay added. A completely new medium bomber was needed, and development and procurement of such an airplane could well follow the B-52's development. That the B-58, generated by the post-World War II enthusiasm for the unconventional delta-wing configuration, evolved from requirements advocated by General LeMay was to prove ironic. Meanwhile, General LeMay's insistence prompted the Air Staff to solicit ideas about a new bomber from the Boeing Airplane Company of Seattle, Washington. Yet, several years would pass and many changes would occur before any specific projects started taking shape.

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[5] Nature, Dr. Lippisch wrote, had designed the flying wing thousands of years before man even thought of flight. The flying wing was the Zanonia seed, a seed from a large vine of the cucumber family. It grew in the dense, moist jungles of Indonesia and adapted its reproductive processes to a region in which there was no wind to distribute the seeds. The vine climbed 150-foot trees, and from the top, the seed—a kidney-shaped platform—began its glide, rising on thermals from the jungle heat, and finally landing at considerable distance from its point of departure. The aerodynamic qualities of the seed attracted attention. Two Austrian engineers, Etrich and Wels, analysed its stability. Etrich eventually combined the Zanonia wing with a conventional monoplane configuration, known as the Etrich "Dove." The Dove became famous in the days before World War I, as the first German military aircraft. Its demise followed the onset of war, when it was abandoned in favor of the more maneuverable Fokker-designed aircraft.

[6] In spite of the declining post-war budget, General LeMay directed improvements in research and development. He also asked for more money. Appearing often before congressional committees, he pointed out on one occasion that the entire annual budget of the propeller division at Wright Field, "wouldn't buy one set of B-29 propellers."

Research Intensification 1949

As suggested by AMC, Headquarters USAF asked Convair to begin a second generalized bomber study for the development of future long-range supersonic bombers. This study, GEBO II, was formalized on 6 June 1949 by contract AF33(038)-2664 and, like GEBO I, ended covering a myriad of configurations. There were many justifications, besides AMC insistence, for the Air Staff's continued interest in the Convair research. To begin with, the shortage of funds forced the Air Force to make difficult decisions. Boeing's XB-55, a design initiated as an immediate result of General LeMay's 1947 request,[7] had been canceled in January 1949 for lack of money, as well as the following reasons. First, there no longer seemed to be an immediate need to originate a design to meet the medium bomber requirements, in view of the currently projected B-47 growth. Also, since the XB-55's development promised to take longer than anticipated, the Air Force thought its design should have been predicated on greater aerodynamic achievements and an improved propulsion system. Finally, and most importantly, continued testing of the delta wing XF-92, first flown in June 1948, was starting to attract wide attention. Even though the Board of Senior Officers in early 1949 had rejected an unconventional strategic bomber proposed by the Fairchild Aircraft Corporation, it was obvious by mid-year that the Senior Officers, with Secretary of the Air Force Symington's full support, were searching for new and imaginative solutions to the strategic bombing problem.

Conventional Alternatives 1949–1950

While looking for novel ideas, the Air Force remained cautious and did not lose sight of Boeing's extensive experience in bomber design.[8] As already noted, the contractor had been encouraged to investigate the development of higher-performance aircraft, long before its XB-55 was canceled. Boeing, therefore, had worked on a series of new turbojet designs in order to compare them with its original turboprop studies and with the XB-55 in particular. Aware of these facts, the Air Force issued termination orders for the XB-55 in such a way as to allow maximum benefit from the studies which Boeing had in progress. Mockup and detailed engineering on the XB-55 were stopped, but the study reports and tunnel tests then underway

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[7] Requirements for a new medium bomber, submitted to industry in October 1947, proved Boeing the undisputed winner of the ensuing competition.

[8] The experimental B-47 earned a first development contract in December 1945; the XB-52, in July 1948.

were to be completed. Moreover, the Air Force soon increased the scope of the Boeing tunnel tests and asked for firm study results.

Competitive Proposals — February 1951

On 26 January 1951, following completion of GEBO II, Convair offered to develop and manufacture a long-range supersonic reconnaissance bomber.[9] The proposal, named Project MX–1626 by AMC, was accepted promptly by the Air Force. However, this did not spell the end of Boeing's related work. In fact, the Air Force endorsed in February the Phase I development of 2 reconnaissance bombers through wind tunnel testing, engineering design, and mockup. The Boeing project was designated MX–1712 and was initiated on 26 February by Letter Contract AF33(038)–21388. A similar document, Letter Contract AF33(038)–21250, had been signed by Convair on the 17th. It called for a 107,000-pound reconnaissance bomber, with a delta configuration and 2-stage system (release and retrieval) based on the parasite principle, using the B–36 as the carrier. The MX–1626's basic difference from the other Convair configurations studied in GEBO II lay in the use of 3 engines, 2 in wing nacelles and the third in a droppable bomb pod. In contrast, the Boeing MX–1712 project proposed a conventional, 200,000-pound medium-range reconnaissance bomber, capable of supersonic flight over a limited portion of its mission. The Boeing design objective involved a 2,000-nautical mile radius, 200 miles of which would be flown at Mach 1.3 or more, and the balance at Mach 0.9. For shorter missions, the supersonic radius would increase, while range extension devices such as refueling or extended wing tips would lengthen the range for longer missions. Power was to come from 4 J67-type engines with afterburners, and the aircraft as projected was to be capable of delivering atomic or conventional bombs from altitudes of 45,000 to 50,000 feet. Sea-level missions were another possibility being considered.

Radical Change — December 1951

The parasite-carrier combination, proposed by Convair in early 1951, did not last long. As conceived, Project MX–1626's primary appeal

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[9] Reconnaissance had not been mentioned before. Most likely, the Heavy Bomber Committee's year-old decision that the heavy bomber program be expanded to include reconnaissance, accounted for the Convair suggestion. As far as Boeing was concerned, reconnaissance, as an adjunct to bombing, was almost routine, the RB–47B being already on the drawing board in March 1951.

stemmed largely from the stringent fiscal restrictions of the post-World War II period.[10] Since money was lacking, the parasite-carrier concept appeared to be the most economical method for tackling the unconventional approach to the long-range, strategic bombing problem. During 1951, however, the Air Force started to view MX-1626 from a different angle. Both the B-36 carrier and parasite aircraft (officially designated B-58 in December 1952) would require complete navigation equipment; the 2 might not locate one another on the return course of the mission; and once rejoined, the composite aircraft would be more vulnerable to attack. Finally, the 2-aircraft attack system would be far more expensive to build and maintain than would a single bomber. Hence, in December 1951, the MX-1626 configuration was altered drastically. The parasite mode of range extension was dropped in favor of air refueling; the third and expendable engine in the bomb pod of the original configuration was eliminated, while afterburners were added to the aircraft's remaining 2 engines. Moreover, a landing gear was provided to allow take-off at a gross weight of about 126,000 pounds, and the number of crewmen was increased from 2 to 3 (1 pilot, 1 navigator-bombardier, and 1 defense-systems operator).

General Operational Requirements 1 February 1952

Concurrent with the elimination of flaws from the initial MX-1626 configuration, the Air Force further defined what would be generally expected of the future Supersonic Aircraft Bomber (SAB). USAF planning culminated on 1 February 1952 with the publication of General Operational Requirement (GOR) SAB-51.[11] This highly ambitious document called for a versatile, multi-mission strategic reconnaissance bomber capable of carrying 10,000 pounds of bombs, and of operating in daylight or darkness under "all-weather" conditions. Production should take place within 5 years. There were many other sophisticated requirements. The aircraft had to be able to cover almost 5,000 miles (4,000 nautical miles) both ways, with a single outbound inflight refueling; about half that distance without refueling. It also needed supersonic speed at altitudes of 50,000 feet or more, and high subsonic speeds when flying at low levels. It was to be easy to fly, highly reliable, and should require few personnel for operation and maintenance. Although due to feature the best electronic countermeasures systems,

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[10] Like the Glenn L. Martin Company, Convair at one point was also working on a Navy proposal for a money-saving carrier-based medium-range bomber.

[11] This actually was GOR No. 8 (SAB-51). It added reconnaissance to the requirements embodied in a December 1951 GOR, which only called for a strategic bombardment system.

"economy from the standpoint of cost to our national resources" was a must. The GOR also emphasized that the future aircraft should be small, a specification apparently suggested in a recent Rand Corporation study which stressed that by minimizing size, one reduced the radar reflectivity of the vehicle and the probabilities of interception by surface-to-air missiles. As it turned out, this "small size" requirement was to influence greatly subsequent decisions.

Revised Requirements 26 February 1952

As customary, the GOR of February 1952 led to a development directive. Also, detailed military characteristics were issued for the benefit of interested contractors. There was a significant change, however. The directive (No. 34, published on 26 February 1952) created a precedent in that it sharply curtailed the general requirements formulated earlier in the month. The revision, formalized on 1 September 1952 by GOR No. 1 (SAB-52-1), stood to reason. As pointed out by Gen. Donald N. Yates, Director of Research and Development, Office of the Deputy Chief of Staff for Development, it was unrealistic to expect the rapid development of a high-altitude, long-range, supersonic reconnaissance bomber that could also be used for low-level missions requiring high subsonic speeds. Some aeronautical engineers argued this could be done with the proper technological efforts and plenty of money, but many in the Air Staff were not convinced. Following discussions with members of the Air Council and representatives of Air Research and Development Command (ARDC), SAC, the Rand Corporation, and the Scientific Advisory Board, the Air Force endorsed General Yates' recommendation. Directive No. 34, as finally worded, only called for the development of a high-altitude, long-range supersonic strategic reconnaissance bomber. However, a low-altitude strategic bomber was still needed. Even though this would be costly, the Air Force issued a separate directive for development of such an aircraft,[12] insisting in both cases that the 2 airplanes should be available by 1957.

Early Problems 1952

If refining and slimming down requirements were not an easy matter,

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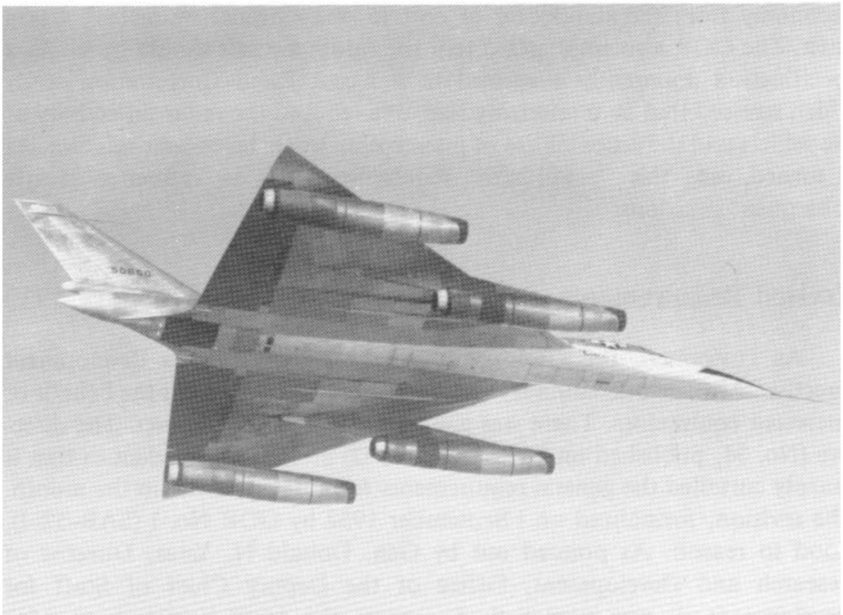
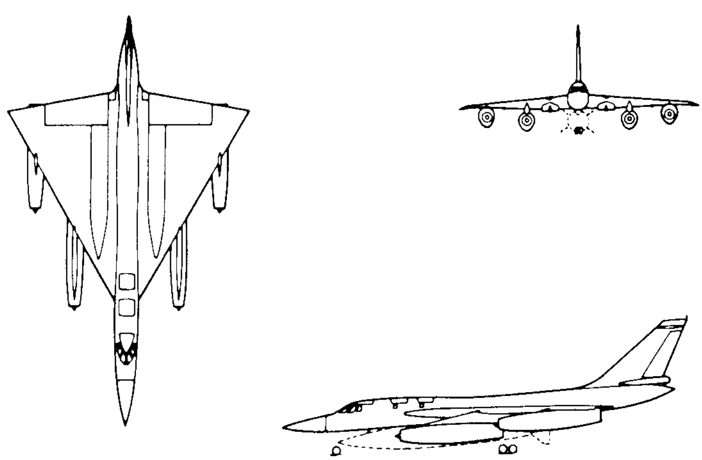
[12] The Martin Company won the competition that ensued with a design featuring a delta-wing planform, but the Air Force canceled the project in 1957. SAC's confidence that the B–47 was rugged enough for low-level bombing accounted in part for the cancellation. Another factor was the Air Force's anticipation that modified B–52s would eventually fulfill the requirements wanted in a low-altitude bomber.



The delta-wing B–58 Hustler was powered by 4 General Electric J79 turbojet engines.



financing the Phase I development of 2 parallel projects was even more difficult during a period of austerity. Boeing's MX-1712 benefited to some extent from the XB-55 cancellation and did not seem to face a serious money problem, but the financial support of Convair's MX-1626 was another story. To begin with, although the 2 letter contracts of February 1951 were fairly similar, Convair's document failed to provide sufficient funds to carry the MX-1626 through the mockup stage. Complicating the situation further, confusing events began to emerge in early 1952. In January, the Air Staff asked Convair to prepare package program costs for specific numbers of airplanes (25, 50, and 100). Estimates were to cover all development and production costs, except for the engines which were to be furnished by the government. Tentative delivery schedules also were required. In late February, however, the MX-1626 project was nearly canceled. The emergency transfer of $100,000 provided some relief, but the MX-1626 status remained precarious until 15 May, when a supplemental agreement to the deficient letter contract assured the MX-1626's General Phase I Development Program of $2,800,000. Meanwhile, the Air Force faced another dilemma. Back in 1951, although reasonably sure that Convair and Boeing offered the best hopes to secure quickly the urgently needed supersonic bomber, AMC had requested informal proposals from other aircraft producers including Douglas, Lockheed, Martin, and North American. The field narrowed, when only 2 of the last 4 contractors submitted proposals. Moreover, the problem was resolving itself since these last proposals did not arouse any special interest. Nevertheless, now that the requirements were changed, the Air Force considered whether the entire aeronautical industry should again be queried.

Preliminary Conclusions 1952

Early in 1952, the Air Force agreed with Brig. Gen. John W. Sessums, ARDC Deputy for Development, that it would be better to forego additional competition along traditional lines. Time and money would be saved in selecting contractors on the basis of experience, facilities, and the intrinsic value of the proposals already submitted. Shortly thereafter, the Wright Air Development Center was given permission to eliminate or reorient current projects. In short, Boeing and Convair were instructed to stop their present investigations and to begin new Phase I designs of their respective projects (MX-1712 and MX-1626), as dictated by Directive 34. Maj. Gen. Donald L. Putt, the newly appointed Wright Air Development Center Commander, also informed the 2 contractors that contracts would be issued in the fall of 1952 for the detailed design and mockup of each supersonic bomber. Evaluation and selection of the winning design would follow in February or

March 1953, which clearly indicated that obtaining production aircraft by 1957 would never be feasible.[13]

Meanwhile, events were determining the shape of the program. To begin with, Development Directive 34 strongly reemphasized the Supersonic Aircraft Bomber design priorities of minimum size and high performance (altitude and speed), already specified by the GOR of February 1952. Secondly, both GOR and the directive called for the application of the weapon system concept, an objective with which Convair was familiar.[14] This concept, in essence, acknowledged that the increasing complexity of weapons no longer permitted the isolated and compartmented development of equipment and components which, when put together in a structural shell, formed an aircraft or a missile. It integrated the design of the entire weapon system, making each component compatible with the others, and put heavy responsibilities on the prime contractor. The weapon system concept coincided with a significant deviation from previous practices. Instead of accepting technology as the determining factor against which a mission could be fitted, the Air Force had decided that mission objectives now should come first and technology could be made to satisfy them. In any case, other events occurred in mid-1952, which also seemed to favor the delta-wing configuration. By that time, the 2 contractors had made considerable progress in their efforts to conform with the requirements set forth in Directive 34. In the process, Convair's former MX-1626 had become project MX-1964, while Boeing's MX-1712 was now known as the MX-1965. Wright Air Development Center's analysis of both designs in the summer of 1952 yielded no startling discoveries. The center tentatively concluded that the 2 designs appeared to meet performance and size requirements, but that extensive development work would be needed to give either configuration the necessary engines and the required integrated electronic system. Soon afterwards, the center's Weapons Systems Division proposed that recent plans be changed. The division's officials felt that selecting 1 of the 2 contractors before design and mockup completion would be advantageous to the Air Force. It would eliminate the many problems created by simultaneous development programs, as well as the need to develop costly electronic and control systems for 2 aircraft. Moreover, an earlier selection would save additional time and money, thereby allowing a more extensive

[13] Assuming all went well, Wright Air Development Center officials speculated, a prototype might perhaps fly in 1957.

[14] The so-called "1954 Interceptor," an upshot of the Convair XF-92, soon symbolized the difficulties involved. It marked the first attempt to apply the weapon system concept, and the concept's practical defeat. Yet, it eventually led to Convair's production of the F-102 and F-106, 2 most-effective and long-lasting fighter-interceptors.

development of the selected system. Since Project MX-1965 was lagging slightly behind the Convair MX-1964, such recommendations could hardly be expected to help Boeing's prospects.

Contractor Selection — 18 November 1952

In September final evaluation of the competing designs by the Wright Air Development Center left little doubt about the forthcoming decision. The center thought that the Boeing MX-1965 design would produce either an aircraft of small size with mediocre supersonic speeds or one so large as to almost preclude any supersonic capability.[15] On the other hand, the MX-1964 design, already nicknamed the "Hustler" by Convair, provided the more promising means of achieving supersonic speeds with a weapon system of minimum size. In addition, the center felt that the Convair approach best satisfied the "spirit" of the Development Planning Objective for Strategic Air Operations during the period 1956-1960. This objective, issued by the Air Force on 29 May 1952, favored a small bomber and underlined that future strategic aerial warfare could be most economically and effectively accomplished by a "combination system that incorporates a tanker cargo airplane for refueling in flight the combat zone airplane." The small bomber concept, embodied by the Development Planning Objective of May 1952, reflected the opinion of Col. Bernard A. Schriever, the USAF Assistant for Development Planning in the Office of the Deputy Chief of Staff for Development,[16] and had been endorsed by the Air Force Council and Gen. Hoyt S. Vandenberg, Chief of Staff of the Air Force. But this Development Planning Objective of May 1952 also ran counter to many established principles. SAC officials and particularly General LeMay, who by 1952 had been heading the command for several years, generally favored large bombers, capable of greater ranges. "Even though the best intercontinental bomber available requires some refueling," SAC insisted, "it does not follow necessarily that the optimum system requires a bomber which has no intercontinental capability without refueling." The command argued that "high performance alone" could "never insure mission success"

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[15] The Boeing supersonic bomber design was conventional. It featured wings swept at 35 degrees, an internal bomb bay, a fore and aft bicycle landing gear which, like that of the B-52, retracted into the fuselage. It called for 4 engines, similar to those proposed for the Convair bomber, but integral with the wing, 2 on each side, tucked inboard against the fuselage. It projected a supersonic speed of Mach 1.8 at 55,000, but promised plenty of room for its 3-man crew. Maximum take-off weight was about 156,000 pounds.

[16] Colonel Schriever was promoted to lieutenant general in 1959 and to full general on 1 July 1961, when he headed the newly organized Air Force Systems Command.

against targets defended by modern interceptors and surface-to-air missiles, and pointed out that the small supersonic bomber's lack of range would prevent it from operating without refueling from most forward operating bases. Also, crew members would be very confined in such a small bomber. Finally, instead of fostering economy and reliability, combining unconventional design and operational techniques made "it entirely possible that the system might prove operationally unsuitable." SAC's arguments notwithstanding, a decision was near. In an unusual step, the decision makers would totally disregard SAC's concern. In late October, following ARDC's thorough review of the Wright Air Development Center's conclusions, Lt. Gen. Earle E. Partridge, the ARDC Commander, recommended to Headquarters USAF that the competition between Boeing and Convair be stopped immediately. General Partridge noted that the MX-1964 supersonic drag and gross weight figures appeared optimistic, and if true, this would further limit the aircraft's range. Also, costs had not been considered properly, and the forecast operational date would inevitably slip, perhaps to 1959. Nevertheless, the ARDC Commander endorsed prompt selection of the Convair project and asked that accelerated development of General Electric's J53 engine (from which the J79 derived) be authorized without delay. This was approved by the Weapons Board, the Air Force Council, and by General Vandenberg on 18 November 1952. Soon informed that the design competition was ended, Boeing reportedly took the bad news well.

Design Refinement — 1952–1953

The Air Force selection of Convair over Boeing was not a blanket endorsement of the MX-1964 design. It took several months and many consultations between Convair, National Advisory Committee on Aeronautics, AMC, ARDC, and Wright Air Development Center personnel to settle on a definite configuration which, as it turned out, was subjected to many later revisions. These initial delays were not unfounded. Development problems with the Convair F-102 interceptor were confirming the Air Force's suspicion that the contractor had failed to make proper allowance for the aerodynamic drag of a delta-wing aircraft, be it a fighter or a bomber. Moreover, the area-rule concept of aircraft design,[17] discovered by National Advisory Committee on Aeronautics researcher Richard T. Whitcomb, had been verified during December 1952 in the agency's new transonic wind tunnels. This concept held that interference drag at transonic

[17] A prescribed method of design for obtaining minimum zero-lift drag for a given aerodynamic configuration, such as a wing-body configuration, at a given speed.

speed depended almost entirely on the distribution of the aircraft's total cross sectional area along the direction of flight. The solution was to indent the fuselage over the wing to equalize the cross section areas (and thus the volume) at all stations, thereby producing the so-called "coke bottle" or "wasp waist" configuration. Yet, as in the F-102's case, Convair did not accept the Whitcomb findings until its own engineers had confirmed their validity. Another delaying factor was the absence of military characteristics, which were deferred until the fall of 1953.

Specific Planning 1952-1953

Although the MX-1964 design was yet to be finalized, the Air Force proceeded with specific plans. In December 1952, the Deputy Chief of Staff for Development endorsed a production schedule developed by the Wright Center. This schedule was based on the 4-year procurement of 244 B/RB-58s (more than twice the final total). Thirty of these aircraft, with the first one due for delivery in January 1956, would be used for testing, while preparations would be made for full scale production of a version incorporating all test-dictated changes. The 30 initial planes would then be reworked on the production line into the approved configuration. This plan, drawn from the "Cook-Craigie production policy," was expected to eliminate the faults in a basic design before many aircraft had been built and to speed the acquisition of operationally effective weapon systems.[18] Recent experiences seemed to justify such an approach. Building aircraft prototypes before selecting one of them, as occasionally done, had proved costly and time consuming. Moreover, the selected prototype, once produced, has often still been found to have design flaws that needed correction. In any case, the Cook-Craigie philosophy, if not an integral part of the weapon system concept, fitted it perfectly. The weapon system concept itself promoted significant changes and therefore more planning.

In early 1953, General Putt, ARDC's new Vice Commander, announced the Air Force's revised management tasks. The B-58 weapon system would require a minimum of government-furnished equipment since the prime contractor would be responsible for system design and engineering

[18] The Cook-Craigie production plan was actually a mere concept, developed in the late forties by USAF Major Generals Laurence C. Craigie, Deputy Chief of Staff for Development, and Orval R. Cook, Deputy Chief of Staff for Materiel. They both knew this concept could be expensive and thought "it was only applicable where you had a high degree of confidence that you were going to go into production." The F-102, a by-product of the "1954 Interceptor," bared some of the pitfalls of the Cook-Craigie plan for early tooling. In October 1953, when testing established unequivocally that important changes had to be made in the F-102's design, 20,000 of the 30,000 tools already purchased by Convair had to be discarded.

and would deal directly with subcontractors to acquire major components. The Wright Air Development Center, now headed by Maj. Gen. Albert Boyd, would contract for major components "only when limitations of industry, operations, or logistic considerations force the USAF to control source and/or methodology." Even then, such components would have to be designed, built, and tested to Convair's specifications. In short, the Air Force's role was to monitor the prime contractor's plans and progress; to approve specifications as well as subcontractors, and to supply the money. It also retained the right to veto any developments that could cause operational or logistical problems. The Air Force management of the B-58 weapon system would be exercised at the Wright Air Development Center by a 20-man joint project office, made up of ARDC and AMC representatives.

Contractual Arrangements 1953

Contracting proved to be a difficult endeavor, far more complex than usual. Limited experience with the weapon system concept prolonged negotiations, as the Air Force and Convair worked out specific provisions to define each party's prerogatives and responsibilities. These clauses became part of Convair's letter contract on 12 February 1953, when a supplemental agreement was signed.[19] This was an important turning point, indicating the B/RB-58 program was getting under way, with the B-58 mockup scheduled for the end of the summer, while that of the reconnaissance version would follow in the fall of 1953. The amendment also gave Convair $22 million to cover pre-production planning costs and the acquisition of long-lead time tools and equipment. Yet, it failed to resolve immediately a few basic problems. As single manager, Convair believed that compensation for its additional managerial efforts should be incorporated in the program's direct cost. The Air Materiel Command disagreed, contending that such payments should be added to the overhead administrative costs of present and future contracts, on a yearly pro-rated basis. AMC also postponed total approval of the funds requested by Convair to expand its Fort Worth facilities, causing the contractor to spend $500,000 of its own to secure extra office space.

Design Approval 20 March 1953

The Air Force selected a firm configuration for the B/RB-58 and

[19] This was the fifth and so far most significant amendment to Letter Contract AF33(038)-21250. The contract itself was not finalized until the end of 1955, even though the letter contract dated back to February 1951.

authorized Convair to begin work on each full-scale mockup version. The approved design incorporated the changes dictated by the National Advisory Committee for Aeronautics's transonic area rule. Specifically, the airplane cross-sectional area was redistributed longitudinally to minimize the compressibility drag rise encountered at transonic speeds. This had been accomplished by fuselage redesign, housing the engines in 4 staggered nacelles, and adding a 10-degree trailing edge angle to the wing, which also increased the wing area to 1,542 square feet. In addition, the wing's leading edge had been cambered and twisted to reduce drag at lift.

Immediate Problems — May 1953

Approval of Convair's new design did not ease the Air Force's concern about the engine of the future aircraft. As summed up by General Partridge, every effort had to be made to safeguard the successful development of the J79 upon which the "vitally important B-58 and other projects will be so heavily dependent."[20] Equally concerned, General Putt informed the General Electric Company that the J79 project controlled "to a very major degree, this country's ability to defend itself during the 1958-1965 period." "This responsibility," General Putt wrote, "should not be treated lightly." The fact remained that the development histories of American and British turbojets showed that 4 to 5 years were needed from the beginning of design to completion of the 150-hour engine test. This was confirmed by the General Electric engineers, who insisted that delivery of the J79 engine could not be scheduled until July 1957. Based on experience, the Air Force thought this schedule might still be unrealistic. The solution therefore was to equip early B-58s with a version of the already-tested Pratt and Whitney J57, but this temporary expedient also would pose problems.

Development Engineering Inspection — 17-18 August 1953

This first development engineering inspection replaced the formal mockup inspection which, obviously, had been scheduled to occur too soon for major subsystems to be available.[21] Nevertheless, except for the missing

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[20] The J79 turbojet became the world's first production Mach 2 engine. In addition to the B-58, it eventually powered the Lockheed F-104, the McDonnell F-4, and the North American Aviation A-5.

[21] A second development engineering inspection took place on 29 September 1953. It covered portions of the RB-58 that differed from the B-58. Also held in Fort Worth, the inspection did not cover major subsystems, most of them still remaining a long way off.

components (for which space was provided), the B–58 mockup was complete. Air Force inspectors, including representatives from SAC, were able to get a good idea of the new weapon system, by then known as Configuration II. The inspection group, and General LeMay in particular, asked for many changes, but none appeared vital. Just the same, as the inspection neared its end, General Boyd most likely expressed everyone's opinion in stating: "It is a radical design, and we must be careful in following through with these technical developments." He added, however, that Convair seemed to have done a very good job.

Military Characteristics II — September 1953

Military characteristics (No. 345) for the B–58 high-altitude bombardment system, at long last issued in September 1953, did not bring any great surprises. The requirements fairly matched the specifications proposed by Convair in August 1952, and the lesser USAF demands embodied in the September GOR of the same year. Yet the new characteristics required the carrying of payloads in addition to the warheads originally specified. While this requirement had been anticipated, it implied that greater performance standards would have to be achieved in order to preserve the aircraft's range, which was unchanged.[22] There were a few other changes, most of which stemmed from SAC's criticism. For instance, the side-by-side seating that General LeMay preferred to the tandem seating arrangement of most Air Force planes was not provided, but the B–58 would at least contain a jump seat[23] for one of the crew members to sit alongside of the pilot during take-off and landing. The new characteristics also included some concessions. Maximum dash speeds at altitudes of 55,000 feet were reduced slightly, and the B–58's operational date was postponed from 1957 to 1958 or later.

Increasing Difficulties — 1953

Much to the disappointment of ARDC, and despite application of the area rule, on-going wind tunnel tests of Configuration II continued to

[22] The B–58 would carry 20,000 pounds of munitions, a 13,000-pound increase. This could be expected to entail a reduction of the aircraft's fuel load and, therefore, a significant loss of range.

[23] Subsequently omitted, for lack of space.

produce high-speed drag figures. Stability test results also caused concern. The elevons and rudder were not inherently balanced and depended on the rigidity of their actuating systems to prevent flutter. The engine positions and the anticipated Mach 2.1 speed similarly produced some qualms. In addition, as first identified by the development engineering inspection of August 1953, it had become obvious that the compartmented pod, housing the bomb and fuel, needed to be entirely redesigned.[24] Finally, other changes had to be made to satisfy the anticipated new requirements of the September military characteristics. Meanwhile, other problems loomed ahead. Subsystem development, never considered to be easy, promised to be especially difficult in the B–58's case.[25]

The future aircraft had already been acknowledged as a most complex, highly integrated, and mutually interdependent weapon system. The Air Force, consequently, kept a close watch on every component's progress. In December 1953, it asked for studies to determine if the Arma Company's A–3A Fire Control System could serve as a back-up for the Emerson Company's Active Defense System earmarked for the B–58. The Air Force also wanted to know if a modified M–2 Bombing System, built by the International Business Machine Corporation, could possibly substitute for the sophisticated Navigation-Bombing and Missile Guidance System, being developed by the Sperry Gyroscope Company. Aware of the state-of-the-art's current and foreseeable limits, the Air Force attached great importance to the B–58's forthcoming bombing and navigation system. How a B–58 would find and hit its targets, given its speed and altitude design characteristics, was a difficult question to answer.[26] The problem was serious enough to justify organizing a special committee to monitor the development of B–58 bombing and navigation procedures.[27]

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[24] This was confirmed in October 1953, when the Air Force authorized Convair to shorten the B–58 pod and to sling it on a pylon under the fuselage.

[25] As early as 1951, the Air Material Command stressed that it took much more time to design, develop, and produce new equipment such as guns, engines, and fire-control systems than it did to produce new airframes.

[26] Worrisome comparisons came to mind. For example, in order to obtain a 3-minute bomb run for a B–17 operating at 25,000 feet, the bombardier would have to get on his target about 11 miles away; in the same vein, with a B–58 operating at 40,000 feet at an airspeed of 450 knots, the bombardier would have to spot and track his target from at least 25 miles away. But to have a 3-minute bomb run at the B–58's designed speed of Mach 2 and at an altitude higher than 50,000 feet, the bombardier would have to be on target some 66 to 70 miles away.

[27] This committee consisted of representatives from the Air Staff, ARDC, SAC, Air Training Command, and the contractors. In early 1954, the B–58 Joint Project Office considered the adoption of the monitoring committee idea for other component systems as well.

New Setbacks 1953–1954

Configuration III, as devised by Convair, did not fare as well as expected. The reconfigured B/RB-58 featured a new bomb and fuel pod that had been shortened from 89 feet to 30 feet, and was now detached from the fuselage and suspended on a pylon. To compensate for the smaller amount of fuel carried by the pod, external fuel tanks had been added to the wing tips. The search radar had also been removed from the pod and placed into the fuselage nose. There were other alterations and deletions. The droppable nose gear was eliminated, and the positions of the bombardier-navigator and the defensive systems operator were reversed. For lack of space, Configuration III omitted a jump seat, a new requirement of the military characteristics. In any case, the Air Force did not share Convair's confidence that the reconfigured B/RB-58 would achieve better performance. Early 1954 tests in the tunnels of the Wright Air Development Center and National Advisory Committee on Aeronautics soon confirmed that the contractor's estimates once again were wrong. In addition, a problem thought to be solved had reappeared. In 1953, the contractor and the Air Force had decided to abandon the previously endorsed split nacelle engine arrangement in favor of 2 strut-mounted Siamese nacelles. The change would save weight, ease engine maintenance, and facilitate retrofit of J57-powered aircraft with new J79s.[28] Recent tests, however, indicated that Siamese nacelles induced extra drag on the composite (pod- or missile-carrying) B-58, although the airframe itself was affected almost equally by either type of nacelles. In practical terms, this meant a return to split nacelles, more testing, more delays, and postponement of the Configuration III's mockup inspection from the initially scheduled May date to September 1954.

Program Reorientation 30 April 1954

Based on a preliminary review of the B/RB-58's third configuration, the Wright Air Development Center finally agreed on 4 December 1953 that Convair could begin the construction of airframe components. Yet, subsequent testing of Configuration III qualified this hopeful decision. In March, the B-58 program underwent a drastic change; research and development came to the fore at the expense of production, and the number of B-58s originally contemplated was reduced from 244 to 30, with the latter quota

[28] Unknown to all at the time, this last advantage would have been of no value since the B-58 schedule slipped and production of the J79 engine caught up with the Convair program.

emphatically referred to as "test vehicles." Moreover, long lead time items such as ground training devices and maintenance and test equipment were canceled. Secretary of the Air Force Harold E. Talbott approved the redirected program on 30 April 1954, and authorized release of the procurement funds necessary to support it.[29] Yet, as illustrated by the June procurement directive that followed, the Air Force again qualified its authorization. The directive freed about $190 million of fiscal year 1955 money for 13 test aircraft, but no procurement of any kind could be initiated prior to determining a firm configuration. As it happened, these 13 aircraft were the only B-58s covered by the first definitive contract, at long last signed in December 1955.[30]

Fourth Configuration — September 1954

Crucial events preceded Convair's achievement of its fourth B/RB-58 configuration. A development engineering inspection of Configuration III, held in mid-May, was a near fiasco. Not only did it endorse the poor results of past and concurrent wind tunnel tests, but SAC representatives insisted that the width of the configuration be altered to allow side-by-side seating of the pilot and the navigator-bombardier, a change considered totally impossible. But as the future of the B-58 appeared at its gloomiest, important research progressed. National Advisory Committee on Aeronautics aerodynamicist R. T. Jones at first had been mystified by the problems of airframes designed to the transonic area rule and tested at supersonic speeds. However, by the summer of 1954, he had ascertained that the position and the extent of the fuselage indentation was indicated by the aircraft's designed speed. This time, the Convair engineers did not question Jones' discovery. In August, Configuration III's fuselage was aligned to the modified transonic area rule for supersonic speeds.[31]

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[29] Secretary Talbott succeeded Thomas K. Finletter as Secretary of the Air Force on 4 February 1953. Mr. Finletter had replaced Mr. Symington, the first Secretary of the Air Force, on 24 April 1950.

[30] The remaining 17 test vehicles were carried on another procurement contract, finally initiated by a mid-1956 letter contract. Indicative of the uncertainties that surrounded the costly B-58 program, it took 5 definitive contracts to get less than half of the number of B-58s first ordered. Furthermore, most letter contracts ended with an unusually large number of supplements and amendments. The whole procedure eventually resulted in substantial amounts of termination costs.

[31] For a transonic body, the area rule is applied by subtracting from or adding to its cross-sectional area distribution normal to the airstream at various stations so as to make its cross-sectional area distribution approach that of an ideal body of minimum drag; for a

Officially referred to as the B/RB-58A configuration, the new design featured other innovations. External wing fuel tanks were eliminated, the tail area was extended to 160 square feet, and the 4 engines were suspended by separate pylons, 2 under each wing. Convair was sure that the new B/RB-58A configuration would satisfy the performance requirements of the military characteristics of September 1953, but conceded that minor refinements might still be needed. The contractor also asserted that its new configuration was "the best design supportable by the current state-of-the-art." However, delivery of the first test aircraft, already delayed by the program reorientation, would slip further if production was not authorized soon. Still in a quandary, the Air Force doubted that the new configuration would meet Convair's expectations, and refused to approve the model specifications. Even so, the Air Force in November asked ARDC to develop 2 important back-up systems, one for the Sperry bombing and navigation system, the other for the Emerson tail defense armament. That same month, after learning that Convair was about to reduce its labor force, the Air Force finally authorized limited fabrication of the new airframe.

Near-Cancellation 1954–1955

After seeming to improve, the B/RB-58A's future once again appeared on the brink of disaster. A chief factor in the new crisis was SAC's dislike of the proposed aircraft. True to character, General LeMay had not changed his mind.[32] In fact, based on the command's arguments of November 1952, a mid-1954 staff study, prepared by Maj. Gen. John P. McConnell, SAC's Director of Plans,[33] had excluded the B-58 from the 51-wing bomber force proposed for the period 1958-1965. At first unimpressed by the SAC

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supersonic body, the sectional areas are frontal projections of areas intercepted by planes inclined at the Mach angle.

[32] At the urging of General LeMay, the Air Force in July 1954 instructed ARDC to initiate the research and development of an intercontinental bomber to succeed the B-52. This eventually promoted North American's ill-fated B-70, a bomber which had its origin in May 1953. Boeing was the recipient of the May 1953 study contract for a nuclear- or chemical-powered weapon system of intercontinental range. In 1955, the Air Force Council agreed that development of a nuclear-powered aircraft would not negate the requirement for a bomber using conventional fuel, and weapon systems 125 (nuclear-powered aircraft) and 110A (B-70) assumed their individual identities. Reminiscent of the B-58's case, North American in 1957 won the B-70 design competition over Boeing.

[33] Promoted to four-star rank in 1962, General McConnell served as Chief of Staff of the United States Air Force from 1 February 1965 through 31 July 1969.

omission, the Air Staff in late 1954 was having second thoughts. In early 1955, after General LeMay had directly confirmed to Gen. Nathan F. Twining (Air Force Chief of Staff since 30 June 1953), that SAC wanted no B–58 aircraft for its operational inventory, the Air Force endorsed a thorough review of the program. A B–58 review board was appointed in February and chaired by Maj. Gen. Clarence S. Irvine, AMC Deputy for Production. The board faced the difficult task of recommending whether the B–58 program should be continued, modified, or canceled. General Boyd, one of the board's members, admitted that Convair's latest configuration might again not meet all requirements of the military characteristics, but still believed, that the B–58 should be built, even if the Air Force could not use it as originally intended. The B–58, the Wright Air Development Center Commander argued, represented major technical advances and, therefore, entailed technical uncertainties and the risk of high costs. These uncertainties would remain until "we have flown such an aircraft," and "we must accept such a risk sooner or later."

The board studied anew other valued opinions that had been discussed in previous months. As already stated by Lt. Gen. Thomas S. Power, in charge of ARDC since April 1954,[34] the B–58 was the first attempt to build a supersonic bomber (making in retrospect the production of supersonic fighters look relatively simple), and this task demanded extensive knowledge of aircraft materials and aerodynamic heating. The board's chairman agreed that from this standpoint the program was probably worth the money it had already consumed. Nevertheless, after an investment of 2 years and almost $200 million, no tangible achievements could be claimed. If the B–58 should now be canceled, the money would actually be lost, whereas another $300 million might suffice to build the 13 test-aircraft included in the reoriented program of April 1954. There were other pro-B–58 arguments. In his testimony before the review board, Convair's chief engineer maintained that, if allowed, the B–58 effort would produce the earliest and most inexpensive integrated weapon system, as well as a very outstanding bomber. At worst, he added, the B–58 would be superior to the existing B–47 medium bomber, a contention fully supported by General Power, who also noted that the aircraft might fulfill Tactical Air Command's requirements for a short-range attack bomber.

On 10 March 1955, the review board submitted its recommendations to the Air Force Council and to the Secretary of the Air Force. Aware that whatever suggestion was adopted could have far-reaching effects for years to

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[34] Deputy Commander of SAC between 1948 and 1954, General Power left ARDC after 3 years. He acquired his fourth star in mid-1957 and returned to SAC, this time as General LeMay's successor.

come, the board took no chances. First, it emphatically recommended that the reoriented program be continued on a modified basis. Only 13 test-vehicles would be ordered; they would be equipped from the start with J79 engines; and all back-up subsystems would be eliminated in order to reduce costs. The board observed that Convair could be asked to submit several new design proposals, one for a B–58 tactical bomber, one for special reconnaissance aircraft, and one for a long range B–58 interceptor. Finally, to complete developments vital to the design and operation of future strategic bomber weapon systems, the board did not exclude another possibility. Instead of limiting the program to 13 test-vehicles, it might be wise to buy also a number of B–58s for the operational inventory.

Development Reendorsement — June 1955

Development of 13 B–58 test aircraft, and nothing more, was approved by Secretary Talbott on 2 June 1955. The Secretary's approval carried stern, if not unexpected conditions. The Air Force wanted the program's costs to be reduced, and it wanted the aircraft to begin flying before November 1956. Furthermore, ARDC was to plan the aircraft's utilization in light of the Air Force's new objectives. In short, there no longer was any question of producing a high-altitude, manned strategic bomber and reconnaissance weapon system out of the B–58 test-aircraft. The program's only purpose was to promote research and development.[35] The Air Force needed to learn more about the aerodynamic problems of sustained supersonic flights at high altitudes, and it needed to test subsystems and components for future weapon systems. There were no delays in satisfying most of Secretary Talbott's demands. AMC had been studying the aircraft's cost problem for several months. An April estimate showed that $554 million would cover 13 B–58s, 31 pods, all engines, other government-furnished equipment and support, as well as Convair's fee. With the aircraft now strictly earmarked for research and development, various items could be deleted. This would save about $50 million and bring total costs close to the Air Force's tentative maximum. Convair seemed unabashed by the cut of its program, believing time would work in its favor. Hence, it went all out to match AMC's cost reductions, while projecting costs for the production of up to 500 aircraft. In mid-June, AMC authorized Convair to resume work on development engineering, tool fabrication, airframe parts, and the like. At month's end, the contractor felt confident it could fly a B–58 by November 1956, which

[35] SAC was pleased with the decision, but thought a 13-aircraft research and development program was larger than necessary.

it did. Meanwhile, personnel of the B-58 project office coordinated with representatives of various offices to identify non-essential B-58 subsystems and components, while preserving the development of any B-58 hardware that could benefit other projects.[36]

Decision Reversal — 22 August 1955

Scheduled for production in December 1952, an object of indecision in April 1954, practically canceled 10 months later, and relegated to research and development in June 1955, the B-58 project was yet to undergo another major change. Abruptly, on 22 August 1955, the B-58 weapon system once again emerged as a production candidate. The decision, approved personally by General Twining, climaxed weeks of debates.[37] General Putt, now Deputy Chief of Staff for Development, had helped to initiate the program and still professed the B-58 could be "a useful SAC tool." General Irvine, the new Deputy Chief of Staff for Materiel, and others on the Air Force Council shared General Putt's opinion. However, attempts to sway General LeMay failed. This failure most probably accounted for the production directive's unusual wording. The directive of 22 August 1955, calling for a wing of B-58s by mid-1960, was most specific in stressing the need for economy but made no mention of the wing's recipient or of SAC in particular.

Contractual Arrangements — 1955–1956

Convair's Letter Contract AF33(038)-21250 of February 1951 was superseded in December 1955 by a definitive contract of the cost-plus-incentive-fee type. This gave Convair an additional $340 million for 13 aircraft, 31 pods, and all contractor-furnished equipment, bringing the contract's total value to about $540 million. The incentive fees depended on technical performance, weight control, and contractor adherence to cost and to delivery schedule. A second letter contract, AF33(600)-32841, issued on 25 May 1956, provided another $13.6 million to buy long-lead items and to maintain B-58 production at a minimum sustaining rate through October

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[36] Included in such projects were the B-70, the nuclear-powered aircraft, and a tactical bomber logged as Weapon System 302A.

[37] Secretary Talbott did not participate in the debates. He resigned his position on 1 August 1955 and was succeeded two weeks later by Donald A. Quarles, who served as Secretary of the Air Force until 30 April 1957.

1956. The Air Force planned to decide in the fall of 1956,[38] if it should buy 17 more upper components (B–58 airframes), 17 powered bomb pods, 12 free fall bomb pods, 3 photo pods, and 3 electromagnetic data (ferret) pods. If it did, an extra $14.9 million of pre-production funds would be needed.

First Flight — 11 November 1956

The initial B/RB–58 made its first flight on 11 November 1956, taking off from the Convair Fort Worth facilities at Carswell AFB, Texas. A second flight on 14 November lasted one hour and was also described as successful. On both occasions, the maximum altitude reached was 30,000 feet, while the maximum speed did not exceed Mach 0.9. Supersonic speeds of Mach 1.6 and Mach 1.35, at altitudes of 35,000 feet, were first reached in a third flight on 4 December. The 3 flights were made by the same plane which, like several subsequent ones, was temporarily identified as a prototype (YB–58). In another departure from the usual, a characteristic that typified the B–58 program from the start, the YB–58 flights of late 1956 and early 1957 proved extremely important. Although testing had just begun, they undoubtedly influenced the Air Force's ensuing decisions.

Initial Testing — November 1956

By virtue of the weapon system concept adopted for the highly complex B/RB–58, the core of the testing program was altered. Also, the Air Force's insistence in 1952 that technological developments fit requirements inevitably affected testing.[39] As a result of such innovations, the flight testing program, an always thorough undertaking, acquired a new, time-consuming, and occasionally frustrating dimension.[40] The Category I tests, begun by the

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[38] This planning was in line with the August 1955 decision to buy a wing of B–58s. As all along understood, this could only be done if there was sufficient evidence that the project was viable.

[39] The Air Force decision of 1952 was one of the many difficulties and momentary contradictions that plagued the B–58. A few years before, when the GEBO study was initiated, USAF engineers asked for more realistic military characteristics and advocated state-of-the-art design compromises.

[40] By chance, this coincided with the end of the 8-phase concept of testing, under which a new aircraft was designed, built, and tested first by the contractor, then at various ARDC centers, and finally transferred to a major Air Force command for operational utilization. The new testing program, although counting only 3 categories, did not degrade in any way the former program's scope (see B–52, p 225).

contractor in November 1956, accounted for almost 3,000 hours of flight tests by March 1962, and the destruction of 1 aircraft (the fifth YB–58, Serial No. 55-664) in November 1959. Furthermore, pod drops, aerial refueling, and a few other special tests, properly part of Category I, were completed under the Category II program, which did not officially start before March 1959.

New Controversy 1957

While the production decision of 22 August 1955 failed to indicate which command would use the new aircraft, it soon again became obvious that the B–58 lay in SAC's future.[41] As technological difficulties increasingly impaired the B–70 development, the command became more involved with the B–58. Willing to believe in the B–58's potential for improvement, SAC in late 1956 was actually preparing to participate in the aircraft's forthcoming test program. In the spring of 1957, imminent budget decisions affecting SAC aircraft nearly shattered the command's fragile cooperation. By that time, the B–58 had established itself as the world's fastest jet bomber. The Mach 2 speed success of the B–58, cited as one of the reasons for decreasing the B–52 production rate, did not satisfy General LeMay. He quickly reasserted his early 1955 position that no B–58s were needed. New studies, General LeMay explained, showed that the B–52G with its programmed penetration aids would be superior to the production-improved B–58 and to any "better" B–58, such as the new B–58B configuration proposed by Convair. This was particularly true from the standpoints of cost effectiveness and availability. As for the B–70, General LeMay added, there was no doubt that it would provide substantial improvements over the B–52G. Therefore, "the B–58 should be limited to a test program. Funding for procurement or model improvement testing should not be provided." The Air Staff bluntly disagreed with General LeMay, stating that it was "most desirable" that SAC get a supersonic bomber at an early date and that the decision had been made to buy a limited quantity of B–58s for the SAC inventory. In a mollifying gesture, the Air Staff underlined that the United States had to protect its technological lead over the Soviets as well as the

[41] General LeMay's lack of enthusiasm for the B–58 put the aircraft within the reach of the Tactical Air Command. It was a fact, however, that the Convair project had been geared from the start to meet SAC's performance criteria, that the recently flown YB–58 basically remained a SAC-configured aircraft, one that would require the time-consuming incorporation of many costly changes if it were to fulfill the Tactical Air Command mission. In early 1957, Gen. Otto P. Weyland, who headed the command, wanted a minimum of 2 B–58 wings, but the Air Staff disagreed.

money already invested in the B-58 program. Also, the B-58 would improve through normal growth, and the program's funding requirements would not affect the B-70's prospects.[42]

Critical Shortcomings 1957

Flight testing of the first 3 YB-58s, while accounting for some spectacular achievements,[43] brought to light several problems. The J79-GE-1 prototype engines, installed on the YB-58s pending certification of the J79-GE-5s,[44] had a number of flaws. Malfunctions in the fuel system sloshed the fuel around when the YB-58 accelerated or slowed down, impairing the aircraft's stability. Afterburner problems caused intermittent yawing at supersonic speeds. Of greater concern were already noted acoustical and sonic fatigue problems as well as excess vibration in the YJ79-GE-1 engines. The acoustical and sonic fatigue difficulties affected the aft area of the fuselage and would cause testing restrictions unless promptly solved. Fatigue created cracks along the rivet lines in the forward section of the fuselage. Since the cracks appeared after less than 50 hours of flight, replacing the YJ79-1 engine by the J79-5 would worsen the problem because the more powerful J79-5 would increase the sound level 10 decibels above the level induced by the YJ79-1. The engine vibrations also might affect components of the electronic equipment, installed in the fuselage's aft section and in the aft portion of the various droppable pods that were programmed for the aircraft. There were other difficulties of varying importance. The brake system was not satisfactory. Because of inadequate heat dissipation after braking, tire failures were frequent following landing at high gross weights and high-speed taxi runs. The upward-type of ejection seat put in the aircraft was unsafe at high speed, due to insufficient thrust. Convair tests of a more powerful, rocket-type catapult seat identified problems of another kind. Other sorts of ejection seats were being consid-

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[42] Indeed, the proposed B-70 fell under a different time period. Nevertheless, by focusing attention on cost, the enormously expensive B-58 program did not help the cause of future high-performance manned bombers.

[43] By the end of 1957, the YB-58s had attained a maximum speed of Mach 2.11 at altitudes over 50,000 feet; made 2 successful pod drops from 42,000 feet at Mach 2 speeds; maintained a speed of more than Mach 1.15 during 91 minutes, and zoomed without pod from a speed of Mach 2 at 50,000 feet to a speed of Mach 1.13 at 68,000 feet.

[44] Even though General Electric's progress had negated the temporary use of Pratt & Whitney J57s, the J79-5's 150-hour preliminary flight rating test was not expected before year's end.

ered, with misgivings. The Air Force and the B-58 contractor greatly favored a capsule-type escape system, under development by both the Martin Company and the Goodyear Tire and Rubber Company, but time was of the essence. Finally, slippage in the bombing-navigation subsystem development program portended a serious delay in the delivery of the initial equipment. This would retard the B-58 flight-test program, as would shortages of spares for both the YJ79-1 and -5 engines.

Another Near-Cancellation 1958

In 1958, the B-58 program came under renewed scrutiny. The YB-58 could fly fast and high, but its range remained poor. With 1 refueling, the aircraft had a radius of 3,800 nautical miles; without refueling, the distance dropped by almost 40 percent. In addition, limited testing had already uncovered far too many problems. Configuration changes worked out between Convair and an 85-man team from ARDC, AMC, and SAC, would probably help a lot. Yet, changes were always costly. In August 1958, General Power, who had been heading SAC for over a year,[45] told the Air Staff that the B-58's deficiencies were exaggerated, a common occurrence, he remarked, when a program was expensive and it became difficult to obtain financial support. Believing that a mixed force of B-52s and B-58s was the best way to replace the B-47s,[46] General Power pointed out that the B-58's bombing and navigation system, already late, might become available sooner than expected since performance of the system's doppler radar was getting better. Agreeing with General Power that the B-58's early difficulties had been taken out of perspective, General White nevertheless cautioned that, should the program survive, the quantity of aircraft to be purchased in fiscal year 1959 would have to be reduced. The money thereby saved would pay for the most important changes and inevitable cost increases. By the end of December, photo reconnaissance, one of the B-58 program's initial requirements, was deleted. ME-1 pods and ground photo

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[45] General Power acquired his fourth star and succeeded General LeMay as SAC's Commander-in-Chief in July 1957. General LeMay moved to Headquarters USAF as Vice Chief of Staff, under Gen. Thomas D. White, becoming Chief of Staff of the Air Force on 1 July 1961, when General White retired.

[46] General LeMay, although acknowledging in November 1957 that the mixed force concept was apparently in the offing, continued to question the wisdom of the proposed combination. The cost, from the standpoint of refueling operations alone, did not favor the B-58. It would take 1 tanker to refuel 1 of the new bombers, while 2 tankers could take care of 3 B-52s. Among the members of the Air Force Council, General LeMay stood alone in his opinion.

processing equipment, under contracts but yet to be delivered, were canceled, as were 45 ALD-4 ferret pods. On the positive side, the MB-1 free fall bomb pod was exchanged for a 2-component bomb and fuel pod.[47] Other approved changes included improved communications equipment (single-side band/high frequency and emergency ultra-high frequency radios), encapsulated crew ejection seats (another new development), tactical air navigation (TACAN) electronics, and various minor improvements. However, as indicated by General White, one-third of the fiscal year 1959 B-58 procurement was canceled.[48]

Category II Testing — March 1959-30 June 1960

Officially initiated in March 1959, but actually started on 15 February 1958, the Category II tests first assumed some of the flight testing normally conducted under Category I. This variance was primarily due to the November 1957 decision to consolidate the B-58 flight test program under the direction of the weapon system office. While the ARDC testing role was not changed significantly, the proposed using command (SAC, as already confirmed) was to participate in all testing, which was unusual. In another departure from past procedures, testing would be carried out as close as possible to the contractor facilities, which made Carswell AFB the obvious location. The Air Force believed that, among other advantages, this arrangement should reduce costs for logistical training and for support of the Convair technicians. As to the consolidated testing program, it should help to discover and solve development problems quicker. SAC's 3958th Operational Employment Testing and Evaluation Squadron was activated on 1 March 1958, too late to monitor the beginning of the Category I tests. Nevertheless, the 3958th, its ARDC counterpart (the 6592d Test Squadron), and representatives from AMC and Convair soon were in place, constituting the test force that took care effectively of the Air Force Category II and III tests.[49] The Category II tests were completed on 30 June 1960, after

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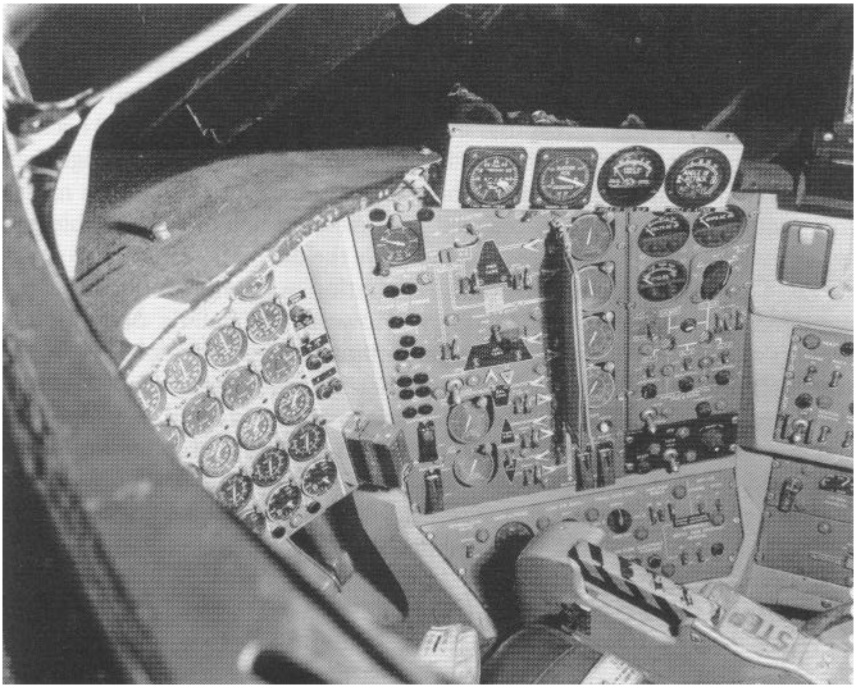
[47] The new 2-component bomb and fuel pod had special merits. After the fuel had been used, the bomb and integral tankage would be dropped on a target, making the aircraft lighter for its return flight.

[48] Letter Contract AF33(600)-36700, issued on 1 November 1957, called for 47 B-58s, bringing forecast procurement to a total of 77—30 so-called prototypes and 47 aircraft for the operational inventory. But the letter contract of November 1957 remained to be finalized, and its 47 aircraft were reduced to 33 on 26 September 1958.

[49] The bulk of the responsibility for the Category I tests did remain with the contractor; Category II proved the airplane's subsystems and was carried out mainly by ARDC's 6592d



A control panel in the B–58.

accumulating 1,216 flight hours that were reached in 256 sorties. Except for a few authorized deviations and some unexpected delays, the Category II testing progressed as planned. Two YB–58As, undergoing stability and control evaluation, were flight tested from Edwards AFB, California, and from Convair's Fort Worth airfield. Another test-aircraft, earmarked for climatic hangar evaluation, went directly from Fort Worth to Eglin AFB, Florida. Finally, the accelerated service test of the J79–GE–5 engine, after 330 flight hours under Category II, was completed under Category III, when SAC crews accumulated 170 additional hours of flight. From the practical standpoint, the Category II tests proved invaluable. Yet, they probably accounted in part for the program's last near-cancellation and final reduction. Seven test-aircraft were lost between December 1958 and June 1960, including 1 which disintegrated in flight on 7 November 1959.

Squadron; the Category III operational tests (always accomplished by the using command) were conducted by the 43d Bomb Wing with the technical assistance of the Test Force.

Program Finalization 1959–1960

While testing was going on, the B–58's fate once again appeared uncertain. A Rand Corporation study, requested by the Air Staff, proved disappointing. Rand thought that the B–52 was superior to the B–58 because the Boeing aircraft could carry heavier payloads and had a longer range than the B–58. Of course, the corporation agreed that air refueling was a means to extend range, but pointed out that such recourse could be unreliable and expensive. Instead, the cheapest way to solve the dilemma would be to equip the B–47s with improved engines. Penetration was another factor to be considered in assessing the bombers. However, in Rand's opinion, the aircraft's penetrative ability was unimportant since enemy defenses of the near future would be so sophisticated that bomber losses would be high, regardless of speed. While these observations appeared valid, the Air Force did not want to alleviate its financial difficulties through retention of an improved but still obsolescing B–47 fleet. The Air Staff, therefore, asked Rand to review its original conclusions. This second round of deliberations served no purpose. Rand returned its study unaltered and without any further solution.

Meanwhile, dissatisfaction with the B–58 program grew. The correction of obvious combat deficiencies was slow, and it seemed almost certain that early inventory aircraft would be short of components and would have no high frequency radio or identification equipment. Some SAC officials were beginning to think that 2 wings of B–58s would be plenty since the aircraft would require greater tanker support than the B–52s. Also, the B–58s would not be able to fly at low level without extensive and costly modifications. Others at SAC wanted more B–58s, having faith in the follow-on B–58B that could be expected to materialize after production of the first 105 B–58As (test-aircraft included).

In May 1959, after reendorsing continued production of the B–52s, as well as support of the B–70 and of the nuclear aircraft program, General White refused to discuss the B–58's future. Just the same, the Air Force on 11 June 1959 began to plan the production and delivery schedules of 185 B–58Bs which, counting the B–58As, would increase the total to 290 aircraft, or enough to equip 5 wings. While at SAC, General LeMay had not liked the B–58A, and as Vice Chief of Staff, he did not change his opinion. The new model would be too expensive, its automatic equipment for low-level flight too complex.[50]

On 7 July, the Air Staff eliminated the B–58B from the program and the

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[50] The B–58B was also due to provide increased range, speed, altitude, and external stores such as multiple free fall bomb pods, fuel tanks, and air-to-surface missiles.

B-58A itself again appeared to be in serious jeopardy. The 60 B-58As, under Letter Contract AF33(600)-38975 and due to be funded in fiscal year 1960, were first reduced to 32, then to 20. General Power tried to justify retaining the 290-aircraft program, but the Air Staff retorted that budgetary considerations were sometimes overriding and Secretary of the Air Force James H. Douglas confirmed that the B-58B was a dead issue.[51] The B-58A came very close to following the B-58B's path. A saving factor again proved to be the money already invested in its development. Also, as noted by Secretary of Defense Thomas S. Gates, a redeeming virtue of the B-58A was its availability in the near term. Yet, even the latter justification was weakening. Time had been catching up with the B-58 weapon system, originally designed to perform against enemy targets of the 1958-1965 period. It was now obvious that the B-58A would not be available in quantity before 1962. Once at the top of the Air Force's priority list, the B-58A program had lost its urgency. In July 1960 (FY 61), Letter Contract AF33(600)-41891 was initiated, but the 30 aircraft and 96 BLU-2/B pods covered by the document were subject to cancellation. The Air Force reached a final decision in December 1960. The fiscal year 1961 purchase was retained, but the fiscal year 1962 procurement was deleted. SAC would receive 2 wings of B-58As and no more.

Category III Testing — August 1960-July 1961

Category II test results and several accidents postponed Category III testing to August 1960, a 6-month slippage. SAC did not want to start the Category III tests before correction of certain B-58 deficiencies. Electrical malfunctions, tire failures, difficulties with the flight control system, and possible structural weaknesses appeared responsible for a rash of recent crashes. Accident findings did not indicate any consistency in the causes, but the B-58 remained under flight restrictions and SAC would not accept the aircraft pending further investigation.[52] Also, modifications required by SAC had to be made to improve safety. By mid-1960, some structural improvements were completed. The aircraft tail had been strengthened, critical side panels had been reinforced, and an ARDC ad hoc committee report was given to SAC. The report emphasized that there were no design deficiencies in either the aircraft or the flight control system, and that when

[51] Secretary Douglas succeeded Secretary of the Air Force Donald A. Quarles on 1 May 1957.

[52] Supersonic speed restrictions were raised to Mach 1.5 in March 1960, but only for the aircraft equipped with modified flight controls.

all functioned, the systems met the specifications. The report also noted that SAC pilots had verified the B–58's good handling characteristics, but pilot training and high proficiency were necessary. In addition, maintenance and control personnel should be highly skilled since those areas could greatly affect B–58 operations.

Obviously satisfied with the committee's report, SAC on 1 August 1960 assumed executive management of the B–58, a function previously vested in ARDC. This marked the beginning of Category III testing, which was accompanied by a number of changes. For example, ARDC's 6592d Test Squadron was inactivated, and the squadron's aircraft and personnel were transferred to the 65th Bombardment Squadron (Medium) of SAC's 43d Bomb Wing. The B–58 Test Force was formally dissolved, although a small nucleus of ARDC people stayed at Carswell AFB to assist the 43d Wing through completion of the Category III tests.

SAC's 3958th Operational Employment Testing and Evaluation Squadron had been a most important member of the now extinct test force. The 3958th was responsible for the proper development of a combat crew training program. It had to select and educate B–58 maintenance personnel and to create a cadre of flight crews that would serve as instructors in forthcoming combat crew training classes. In addition, the 3958th put together standard operating procedures for the future B–58 wings. When it took over, SAC's 65th Bombardment Squadron (Medium) found no fault in the 3958th's performance. Formal 3-month classes for combat air crews, started in mid-1960, encountered no personnel difficulties. Selected students, former B–47 pilots and regular officers for the most part, were highly qualified, with a minimum 1,000 hours of jet flying experience. Student navigators, with 500 hours of flying time on multi-jet aircraft, and defense system operators, with a minimum of 200 hours, were also excellent candidates. The 65th Combat Crew Training Squadron used Convair 2-place TF–102As to start training B–58 pilots and welcomed the August 1960 delivery of the first TB–58A trainer. As a rule, 3 TB–58 flights were made before a pilot could solo in a B–58A.

Even though nearly 1,879 combat crew training hours were flown as part of the Category III tests, the program had little to do with the 43d Bomb Wing's combat crew training. The Category III task was to evaluate the overall operational performance of the B–58A. Since the aircraft was a highly integrated, complex weapon system, the scope of the Category III tests was unusually broad. The tests covered all aircraft systems, passive defense, electronics, communications and the like, but also aerospace ground equipment and supply, for all these factors played a part. Still, because of its critical importance, a great portion of the Category III tests was devoted to the ASQ–42V Bombing-Navigation Electronic System. Ended on 31 July 1961, after the loss of 1 more B–58, Category III testing was credited with some 5,265 hours of flying time, of which about 945 hours were used strictly for testing. The rest was accumulated in various ways. A subtotal of 1,878 hours was flown to meet various Category III combat crew training objectives. The remaining hours, approximately 2,439 of them, encompassed maintenance test flights, the acceptance and delivery flights of new and retrofitted B-58As, airshows and record-breaking flights, and the hours flown for ferry missions.

Enters Operational Service 1961

B-58As, a first lot of 12, began reaching the 43d Bomb Wing at Carswell AFB in August 1960, but the 43d did not gain an initial operational capability until 1961, and waited until May of that year to get its full complement of 36 B-58s.[53] An unreliable bombing and navigation system, maintenance difficulties, shortages of ground equipment, and continuous involvement in the Category III tests combined to delay the 43d Bomb Wing's combat readiness. A second SAC wing, the 305th[54] at Bunker Hill AFB, Indiana,[55] received its first new bombers in May 1961 to start converting from subsonic B-47s to supersonic B-58s. SAC expected that the 305th would have its full allocation of B-58s by May 1962. Twenty KC-135 tankers were already in place at Bunker Hill.[56]

Initial Shortcomings 1960-1961

The first 47 B-58As did not have tactical air navigation (TACAN) electronics. The system, developed by the Hoffman Laboratories, was provided

[53] In later years, this number was increased to 45, a total which included 4 of SAC's 8 TB-58As. The other 4 trainers went to SAC's second wing of B-58s.

[54] SAC had earmarked the 305th as the first B-58 recipient. Initially, this was changed as a result of the new testing arrangement. Later, the 43d Bomb Wing's proximity to Fort Worth remained an important factor in view of the B-58's early operational problems.

[55] Bunker Hill was renamed as Grissom AFB on 12 May 1968, in honor of Lt. Col. Virgil Ivan ("Gus") Grissom (1926-1967). Colonel Grissom, one of the original 7 United States astronauts, made the second Project Mercury flight and a Project Gemini flight in July 1961. He died on 27 January 1967 in a fire aboard an Apollo spacecraft under test at the Kennedy Space Center, Fla.

[56] Aerial tests, completed in October 1959, showed that Boeing KC-135 tankers could refuel the B-58s. However, air refueling training and operations were limited at first because the B-58 search radar was not compatible with the refueling rendezvous equipment installed in the KC-135.

as government-furnished equipment and due to be retrofitted in most of these early planes. Also, the B-58As could not fly at low levels. Design changes to give the aircraft this added performance were being worked out. Prompt results could not be expected since the changes had only been authorized in mid-1959, when Convair's subsequent model series, the improved, low-level flying B-58B, was canceled. There were many other deficiencies of varying importance. The aircraft's ejection seats were still unsatisfactory. Development of a capsule-type of escape system for a single crewman, now handled by the Stanley Aviation Corporation, was progressing well. However, the capsule's stability remained marginal after ejection, thereby preventing Convair from incorporating the capsule during production. This meant that all B-58s would have to be retrofitted, a task started in late 1962.[57] Meanwhile, another retrofit project was taking place. B-58As were re-equipped with sturdier wheels and new tires, marking the end of at least one long-standing problem.[58] But this was just a beginning. In mid-1961, following completion of a 6-month study, the Air Staff decided that much more would have to be done to enhance the B-58A's performance. It also approved modification of existing B-58s (about 70 of them) to allow the aircraft to carry a greater variety of weapons, 4 of which would be transported externally. Subsequent B-58As would be so equipped on the production line.

Post-Production Modifications 1962–1964

Significant modifications were initiated in November 1962, under the code name of Hustle Up, a 2-phase project accomplished in Fort Worth by the prime contractor, and in San Antonio, Texas, by technicians of one of the Air Force Logistics Command's air materiel areas. The first phase of Hustle Up covered 59 B-58As; the second phase, only 36. However, Phase II also modified 76 pods of various configurations. Modification kits, including aircraft kits, pod kits, training kits and kit spares, were acquired through special contract at a cost of $6.1 million and used by both the Convair people and personnel of the San Antonio Air Materiel Area. Retrofitting the escape capsules and installing

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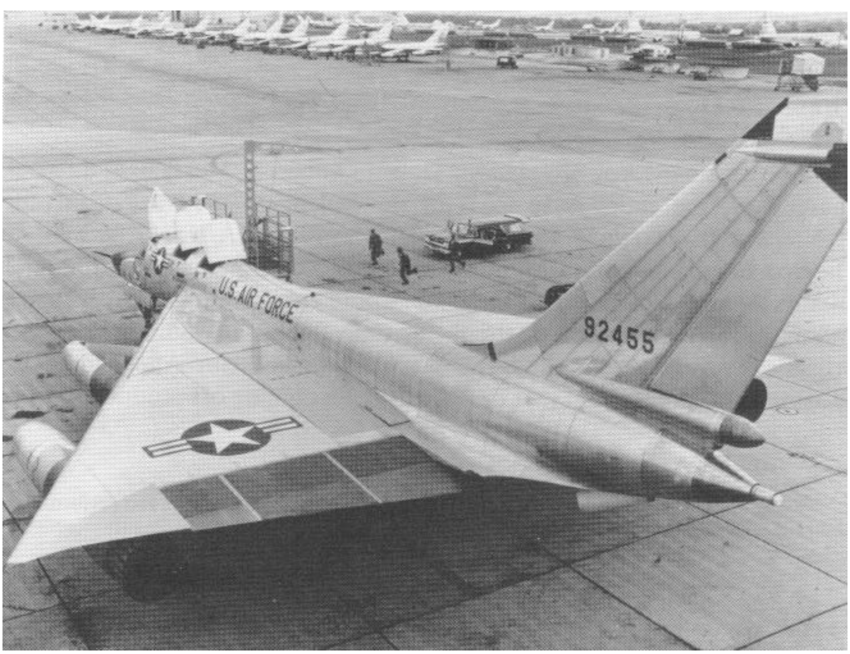
[57] The B-58 was the first aircraft with individual escape capsules for emergency use at any speeds. This escape system could rocket the crew to safety from anywhere between ground level at 120 knots and 70,000 feet at Mach 2.2. The capsule, fitted with clam-shell doors, was pressurized. Once sealed and ejected, it stabilized itself and descended by parachute. It was equipped with a flotation system that deployed automatically in the event of a landing on water. The capsule was not large, restricting the size of the crew. Even so, the capsule consumed space and made the B-58's small crew compartments more cramped.

[58] The loss of a B-58A on 16 September 1959 (totally destroyed by fire after an aborted take-off from Carswell) was directly attributed to tire failure, followed by disintegration of the wheel.

multiple weapons proved to be the most extensive modifications covered by Hustle Up, which was completed in May 1964. Meanwhile, contrary to SAC's hope that the development program would yield a trouble-free aircraft, the B–58A weapon system was again encountering more than its share of difficulties. Two fatal accidents and 30 in-flight "incidents" between March and September 1962 imposed new flight restrictions and generated another major modification program. This program, centering essentially on the aircraft's flight control system, was also conducted in several phases. Phase I put a gang bar on yaw damper switches, but provided minimal improvements. Phase II (redesignated Phase I, following the May 1963 completion of the program's initial phase) modified the mach altitude repeater and improved the unreliable amplifier computer assembly circuitry, thereby allowing the B–58As to fly again at speeds up to Mach 1.65. Started in April 1964, the new Phase I closed before year's end, as scheduled, with 13 B–58s of the 305th Bomb Wing being so improved while undergoing the last part of the Hustle Up modification program. The next phase (Phase III, now known as Phase II) did not fare as well. It was due to further improve the flight control system, which in turn would allow the B–58A to use its desired Mach 2 speed. Many costly changes were involved, totaling $30 million. Furthermore, this phase was not intended to take place before the fall of 1966.



Crewmen dash for their B–58 during alert training at Carswell AFB, Texas, July 1961.

Unrelenting Problem 1965

Besides its obvious shortcomings, the B-58A was plagued from the start by a very serious problem. Its bombing and navigation system (the AN/ASQ-42) was far less reliable than that of the B-52 and the B-47. The problem, confirmed during Category III testing, did not lend itself to easy solutions. The AN/ASQ-42 was extremely complex. Its electronic signal loops were generated and circulated within several interconnected electronic "black boxes." Thus, malfunctions were hard to track down, since it was difficult to identify which black box was primarily responsible for the failure. By 1965, the AN/ASQ-42 had become an old problem, with no remedy in sight. Occasionally, malfunction causes were identified, but more often, they were merely suspected or totally undetermined. That the AN/ASQ-42 system had to be made to work well was obvious. To begin with, it was SAC's most sophisticated bombing system. Also, once fully operational, the AN/ASQ-42 would allow the B-58A to find and bomb any target, be it at high-altitude/supersonic or low-altitude/subsonic speeds. Yet, improvement proposals, submitted by various contractors in September 1965, were found unacceptable. They did not meet requirements, carried no guarantees, and fluctuated around $70 million, twice the anticipated cost. In any case, circumstances beyond SAC's control raised doubts about the AN/ASQ-42's potential performance.

Phaseout Decision 1965

In December 1965, Secretary of Defense Robert S. McNamara directed phaseout of the entire B-58 force by the end of June 1970.[59] Secretary McNamara also publicly announced that the FB-111A would be built.[60] The new bombers, along with improvement of the Minuteman and Polaris missiles and modernization of the B-52, would enhance strategic deterrence and make longer retention of the B-58s superfluous. In addition, Defense officials deemed necessary budget cuts another valid factor. Appalled by the decision, SAC pointed out that the B-58A, after coming off production with

[59] The decision followed completion of a study of the comparative costs and performance of a proposed bomber (the FB-111A) and existing B-52 and B-58 strategic aircraft.

[60] The FB-111A medium-range strategic bomber, like the B-58, was built in Fort Worth by the Convair Aerospace Division of the General Dynamics Corporation. The FB-111A, a modified version of the F-111A tactical fighter, was part of an interrelated and highly controversial program. As such, the FB-111A coverage was included in Marcelle S. Knaack, *Encyclopedia of U.S. Air Force Aircraft and Missile Systems, Vol 1: Post-World War II Fighters, 1945-1973* (Washington: Office of Air Force History, 1978).

many weaknesses, was well on its way to becoming a sound, effective weapon system. Stressing the declining number of manned bombers, SAC in the ensuing 2 years kept pressing for retention of the B-58s, at least until June 1974. But the decision of 1965 was to prove unshakable.[61] And while it did not spell the end of the modifications programmed at the time, the overall B-58 improvement program was immediately affected.

Reduced Improvements 1965-1969

Modifying the B-58A for low-level flying would be a meager improvement if the aircraft were not properly equipped. SAC insisted from the start that the B-58A, to be truly effective at low levels, needed a terrain-following radar to penetrate increasingly fierce enemy defenses. Prototype development of the radar, approved with misgiving in view of the entire venture's cost and technical hazards, was the first casualty of the B-58's early phaseout. It was canceled in late 1965, when SAC settled for a reliable radio altimeter and a forward-looking visual sensor (day/night television) system. This much less expensive project, installation and modification included, was completed in early 1969. Another modernization project had an even more disappointing fate. The B-58A's electronics countermeasures systems, never updated since the aircraft's production, were nearly obsolete. Should the high-altitude B-58A be committed to combat, it would be extremely vulnerable to surface-to-air missiles, such as the SA-2s. Several contemplated modifications had been held in abeyance pending the development of better techniques. One of them, modification 1180, had been approved in mid-1966 and would give the B-58A a new version of the ALQ-16 trackbreaker. However, when flight tested in 1968, this component did not work. As to other penetration aid improvements, they had not even reached the testing stage. Ongoing talks that the B-58s might, after all, be retained through 1974 kept the electronic countermeasures improvement projects alive until the end of 1969. When the B-58's longer retention did not materialize, all penetration aid modifications were canceled.

Retained Modifications 1965-1969

Retirement of the B-58 by mid-1970 meant that modifications, even if approved, would be deleted if not funded by mid-1968. Aware that several

[61] On 21 February 1968, General McConnell, Air Force Chief of Staff since 1 February 1965, reaffirmed before the Senate Armed Services Committee that the entire B-58 fleet would be phased out before June 1970.

B–58 problems would take a long time to solve, SAC asked for a waiver of the so-called 2-year utilization rule, but the request was denied. Nevertheless, many of the modifications, pursued all along by SAC, came to fruition. After numerous setbacks, a solution was found for the B–58A's erratic flight control by adding a redundant yaw damper to the system. Retrofit kits were purchased in 1967, and the installation undertaken in May 1968 progressed smoothly. During the same period, an improved version of the AN/ASQ–42, flight tested in mid-1967, proved successful. Production of the improved system, approved on 27 September 1967 and funded within prescribed time limits, foretold no problem. Technical data and the delivery of spare parts had been included in the necessary contract. Moreover, installation of the system, as started in May 1968, was not expected to disrupt significantly SAC's operational plans. Another modification had also been sought by SAC, almost since the aircraft had become operational. The command wanted the B–58A crew to be capable of starting their engines without having to depend on pneumatic ground starting carts. Equipping the aircraft with a cartridge self-starter would allow it in an emergency to take off from dispersal, post-strike, and other remote bases. Yet the project had been handicapped from the start. It was approved, canceled, reapproved, modified, and constantly hampered by technical difficulties. SAC, nonetheless, won its case and the B–58 was equipped with a cartridge self-starter. The installation began on 7 May 1968, approximately 6 months after all B–58s had exchanged their J79–5B engines for improved J79–5Cs.

Inspections and Repairs 1966–1969

In mid-1965, the San Antonio Air Materiel Area recommended a program of inspect and repair as necessary (IRAN) for a scheduled, comprehensive depot-level inspection of the B–58. So far, San Antonio and SAC had taken care of the aircraft's difficulties as they arose. However, increasingly serious problems were being uncovered. The plumbing and wiring of the B–58As and TB–58As were deteriorating, and the aircraft were also showing signs of structural fatigue and corrosion. SAC had no objections to the IRAN program proposed for the B–58, a routine procedure for most aircraft. Nor did it object to the 36-month cycle favored by the materiel area. However, the command qualified its approval. Since fuel leaks indicated that corrosion was further along than estimated, corrective action could not await the January 1966 implementation of the IRAN program. Also, B–58s of the 43d Bomb Wing should be treated first, which they were. Initially conducted from Convair's Fort Worth facilities, the IRAN program was moved in mid-1967 to James Connally AFB, near Waco, Texas. There were no other changes. The B–58 modification/IRAN program was thorough. Major tasks included removal of all releasable panels; inspection and repair of the aircraft's primary and secondary structures; and inspection and repair of all wire bundles and cables, hydraulic lines and fittings, and air conditioning and pressurization duct components. The program also included bench testing and calibration of all electronic units, removal and overhaul of landing gear assemblies, and repair and treatment of corroded areas. This work consumed 16,000 manhours. In 1967, the cost per aircraft totaled $181,000; $201,000 in 1968.

End of Production — 1962

Production ended in the fall of 1962, with the last 3 B–58s being delivered on 26 October, 1 month ahead of schedule.

Total B–58s Accepted — 116

All B–58s were built at the contractor's Fort Worth plant.

Acceptance Rates

The Air Force accepted 3 B–58s in FY 57; 8 in FY 58; 16 in FY 59; 11 in FY 60; 30 in FY 61; 33 in FY 62; 15 in FY 63 (the last 3 in October 1962).

Research, Development, Test, and Evaluation — $1.4 billion

The Air Force estimated the B–58 weapon system program's research, development, test, and evaluation at $1,408.6 million.[62]

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[62] Air Force records reflecting appropriations for fiscal years 1954 through 1961 showed that a total of $3,174.4 million was approved for the B–58 program. This was reduced to $3,026.2 million in fiscal year 1962, after total procurement was set at 116. Prorated, this brought the cost of every B–58 weapon system to $26.9 million. However, additional costs were later incurred. In 1967 SAC estimated that each B–58 cost about $30 million.

Flyaway Cost Per Production Aircraft **$12.44 million**

Airframe, $6,447,702; engines (installed), $1,117,120; electronics, $1,294,791; ordnance, $26,674; armament (and others), $3,555,573.[63]

Average Cost Per Flying Hour **$2,139.00**

Average Maintenance Cost Per Flying Hour **$1,440.00**

Subsequent Model Series **None**

Other Configurations **B-58C, RB-58A, and TB-58A**

B-58C—This model of the B-58, designated B-J/58 by Convair, but known unofficially by the Air Force as the B-58C, incorporated significant airframe modifications, including a new wing leading edge, more tail area, a 5-foot fuselage extension, and 4 Pratt & Whitney J58 engines without afterburners. In 1960 Convair estimated that its all-supersonic, Mach 2.4 B-58C would be as efficient and much cheaper than the B-70. The Air Force did not test these propositions for several reasons. Even if the proposed airplane approached the B-70's anticipated performance, it had neither the payload nor the growth potential of the latter. The B-70 was the beginning of a design, the B-58C would be the ultimate product of an old configuration. Further study of the Convair proposal practically closed the case. In April, ARDC reported that the contractor's estimate of a 5,200-nautical-mile unrefueled range was probably 25 percent too optimistic. Also, extensive use of aluminum in the B-58C could create problems since the effects of this metal's exposure to high temperatures (aerodynamic heat) was not known. Lack of funds prompted the final decision. Greatly concerned with the B-70, recently confined to development status,[64] the Air Staff as well as SAC did not want to risk the financial interference of a new project.

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[63] Excluding prorated research, development, test, and evaluation costs and the expenses of modifications and engineering changes, added on after approval of a basic contract.

[64] In early 1961, the Kennedy Administration asked the Congress to cancel production of the "unnecessary and economically unjustifiable" B-70 Valkyrie. Thereupon, the B-70 funds were reduced and the program was limited to 3 experimental planes.

In late April, Convair was informed that the Air Force had no interest in the B–58C.

RB–58A—The early photo reconnaissance pod program, due to transform the B–58 into a high-altitude and speedy reconnaissance weapon system had been canceled, reinstated, and again canceled by December 1958. One pod, delivered in June 1958, was lost as the plane it equipped crashed in June 1960. The electromagnetic reconnaissance program followed the same pattern, being canceled in October 1957, then reendorsed, and finally abandoned in May 1958, after delivery of two pods. In 1963, another change took place. As a result of the October 1962 Cuban Crisis, SAC decided the B–58A could be used to great advantage for low-level, high-speed photographic reconnaissance. This was based on the assumption that the extra task could be carried out without making a reconnaissance aircraft out of the few available B–58As. After rejection of several unsatisfactory proposals, a solution was found. It simply involved the incorporation of a KA–56 panoramic camera into the nose fairing of the MB–l pod. Approved by the Air Staff in mid-1963, the modification was successfully flight tested on 30 October and 10 cameras and associated equipment were purchased. Known as Project Mainline, the modification of 44 B–58As and 10 MB–1 pods was completed on 6 December at a cost of approximately $1 million.

TB–58A—The flight characteristics peculiar to delta-wing planforms and the B–58's unmatched high speed called for a trainer version of the new bomber. The Air Force first authorized the conversion of 4 early test B–58As to the training configuration on 25 February 1959. The modification, done under production contract AF33(600)–36200, provided side-by-side seating for pilot training, with the instructor placed aft and 10 degrees right of the student. The Air Force took delivery of the first TB–58A in August 1960, and subsequently ordered the conversion of 4 additional test B–58As to a similar configuration. This last lot was modified under special contract, but the costs were lumped together for a total of almost $16 million.

Phaseout 1969–1970

Phaseout of the entire B–58 force by the end of fiscal year 1971 (June 1970) was directed in December 1965. This schedule was a change from Secretary McNamara's earlier plans and gave the aircraft an extra year of operational life. However, once underway, the B–58 retirement program moved fast, actually ending 6 months ahead of time. It was completed on 16 January 1970, when the 305th Bomb Wing's last 2 B–58s (Serial Numbers 55–662 and 61–0278) were flown to Davis-Monthan AFB, Arizona. The planes joined 82 other B–58As, including the 8 converted trainers, retired since 3 November 1969. Two B–58As, responsible for record-breaking flights in 1962 and 1963, escaped retirement at Davis-Monthan and were placed in museums.

Record Flights 1961–1963

If the B–58 established itself at home as one of the most expensive and controversial weapon systems, it also attracted the world's attention as one of the most extraordinary airplanes. Actually, the B–58 broke a great many speed records (some still standing 10 years later) and won almost every major aviation award.

The aircraft's historical achievements commenced on 12 January 1961, when a B–58 of the 43d Bomb Wing set 6 international speed and payload records on a single flight, in the process breaking 5 previous records held by the Soviet Union. Two days later, another B–58 of the 43d Bomb Wing broke 3 of the records set on 12 January. The plane flew over a 620-mile closed course with similar payloads of 4,409.2 or 2,208.6 pounds and no payload at all, at an average speed of 1,284.73 miles per hour—an increase of 222.9 miles per hour. On 28 February, the crew was awarded the Thompson Trophy for 1961. This was the first time in 31 years that the trophy was awarded to a medium bomber. On 10 May, a new record for sustained speed was set by a B–58, flying 669.4 miles in 30 minutes and 45 seconds at an average speed of 1,302 miles per hour. This earned the aircraft's pilot, Maj. Elmer E. Murphy, the Aero Club of France's Bleriot Cup, a trophy named for Louis Bleriot, famous for his pre-World War I flight across the British Channel.[65] The B–58 continued its record-setting pace on 26 May when it flew the 4,612 miles from New York to Paris in 3 hours, 19 minutes and 41 seconds. The time was almost one-tenth that taken by Charles Lindbergh in his famous solo flight of 1927. The flight of 26 May 1961 earned the B–58's 3-man crew the Mackay Trophy, a trophy first won on 9 October 1912 by Gen. "Hap" Arnold, then a young lieutenant flying a reconnaissance mission with an early version of the Wright biplane.

The B–58 had another notable year in 1962. On 5 March, a 43d Bomb Wing B–58 broke 3 speed records in a round-trip flight between New York and Los Angeles. The B–58 made the entire trip in 4 hours, 41 minutes and 14.98 seconds while averaging 1,044.46 miles per hour. Three in-flight refuelings by KC–135s were required. The entire flight earned the crew the

[65] One of the first warplanes employed by the allies during World War I bore the name of France's aviation pioneer, Louis Bleriot. The Bleriot Cup, established in 1931, was badly damaged during World War II, while in Italy's possession. Subsequently remade by the Italians, the 1,600-pound trophy had been awarded before, but only provisionally. Not until the required speed and duration marks were reached by the B–58 could the trophy be won permanently.

Mackay Trophy. A part of the same flight was particularly impressive. The B–58 flew from Los Angeles to New York in 2 hours and 58.71 seconds, for an average speed of 1,214.65 miles per hour. For this the crew received the Bendix Trophy, first awarded in 1931 to Jimmy Doolittle for his 9-hour and 10-minute flight from Los Angeles to Cleveland. The B–58 closed 1962 with 2 altitude records, acquired on 18 September and worthy of the Harmon Trophy.

The B–58 set its last 5 records in 1963, all of them on 16 October. On that date, a B–58 of the 305th Bomb Wing set an official world speed record by flying 8,028 miles from Tokyo to London in 8 hours, 35 minutes and 20.4 seconds, averaging about 938 miles per hours.[66] Another B–58 established speed records, flying from Tokyo to Anchorage, Alaska, and from Anchorage to London.

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[66] At retirement, this B–58 (Serial Number 61–2059) went to the SAC Aerospace Museum, Offutt AFB, Neb. The B–58 (Serial Number 59–2458) which set the speed and altitude records of March 1962 went to the Air Force Museum, Wright-Patterson AFB, Ohio.

Program Recap

The Air Force bought 116 B-58As, including 30 early planes identified as prototypes or test-aircraft. In 1959, the Air Force decided that 15 of the first YB-58As would be brought up to the production configuration's latest standards. Eight TB-58As, acquired through production modifications, were also part of the total contingent. The B-58 program proved costly, reaching over $3 billion, and its acquisition process was complex. It took 5 contracts (AF33(038)-21250, and AF33(600)-32841, -36200, -38975, -418911), all of the cost-plus-incentive-fee type, to acquire the aircraft, and each contract carried an unusual number of amendments and supplements. The Air Force also entered in almost a dozen miscellaneous contracts to secure B-58 modification kits, multiple weapon kits, mobile training units, flight simulators, and various items of lesser importance.

TECHNICAL AND BASIC MISSION PERFORMANCE DATA

B–58A AIRCRAFT

Manufacturer (Airframe)	Convair Division of General Dynamics Corporation, Fort Worth, Tex.
(Engines)	General Electric Company, Evandale, Ohio.
Nomenclature	Strategic Medium Bomber
Popular Name	Hustler

Length/Span (ft)	96.8/56.8
Wing Area (sq ft)	1,542.5
Engine: Number, Rated Power per Engine, & Designation	(4) 15,000 lb st J79–GE–5B (with afterburner)
Armament	1 M–61 Gatling gun
Crew	3
Basic, High-Altitude, Refueled Mission[a]	
Weights (lb)	
Empty	55,560
Combat	82,595
Takeoff	163,000
Takeoff Ground Run (ft)	
At Sea Level	7,850
Over 50-ft Obstacle	13,700
Rate of Climb (fpm) at Sea Level[b] (Takeoff Weight/Maximum Power)	
With MB–1C Pod	17,830
With MB–1C Pod & 2 small weapons	16,805
Service Ceiling at Combat Weight (100 fpm Rate of Climb to Altitude)	63,500
Combat Ceiling with Max Power (500 fpm Rate of Climb to Altitude)	
With MB–1C Pod	63,080
With MB–1C Pod & 2 small weapons	62,900
Average Cruise Speed Outside Combat Zone (kn)	503
Max Speed at Combat Service Ceiling (kn/ft)[b]	
With MB–1C Pod	1,147/63,500
With MB–1C Pod & 2 small weapons[c]	1,147/62,500
Initial Cruise Altitude with MB–1C Pod (ft)	22,500
Target Altitude with MB–1C Pod (ft)	55,650
Final Cruise Altitude with MB–1C Pod (ft)	46,880
Combat Distance with MB–1C Pod (nm)	4,275
Combat Zone Distance with MB–1C Pod at Combat Zone Speed (nm/kn)[d]	500/1,147
Total Mission Time With MB–1C Pod (hr)	11

Basic, High-Altitude, None-Refueled Mission[d]

Weights (lb)	
Empty	55,560
Combat	81,345
Takeoff	163,000
Takeoff Ground Run (ft)	
At Sea Level	7,850
Over 50-ft Obstacle	13,700
Rate of Climb (fpm) at Sea Level[d] (Takeoff Weight/Max Power)	17,830
Service Ceiling at Combat Weight (ft) (100 fpm Rate of Climb to Altitude)	63,850
Combat Ceiling with Max Power (ft) (500 fpm Rate of Climb to Altitude)	63,400
Average Cruise Speed Outside Combat Zone (kn)	531
Max Speed at Combat Service Ceiling (kn/ft)[d]	1,147/63,400
Initial Cruise Altitude (ft)	28,200
Target Altitude (ft)	55,900
Final Cruise Altitude (ft)	46,900
Combat Radius (nm)	1,400
Combat Zone Distance at Combat Zone Speed (nm/kn)[d]	500/1,147
Total Mission Time (hr)	5.09

Abbreviations

fpm = feet per minute
kn = knots
max = maximum
nm = nautical miles

[a] Under so-called "Post-Strike" conditions, which actually meant that all performance data were based on the assumption that the plane would have to fly 1,500 nm from the target to a recovery base.

[b] High speed restricted by engine and airframe structural limits.

[c] Altitude limited by physical load limits.

[d] All data based on airplane carrying MB-1C pod and no small weapons.

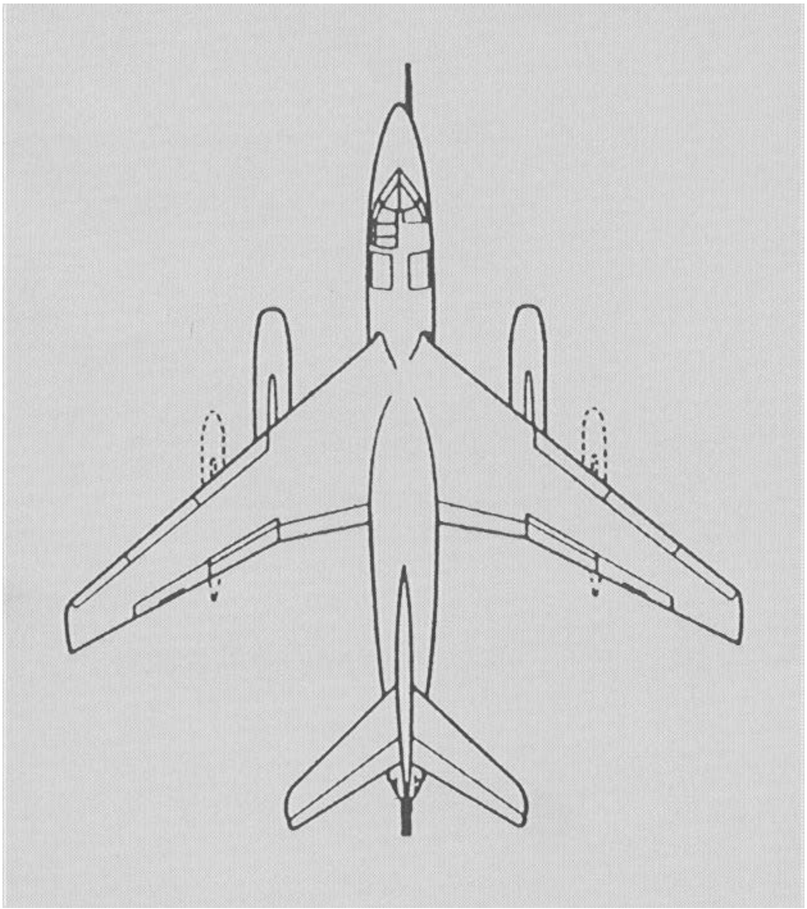
Basic Mission Note

Refueled mission's range data were based on refueling the B–58 with a Boeing KC–135 tanker having a 1,000-nautical mile post-refuel stage. The B–58 took off, climbed on course with military power,* then buddy-cruised with the tanker at Mach 0.8 to point of hookup for refueling. Range-free allowances included: 10 minutes for rendezvous after climb-out, additional fuel equal to 5 percent of fuel burned prior to hookup, and service tolerances amounting to an additional 5 percent increase in fuel consumption for both pre-refuel and post-refuel stages. Refueling was conducted at an altitude of 25,000 feet, at a Mach number of 0.8, and with the high-speed boom.

Formula: Basic Mission's Post-Strike Stage
After refueling, accelerated with military power to the speed for maximum range, cruised at maximum-range speeds and altitudes until initiating the maximum-power acceleration and climb to supersonic zones. The supersonic zone distance was 500 nautical miles and consisted of flying in at Mach 2.0 and dropping the MB–1C pod. After dropping the pod, cruised 1,500 nautical miles to complete mission at Mach number and altitudes for maximum range. Range-free allowances included: 5 minutes of normal-power and 1 minute of maximum-power fuel consumption for warm-up and take-off, 10-minute fuel consumption to cruise on Mach 0.8 flight path for buddy-refueling, 5 percent of fuel burned prior to refueling, and service tolerances amounting to an additional 5 percent increase in fuel consumption for the pre-refuel and post-refuel stages. A reserve fuel allowance sufficient to fly 8 percent of the creditable mission range after refuel, plus the amount of fuel required for 1 ground-controlled approach (GCA) go-around, was also included.

B/RB-66 Destroyer

Douglas
Aircraft Company



B/RB-66 Destroyer
Douglas

Navy Equivalent: A3D-1

Overview

As in the B-57's case, the Air Force bought the B/RB-66 for lack of any better choice. The analogy did not stop there. Like the stopgap B-57, which it was due to replace, the B/RB-66 was to be an interim weapon, primarily earmarked for tactical reconnaissance, until the subsequently canceled B-68 came into being. Similar misjudgments occurred: the difficulty of Americanizing a British aircraft was underestimated and, while not overlooked, the complexity of turning a Navy plane into an efficient land-based system was improperly assessed. On both occasions, the Air Force requirements proved too ambitious, too hasty, and the 2 programs fell behind schedule. Finally, it took years, and particularly the conflict in Southeast Asia, to justify the costs involved, a conclusion actually far more applicable to the B/RB-66 than to the B-57.

Based on a year-old proposal by Douglas, the Air Force in 1952 bought the Navy's yet-to-be-flown A3D-1 Sky Warrior. Hurriedly, and in keeping with the mood of the time, exacting requirements were levied which, in view of the program's urgency, proved totally unrealistic. The future B/RB-66 Destroyers, as the Air Force versions of the Navy aircraft were designated, had to be fast, highly maneuverable, and able to perform in all types of weather, at very high or low altitudes, and from makeshift or short runways. The B/RB-66s also had to have a 1,000-nautical mile radius and be large enough to accommodate a 10,000-pound payload of either atomic, conventional, or photographic flash bombs. The bomber and reconnaissance versions were to be kept closely alike. Finally, and of great importance, all versions were to be fitted with sophisticated electronic countermeasures components to deal with enemy radars.

As a necessary start, Douglas deleted the folding wings, catapult capability, and arresting gear from the Navy A3D configuration. In keeping with Air Force instructions, adaptations were kept to a minimum in order to expedite matters. The next major steps, therefore, were addition of upward ejection seats, a must when flying low at high speeds, and reinforcement of the aircraft structure to compensate for the greater stresses of low-altitude, high-speed operation. To the Air Force's dismay, once these changes were made, new requirements emerged, as did design and layout deficiencies. Hence, larger tires were provided, as were emergency air brakes, wing spoilers, and improved lateral controls. The wing's angle of incidence was altered to minimize dutch roll, the cockpit pressurization was improved, and a number of other development modifications took place. Just the same, problems remained. A more serious handicap was the need for better jet engines, still at a premium.

The RB-66's first flight in June 1954, 6 months behind the Air Force's deadline, was not a success. The aircraft did not handle well, it pitched up unexpectedly, the wings vibrated excessively, the vision from the canopy was poor, and the landing gear doors did not function properly. Ensuing efforts were hardly rewarding. In 1955, reminiscent of yet another aircraft, the B-58, the Air Staff pondered whether the B/RB-66 should be canceled, for a cold loss of perhaps up to $600 million. No substitute aircraft were available, and this fact also had to be considered. The dilemma was solved in familiar fashion; the program was retained, but reduced.

Improved RB-66s entered operational service in 1956, permitting the long overdue replacement of the obsolete RB-26s, and allowing phaseout in early 1957 of the problem-ridden RB-57As. While the bulk of the small contingent of B/RB-66s, 294 instead of the 342 aircraft initially programmed, was earmarked for the Tactical Air Command (TAC), some of the badly needed reconnaissance models promptly joined the Pacific Air Forces in the fall of 1956. Others went to the United States Air Forces in Europe in late 1957. Whether at home or overseas, every version of the aircraft remained troublesome. Their successive engines, Allison J71-A-9s and J71-A-11s were better, but not good enough, and the subsequent retrofit of more powerful J71-A-13s caused other problems.

In the long run, the B/RB-66s were made to work, and the aircraft became a main asset of the Air Force intelligence gathering and electronic warfare forces. Even though lack of money precluded numerous special modifications and most modernization projects, many changes were effected as the aircraft's specialized roles accrued. Because of the United States involvement in Southeast Asia, the aircraft's life-span was extended far beyond expectation. Some B-66Bs were phased out in 1963, only to be reactivated within a few years. After refurbishing, the aircraft, now known as the EB-66, headed for the war theater. Other B/RB-66s, although earmarked for retirement, were kept active, re-equipped, redesignated, and committed to combat as early as 1965.

In 1966, press accounts began to give the EB-66s credit for neutralizing surface-to-air missile radars as well as much of the enemy's radar-controlled but conventional anti-aircraft weaponry. As the war escalated and enemy defenses grew, the old aircraft, with their upgraded electronic devices and despite their worn-out engines, became invaluable and so remained until the end of the conflict. Thus, a difficult decision, made nearly 20 years before by a greatly concerned and cautious Air Staff, proved correct.

Basic Development 1951

The B/RB-66 Destroyer grew out of the Douglas Aircraft Company's XA3D-1, a high-altitude, light bombardment airplane developed for the U.S. Navy. The A3D-1 Skywarrior, the production version of the experimental carrier-based bomber, was first flown on 16 September 1953.

Initial Requirements 14 June 1951

The beginning of the Korean conflict caught the Air Force with a tactical inventory of light bombers and reconnaissance aircraft consisting essentially of World War II B/RB-26s. This was supplemented by a few B-45s, acquired between 1948 and 1950. However, 50 of the B-45 Tornadoes had been modified to carry atomic weapons, and another 60 were unable to meet the projected need for tactical bombers designed to carry conventional munitions. This predicament accounted for the March 1951 production order for the B-57 light bomber (too small to carry current atomic weapons). Yet the Air Force harbored no great illusions. Although it thought erroneously that the B-57 Canberra would be available between 1952 and 1953, it never overestimated the new aircraft's potential. The Air Force also knew that, realistically, the ideal weapon system for tactical bombing and reconnaissance—Weapon System 302A—remained a long way off.[1] The solution, therefore, was to seek a more satisfactory interim airplane that

[1] Design studies for Weapon System 302A were submitted by the Glenn L. Martin Co. and Douglas Aircraft Co. in 1952 and again in 1954, along with an entry from North American Aviation, Inc. A proposal by Boeing Airplane Co., presented after the competition deadline, was automatically rejected, and Martin ended being the winner. Unfortunately, the proposed B-68's inertial guidance bombing and navigation system ran into serious difficulties. This meant that production quantities of the B-68, should they be approved, would be postponed to at least 1963. This problem soon became immaterial. In early 1957, citing stringent budget limitations and the higher priorities of other weapon systems, Air Force Headquarters canceled the B-68 program.

would become operational around 1954. While the Air Force's June 1951 objective centered on a reconnaissance vehicle, this requirement was extended in August to include tactical bombing.[2]

Potential Candidates — Fall 1951

Defining a requirement was usually easy; finding the best aircraft for the task was always difficult. An improved B-45 might satisfy the Tactical Air Command's demands of the mid-fifties. However, the Tornado's relatively slow speed and inferior defense armament were not encouraging. The Air Research and Development Command (ARDC) believed the B-47 would be a preferable choice, even though the Boeing medium bomber was a Strategic Air Command airplane and rather costly. It also called for more maintenance than practical for tactical theatre operation. In any case, ARDC was the first to recognize that the B-47 would not be the absolute answer. TAC could put the aircraft to good use for high-altitude bombing, but the command's close air support missions would probably be better served by the Martin B-51. The latter, still in the experimental stage, was a 3-engine all-weather airplane designed primarily for low-level bombing. On the other hand, the XB-51 was far from perfect. First flown in October 1949, it had a short radius of action and could not carry more than 4,000 pounds of bombs. A fourth candidate, the Navy's Douglas XA3D-1, was the most promising on paper; however, as the plane was not expected to fly before another year, there was no knowledge of this plane's stability and control characteristics.[3] Finally, to make matters worse, whatever plane was chosen would suffer at first from a probable shortage of engines and a lack of reconnaissance equipment.

Tentative Selection — 29 November 1951

Based on a Douglas proposal of 29 August, the USAF Aircraft and Weapons Board opted in November for an Air Force version of the future A3D-1. Inasmuch as the adaptation suggested by Douglas would require such major changes as deletion of naval aircraft carrier provisions; addition

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[2] Tactical bombing is the bombing conducted, usually by tactical air units, in support of surface forces. Bombing to achieve air superiority or to carry out interdiction is a part of tactical bombing, although the term tends to be restricted to battle area operations.

[3] The XA3D-1 flew for the first time on 28 October 1952.

of ejection seats, of a larger search antenna, and an increase of the aircraft's load capacity, the board wanted to start with a few service test aircraft. The board also recommended procurement of modified RB-57s to fill the gap until Air Force A3Ds could be purchased in significant quantities, planning centering at the time on a fleet of about 350 interim aircraft. The Air Materiel Command (AMC) took exception, and actually did prevail, after arguing that such an arrangement would be wasteful, since the new aircraft most likely would be available only 8 months later than the additional RB-57s proposed by the board.

Definite Endorsement 12 January 1952

On 12 January 1952, AMC was informed by USAF Headquarters that the USAF Aircraft and Weapons Board selection had been fully endorsed, because the adapted A3D came closest to fulfilling the interim tactical requirements than other candidates, and that the Air Force version of the Navy aircraft would be designated B-66. Although brief, the Air Staff message carried specific instructions. Reconnaissance would have priority, the RB-66 would be immediately equipped for night photography, and electronic reconnaissance equipment, as well as electronic countermeasures components, would be added at the earliest possible date. AMC notified Douglas of the Air Force production decision on 15 January.

General Operational Requirements 1952

The Air Force issued the general operational requirement (GOR) for the future RB-66A, RB-66B, and RB-66C on 21 January 1952. A second GOR, strictly concerned with the B-66B, was published in April. In essence, these documents were basically alike. They asked for a fast, highly maneuverable tactical reconnaissance bomber that could perform in all types of weather, at very high or low altitudes. Nevertheless, the requirements were quite explicit. A 1,000-nautical mile radius was needed, and the planes had to be capable of carrying large amounts of equipment (radio, radar, electronics) without affecting their normal performance. The B/RB-66s had to be large enough to accommodate a 10,000 pound payload of either atomic, conventional, or photographic flash bombs. They had to be fitted with defensive armament, and would require sophisticated electronic countermeasures components to deal with enemy radars. Finally, the Air Force wanted every model of the new aircraft to be able to use makeshift or short runways. It also insisted that the B/RB-66's maintenance and logistic support be fairly simple.

Contractual Arrangements 1952

On 12 February 1952 letter contract AF 33(600)-9646 initiated the procurement of a test quantity of 5 RB-66As. The purchase of 2 Navy A3Ds, also directed by the Air Staff, was canceled after AMC pointed out that the testing value of the 2 would be negligible in view of the anticipated differences in the Air Force version. The February letter contract gave way to a definitive contract, which was signed on 4 December 1952. In spite of the configuration changes that were to be expected, the Air Force originally thought that the urgently needed RB-66As would be more or less off-the-shelf copies of the A3D. Hence, there would be no experimental or prototype B/RB-66s. Moreover, the December contract already called for production tooling for a peak rate of 12 airplanes per month by March 1955, and for a total of 342 airplanes. The Air Materiel Command warned, however,that since no A3Ds had been produced it could not properly assess the cost of changes necessary to satisfy USAF requirements. This precluded the usual fixed-price-firm (FPF) type of agreement then favored by the Air Force. Instead, the December contract covered cost, plus a guaranteed profit of 6 percent. In the meantime, Letter Contract AF 33(600)-16314 had been signed on 24 April 1952. This contract, providing for the fiscal year 1953 procurement of 127 RB-66As, also did not follow the standard procurement pattern. It was first negotiated as a FPF contract with a renegotiable clause, but reverted to the terms of the preceding letter contract in August of the same year, when the FY 53 procurement of the B/RB-66s was significantly altered.

Basic Configuration May 1952

While the Air Force seemed to believe—or perhaps, hope—that the eagerly awaited B/RB-66 would partly replicate the A3D, the new aircraft's basic configuration was being worked out. Not yet incorporated were a few major changes proposed by Douglas back in August 1951, and subsequently approved by the Aircraft and Weapons Board. The difficulty of these basic alterations could be disputed. What was termed "major" appeared almost routine. The first step was to delete from the Navy A3D the various inherent features of a carrier-based aircraft, such as folding wings, catapult capability, and arresting gear. Satisfying the stated Air Force requirements came next, keeping in mind that only a minimum of adaptations could be tolerated in view of the program's urgency. Essentially, this meant that upward crew ejection seats had to be installed, since one of the aircraft's many roles would be to fly at low altitudes and at fairly high speeds. In the same vein, the airframe structure had to be strengthened to compensate for the greater stresses of low-altitude, high-speed operation. Finally, a 45-inch search radar antenna needed to be substituted for the 30-inch antenna of the A3D. These changes were the salient points of the basic configuration approved by the Air Force in May 1952. While they brought the airplane closer to the Air Force's tactical requirement, they reduced range from 1,325 to 1,070 nautical miles.

Additional Alterations 1952

That the May approval of the B/RB-66's basic configuration proved to be a mere beginning came as a surprise. The Air Force from the start had planned to define further the actual configuration of the new aircraft's bomber version.[4] And, while going along with the so-called major changes of the approved configuration, it had been busy identifying necessary minor improvements. Under this category fell the exchange of Navy- for Air Force-designed equipment, a substitution which would simplify the airplane's logistic support. An unexpected jolt, however, was the snowball effect of the changes introduced in the approved basic configuration.

Also, new requirements kept showing up, as did design or layout deficiencies. By mid-1952, the quasi A3D that the Air Force hoped to rush into production had acquired a long list of innovations. To decrease footprint pressures[5] and permit landing on runways designed for fighter aircraft, the B/RB-66 required larger tires. It also needed new emergency air brakes, wing spoilers, improved lateral controls, changes to the wing's angle of incidence to minimize dutch roll,[6] better cockpit pressurization, and a number of other improvements. The Air Force did not like the A3D's hydraulic system and wanted the system to be completely revised. It wanted the aircraft's fuel system to be redesigned and insisted that the B/RB-66 should carry a fuel purge system, a feature missing from the A3D. Finally, all B/RB-66s were to be fitted for in-flight refueling, the photo/navigator station had to be relocated, and better engines were needed.

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[4] The Air Force nevertheless wanted the aircraft to be interchangeable, and every effort was to be made to keep the bomber and reconnaissance versions closely alike.

[5] Footprint pressure is the pressure of an aircraft's wheels (with tires inflated) upon the unyielding contact surface of a runway, expressed in terms of pounds per square inch, as determined by a ratio of static gross takeoff weight to the contact area.

[6] Dutch roll is the colloquial expression used to describe the combined yawing and rolling motion of an airplane. Dutch roll is usually caused by rough air, but it can occur even in still air.

Engine Problems 1952

As anticipated in late 1951, engine difficulties materialized. Development of the Westinghouse J40-WE-5, due to equip the Navy A3D, was not progressing well. This confirmed the Air Force's suspicion that such an engine would be unable to give the B/RB-66s the radius of action and overall performance required of the airplanes. An engine competition, initiated by AMC on 17 May, yielded several possibilities. Westinghouse offered a new version of the J40, which was turned down because of excessive fuel consumption and because the engine's 7,250-pound thrust was minimal, when compared to the 9,750 pounds of the J71 engine proposed by Allison, a division of the General Motors Corporation. The General Electric J73 failed because of its cost and the fact that its development lagged behind the J71. In addition, and perhaps of greater significance, General Electric at the time was fully occupied with the J47 engine program. Douglas Aircraft favored the Pratt and Whitney J57, but because it was earmarked for several weapon systems of higher priority than the B/RB-66, the Air Force, did not feel the manufacturer could produce enough J57s to satisfy all demands.[7] This left Allison's J71 as the undisputed winner of the competition. Yet, even though Allison had guaranteed the development status of its engine, problems in getting the J71-A-9 engine through its 50-hour test held back the Air Force production order until 5 August 1952, 2 months later than required in order to maintain the aircraft's schedule lead time. In fact, AMC authorized the engine's production before completion of the 50-hour test, a risk frowned upon by the Wright Air Development Center.

Mockup Inspection June–July 1952

The RB-66A's official mockup inspection was held at the Douglas Long Beach Plant, California, from 27 June through 2 July. Sixty-three of 83 changes requested by the board members were approved. Most of the endorsed alterations were minor, a main exception concerning the aircraft's landing gear. The Mockup Board determined that the landing apparatus of the RB-66A, now stressed to the 70,000 pounds of the configuration first sought by the Air Force, would be altered in order to accept the 83,000-pound limit of the B-66. The decision confirmed the Air Force's intent to keep reconnaissance and bomber versions as similar as possible. Obviously, it also promised to simplify production.

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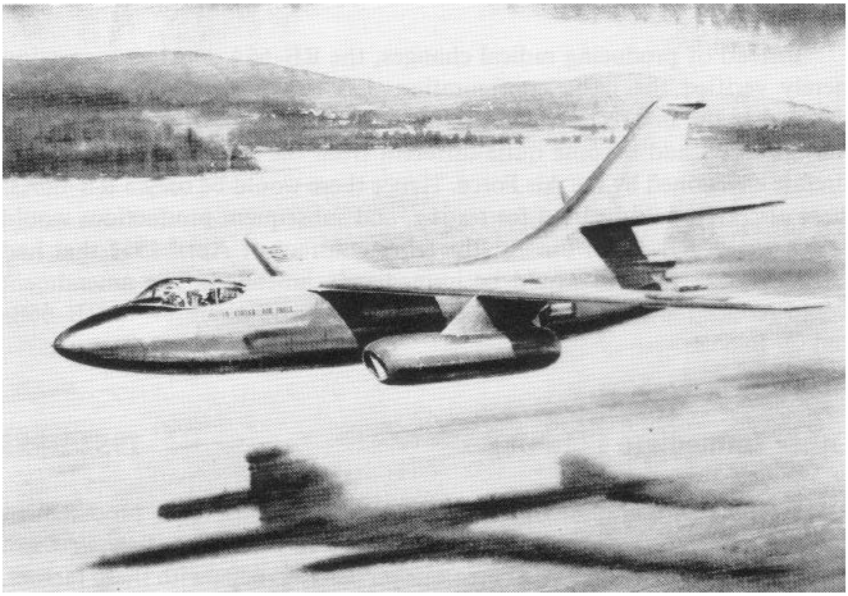
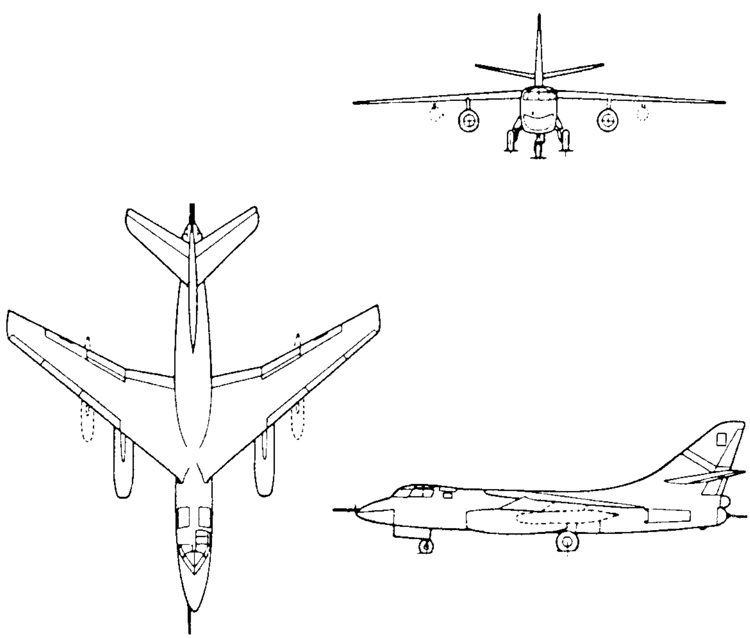
[7] The J75 was subsequently selected by the Navy to replace the A3D's J40s.



A drawing of the Douglas B–66 in flight.



Program Revision August 1952

Instead of producing radical changes, the RB-66A mockup inspection merely verified the basic configuration that had evolved since February 1952, when the first technical inspection of the aircraft had taken place. This configuration had become quite different from the slightly modified A3D aircraft envisioned by the Air Force. Hence there would be only 5 RB-66As; these aircraft would be used for testing, and subsequent productions would be known as RB-66Bs. Finally, the letter contract of April 1952 that had called for 127 RB-66s would be immediately amended. The amendment would reduce the fiscal year 1953 procurement to 99 aircraft—73 RB-66Bs and 26 B-66Bs.

Other Immediate Planning 1952-1953

If the configuration changes, program revisions, and procurement amendments deriving from such changes seemed confusing, they were not particularly unusual. The Air Force was prepared to cope with these factors, its task greatly eased because selection of the basic A3D design had been unanimous, a rather extraordinary occurrence. Actually, the Air Force's essential concern was to ensure that no configuration changes would preclude the urgently needed program from proceeding as scheduled. To that effect, a conference held in August paved the way for prompt approval of the B-66B configuration. In the same month, the Air Force directed a review of available and forthcoming electronic countermeasures components that could possibly be installed in the entire B/RB-66 fleet. Early in 1953, the Air Force ordered procurement of the RB-66C, the RB-66's ferret version,[8] and decided that the future B-66B would carry only atomic or modern conventional bombs, and not the bulkier high explosives from World War II. Late in the year, as the Allison J71 successfully completed its 50-hour test, AMC ended its search for an alternate engine, which until then had been considered an unavoidable form of insurance.

First Flight (RB-66A) 28 June 1954

The RB-66A's initial flight on 28 June 1954 was 6 months behind schedule and could hardly be called a success. Engineering flaws appeared

[8] The term "ferret" denotes an aircraft specifically equipped to detect, locate, record, and analyze electromagnetic radiation.

that required immediate attention. The aircraft did not handle well, the landing gear doors did not function properly, and vision from the canopy was poor. Although the Air Force officially accepted the initial RB-66A (Serial No. 52-2828) in June, it did not take possession of the plane, leaving it with Douglas for correction of the most obvious defects, prior to the beginning of the usual contractor flight tests. Douglas pilots flew the plane thoroughly, accumulating by mid-1956 300 hours of flying time in 192 flights.[9]

Increasing Difficulties 1954-1955

Flight of the first RB-66A was promptly followed by delivery of the 4 other RB-66As ordered from Douglas. The Air Force accepted these planes between August and December 1954, gaining nothing but problems in the process. Speed and load restrictions placed in effect in August hampered testing, actually preventing the early detection of many additional deficiencies. Yet, the restrictions could not be avoided. As suspected, even before the RB-66A's initial flight, the aircraft's flight control system was unreliable, and flying the plane using emergency manual control had proven hazardous. Besides, the RB-66A was unstable because its wings vibrated excessively, and the aircraft had the dangerous habit of pitching-up unexpectedly.

Near-Cancellation 1954-1955

The Air Force knew that an improved cockpit, giving the pilot better visibility, might not appear on the B/RB-66s before production of the 100th aircraft, but it did not anticipate the many aerodynamic shortcomings that came to light as soon as the RB-66As were flown. AMC's San Bernardino Air Materiel Area, responsible for the new weapon system, faced a difficult situation in the fall of 1954. TAC thought the first aircraft would be forthcoming in February 1955; Douglas admitted this could not be done, but insisted that deliveries could start no later than July—which was still unrealistic. The contractor, naturally enough, contended that the B/RB-66 was a good aircraft, which could be improved in several stages. Yet, Douglas

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[9] Completion of the contractor's Phase I and Phase III tests in June 1956 marked the beginning of additional special modifications. When these changes were completed in October 1957, the plane was loaned to the Hughes Aircraft Company to participate in various experimental programs. However, Hughes pilots did not fly the plane, and it was returned to the Air Force in March 1958.

was unable to estimate the impact of the future modification work, since not enough was then known to define the number and types of changes needed. To the contractor's credit, Douglas at the time was also asking for an accelerated and intensified flight-test program. Meanwhile, the Air Force plant representative had reported that the contractor, to prevent further slippage of its original production schedule, was excessively resorting to expensive overtime. In late December, as recommended by the Air Materiel Command, Headquarters USAF cut off all overtime at the Douglas Plant and asked AMC to consider stopping or at least limiting production. In early 1955, the Air Staff began to investigate which aircraft could be substituted for the B/RB-66s, should this program be canceled. No rash decision had to be made, but the Air Staff wanted AMC and Air Research and Development Command to complete as soon as practicable their on-going evaluation of the new aircraft's many problems.

Final Decision — 17 May 1955

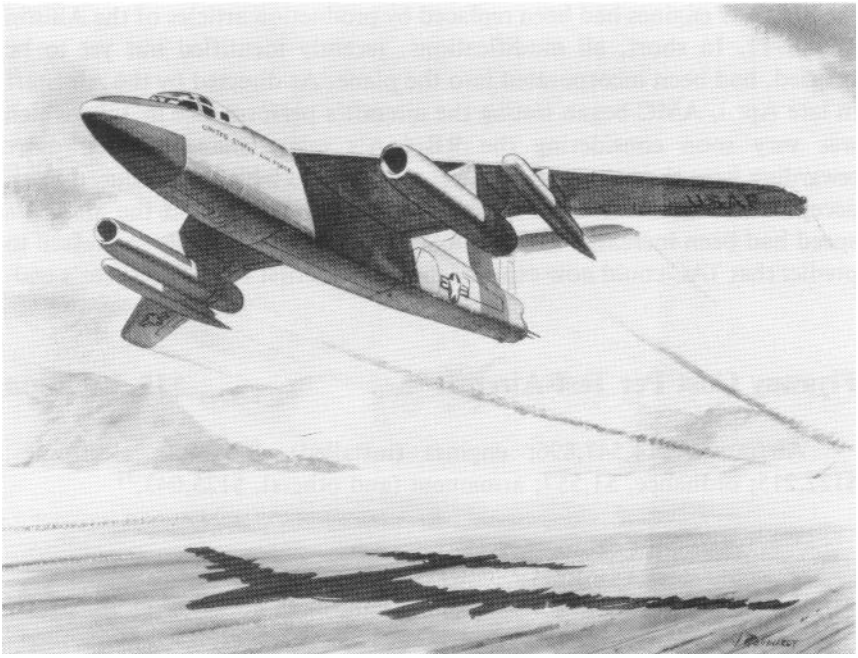
Even though AMC and ARDC gave the Air Staff their appraisal of the Douglas program in February 1955, the B/RB-66's fate was not immediately determined. There were valid reasons for the delay. Phase II flight-test results were an essential part of the combined review. However, because of the flying restrictions still imposed on the RB-66As, the Air Force tests, like those conducted by the contractor, were not totally conclusive. For example, the airplane's high-speed limitations were still unknown. A great deal remained to be done. The static test program was incomplete, and the majority of the aircraft's equipment and subsystems had yet to be tested. Finally, the modifications needed to correct most of the aircraft's problems had been identified, but not verified. In essence, the 2-command evaluation of February 1955 pointed out that immediate termination of the program would cost the Air Force $300 million, a total that would double by mid-May. If the potential loss of $600 million influenced the Air Force to retain the program, the lack of suitable replacement aircraft undoubtedly was an equally important factor. At a meeting held in Washington on 17 May, General Nathan F. Twining, Air Force Chief of Staff, Lt. Gen. Clarence S. Irvine, Deputy Chief of Staff for Materiel, Lt. Gen. Frank F. Everest, Deputy Chief of Staff for Operations, and Mr. Roger Lewis, Assistant Secretary of the Air Force for Materiel, all agreed to stay with the program. However, this was not a blanket endorsement of the B/RB-66 aircraft, and several conditions, listed by the Air Materiel Command, qualified the decision, which in the long run would prove to be sound. As so often the case with many of the Air Force's new aircraft, the B/RB-66s had a shaky beginning, underwent many changes, but ended paying dividends.

Program Reduction 1955

Retention of the B/RB-66 was accompanied by a significant reduction of the program. Yet, it took several months to study the cost and logistic aspects of various possible changes. The Air Staff's goal, as related to AMC in late May, was to "reduce the B-66 program by the most economical and feasible method and still retain an RB-66B/C capabilty." By mid-August, a revised program, developed by AMC and Douglas, was approved by Headquarters USAF. The revision reflected an overall decrease of 48 aircraft from the total once approved for procurement. As directed, the brunt of the decrease fell on the B-66Bs.

Other Changes 1955

Engineering changes, as worked out between the Air Force and the prime contractor, were many. Forty-seven of them had been approved by the end of March, and additional ones most likely would be necessary in time. As a start, the Air Force wanted the B/RB-66 aircraft to be equipped with



An artist's conception of the B-66A taking off.

a parachute brake and an anti-skid device; it also desired immediate revision of the cockpit enclosure and relocation of the cockpit instruments. In addition, the aircraft's 2 J71–A–9 engines had to be replaced by more efficient J71–A–11s. Of course, these changes did not exempt Douglas from correcting the many problems already uncovered during the aircraft's flight tests. Moreover, none of the aircraft thus far produced by Douglas would be accepted by the Air Force before completion of so-called "turnaround" modifications.[10] Set on preventing further costly mistakes, the Air Force by June 1955 had also imposed various administrative adjustments on the contractor. To begin with, production would not exceed 7 aircraft per month until the fall of the year. All fiscal year 1955 subcontracts, not related to the RB–66C, had to be canceled. Finally, Douglas had to stabilize its labor force at the June 1955 level and keep overtime at or below 7 percent of the total labor effort.

Engineering Improvements — Mid-1955

By mid-1955, Douglas had significantly modified 1 RB–66A. The reworked plane featured an improved control system, a reconfigured tail turret, and heavier wing tips. Better engine pylons had been installed, and the J71–A–9 engines had been replaced by production articles of the Allison J71–A–11. In short, all modifications, recently identified but yet to be verified, had been incorporated into the plane. As directed by the Air Staff in late April, AMC began testing the aircraft's performance in July, which was very soon considering the RB–66A's many changes. Even more rewarding were the test results. Buffet appeared to have been reduced to an acceptable level, the control system worked fairly well, and the aircraft's speed had been increased to 550 knots. AMC was sufficiently impressed to predict that TAC could now expect delivery of its first RB–66s by year's end.

Flyaway Cost Per Test Aircraft — $15.5 million

Airframe, $14,547,896; engines (installed), $719,500; electronics, $122,215; ordnance, $1,557; armament (and others), $125,043.[11]

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[10] The "turnaround" modifications brought such aircraft to the level of the reworked RB–66A of mid-1955.

[11] Only 5 RB–66As came into being. As in the case of the B–57A and other aircraft, this limited production resulted in a high cost per aircraft.

Subsequent Model Series

RB-66B

Ultimate Use

None of the 5 RB-66As ever joined the Air Force's combat forces. Use of the aircraft exclusively for testing led to improved B/RB-66s and acquisition of considerable technical knowledge.

RB-66B

Manufacturer's Model 1329

Weapon System 308

New Features

The RB-66B at first closely resembled the improved RB-66A. Differences emerged over the years, as the B-model received better cameras and electronic countermeasures equipment. Some changes were made on the production lines; others, long after completion of the entire program. The J71-A-13 engine, an important feature of the aircraft, appeared on the last 17 RB-66Bs, earlier productions acquiring the higher-thrust engines through retrofit.

Special Testing 1955

Even though the improved RB-66A had been thoroughly tested, the Air Force Flight Test Center conducted extensive qualifying flight tests on one of the initial RB-66Bs. In contrast to the reworked RB-66A, which had been refitted with J71-A-11s,[12] this plane and 19 other early RB-66Bs carried the less powerful -9 engines. Nevertheless, the flight center's tests and subsequent RB-66B acceptance flights were generally successful. Electronic interference disturbed the image on the aircraft's AN/ARC-21 radar receiver, but Air Research and Development Command engineers soon found out that the ionization of particles in the jet engine exhaust caused the problem. This helped the contractor to swiftly devise an effective production modification.

First Flight (Production Aircraft) 29 October 1955

The first truly official flight of the RB-66B occurred on 29 October,

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[12] This model powered most of the aircraft until the -13 engine became available.

after 8 of the aircraft had already been accepted by the Air Force. The flight, which was considered satisfactory, confirmed earlier test-flight results.

Enters Operational Service — January 1956

The first RB-66Bs joined the 9th Tactical Reconnaissance Squadron of the 363d Tactical Reconnaissance Wing (TRW), at Shaw AFB, South Carolina. Although the aircraft's initial all-weather capability was limited, arrival of the RB-66Bs permitted the long overdue replacement of the obsolescent RB-26s, and speeded phaseout in early 1957 of the problem-ridden RB-57As. The RB-66B program was a year behind schedule, but by the end of 1956 two-thirds of the RB-66Bs on order had been delivered, allowing activation of 2 other squadrons within the 363d TRW, the 41st and 43d, both located at Shaw AFB. The RB-66B in time became the primary night photographic weapon system of the Tactical Air Command.

Development Engineering Inspection — 26–29 June 1956

A special development engineering inspection verified the proper installation of active defense electronic countermeasures equipment in forthcoming RB-66Bs. Several new devices were involved, most of which were intended to jam hostile radars. The 2-day development engineering inspection also covered retrofit of the 46 RB-66Bs, already accepted from Douglas. Even though attendees submitted 32 requests for alteration, the inspection board only approved 22 of them. The endorsed changes represented no extra expenses for the Air Force, since they all fell under the purview of Douglas's contract.

Overseas Deployments — 1956–1957

While the bulk of the B/RB-66 contingent was earmarked for TAC, the Air Force originally wanted some of the delivered aircraft to be deployed overseas immediately. Slippage of the program changed this planning. Still, the 12th Tactical Reconnaissance Squadron, at Itami, Japan, a unit of the Pacific Air Forces (PACAF), received its RB-66Bs in late 1956, at about the same time that TAC activated 2 additional RB-66B squadrons. The United States Air Forces in Europe (USAFE), however, did not get any of the new aircraft until the fall of 1957. The 2 RB-66B squadrons, first assigned to the USAFE's 66th Wing, were later transferred to the 10th Tactical Reconnaissance Wing, another USAFE unit.

Operational Difficulties 1956–1957

The fact that the RB–66Bs were operational, at home and overseas, did not mean that all was well with the aircraft. To begin with, the program's near-cancellation and subsequent indefinite slippage, combined with overall financial restrictions, had created troublesome setbacks. TAC's 363d TRW was ill-prepared to support its first aircraft. The wing did not have enough MA–3 all-purpose servicing units and had too few of the MA–1 air conditioners that were necessary to preflight the RB–66s. There were also serious shortages of personal equipment, helmets in particular. The RB–66Bs themselves were encountering some of the problems often experienced during the early operational life of a new aircraft. Cautious, the Air Force grounded all RB–66Bs in mid-1956 after an incident at Shaw in which an aircraft suffered engine failure because bolts or screws either worked loose or sheared from the alternator. The grounding did not last, but similar restrictions were imposed in September, following the discovery of cracks on the horizontal stabilizer of a B–66B. The grounding this time affected both the B–66Bs and the RB–66Bs and remained in effect until all aircraft had been inspected and repaired, as necessary.

Engine Problems 1956–1957

Slow acceleration, flameout, stall, and surge were malfunctions that characterized the performance of the J71–A–9 engines that originally equipped 20 RB–66Bs and 17 B–66Bs. Allison improved the engine's bleed air system (reduced from the 16th to the 8th stage), and this with other minor changes led to the production of the J71–A–11. The new engine reached the Douglas plants promptly, equipping most B/RB–66s from the start. But the J71–A–14, despite its 9,700 pounds of thrust, proved disappointing. To begin with, the engine was still underpowered. In addition, like its predecessor, the J71–A–11 often stalled under high acceleration because of sticking compressor bleed valves and poorly designed electrical relays. Even though the most serious stall problems were solved without delay, TAC kept on insisting that better engines were needed. The command had in mind still another version of the Allison J71, namely, the 10,200-pound thrust J71–A–13, which could be injected with a mixture of water and alcohol. TAC believed, rightly as it turned out, that the higher-thrust engines would decrease takeoff roll by nearly 40 percent, would ensure a range increase of 10 percent, and would guarantee a 5-percent improvement of the aircraft's maximum speed. The Air Staff, in the fall of 1956, finally endorsed TAC's request. This meant that nearly 200 aircraft had to be retrofitted with J71–A–13s, while the B/RB–66s that had yet to clear the Douglas production lines would receive the new engines directly. Unforeseen by all parties—the Air Force, Douglas, as well as Allison— were the many difficulties that the new engines would soon create.

Significant Achievements — Mid-1957

Operational difficulties and forthcoming engine changes notwithstanding, the RB-66B by mid-1957 seemed to have shed most of its developmental flaws, and for all practical purposes the incorporation of production fixes had ceased. The aircraft, in addition, contributed to the successful development of a rain removal system that would serve the entire program, and other Air Force jet bombers. This system used a stream of engine bleed air, which was blown over the aircraft's windshield. Tested by the Wright Air Development Center under both artificial and natural conditions, the new development appeared to be the most effective and reliable means thus far devised to control a visibility problem of long standing. Indicative of the system's importance, the Air Force by mid-1957 had already initiated the procurement of retrofit kits for installing the new rain removal system on all B/RB-66s. The kits were geared to the J71-A-13s, since these engines were now due to appear on every B/RB-66 aircraft.

Unexpected Setbacks — 1957-1958

Unforeseen problems were caused by the J71-A-13s, whether production installed or retrofitted on the B/RB-66s, because the new engines' higher thrust was accompanied by greater noise. Evidences of acoustically induced sonic fatigue were immediately noted, as skin cracks and stress breaks increasingly appeared in the ailerons, flaps, dive brakes, elevators, stabilizers, and rudders of the J71-A-13-equipped aircraft. Remedial procedures, undertaken without delay, consisted of pouring a powdered substance, known as Sta-Foam, into the aircraft's control surfaces that were subject to stresses. The powdered Sta-Foam, subsequently combined with chemicals causing it to foam up and solidify, promised to be a counteracting stress agent in the aircraft's most vulnerable surfaces.[13] TAC was greatly concerned by the stress problems besetting its new aircraft, particularly because the Sta-Foaming program, as initiated in 1957, would be lengthy. In effect, the most exacting work was assigned to Douglas, while tactical units

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[13] The B/RB-66s predated metallic honeycombing, an industrial technique used to absorb the higher acoustical disturbances caused by the higher thrusts of later engines.

would accomplish the simpler tasks. Yet TAC insisted that whether the B/RB-66s were flown to the manufacturer for rework, or whether Douglas shipped Sta-Foamed surfaces to the tactical units, its new aircraft would be kept out of operation for an excessive period. In mid-1957, TAC again protested the program's pace, and suggested to save time that its RB-66s be flown to the San Bernardino Air Materiel Area where reworked surfaces would be exchanged for damaged and unmodified surfaces. Once flight tested, the modified planes would fly back to their bases. The Air Staff endorsed the TAC proposal, but new problems arose within a month. In August 1957, the command was informed that the B/RB-66 overall modernization program had to be curtailed for lack of money. The cut would be drastic, up to 80 percent if possible, and the entire inspect-and-repair-as-necessary (IRAN) program was eliminated. However, neither the aircraft conversion to J71-A-13 engines, nor the Sta-Foaming of fixed and movable surfaces were affected. The irony of the latter exemption came to light in February 1958, when the Sta-Foaming program was stopped. To some degree, 98 percent of the TAC B/RB-66s carried Sta-Foamed surfaces. Unfortunately, there was now clear evidence that the Sta-Foaming technique was a failure. The compound promoted corrosion and could eventually absorb up to 180 percent of its own weight in moisture, thus affecting aircraft balance. Although Douglas estimated that it would take some 8 months to fabricate new B/RB-66 control surfaces, the Air Force stated categorically that the work had to be done in little more than half that time.

Post-Production Improvements 1957-1958

Not only was the so-called all-weather RB-66B incapable of performing under adverse weather conditions, but it could not take photographs at night from high altitudes. Obvious from the start, the lack of proper tactical reconnaissance equipment was an increasingly crucial problem. To remedy the deficiency, Headquarters USAF in mid-1957 approved a TAC request for replacement of the aircraft's 12-inch cone K-37 camera by two 24-inch K-47s. However, the funding restrictions of the new fiscal year (FY 1958) postponed procurement of the more efficient cameras until mid-1958—fiscal year 1959. This would be in time to prevent Fairchild from shutting down its K-47 production lines, thereby saving the expense of re-establishing production, a financial burden that Air Force would have had to bear. Just the same, while this timing was a plus, the postponed camera procurement presented TAC with another delay, since the installation of K-47 cameras on all RB-66Bs would require nearly 1 year. Meanwhile, the acquisition of a high-resolution radar, to give the aircraft the capability to navigate in all types of weather, was almost at standstill. In late 1957, various radars were being considered and some testing was being done, but no solution was in sight.

Modernization 1958–1960

The B/RB-66 overall modernization program, postponed because of the FY 58 funding restrictions, finally got under way in May 1958. Tagged as "Little Barney," the $29 million project encompassed a myriad of technical order compliances, which had been delayed for lack of money. It covered the installation of J71-A-13 engines in the aircraft still equipped with J71-A-11s and the improvement of all PACAF and USAFE B/RB-66s which, in contrast to the TAC aircraft, had never benefitted from any type of modification. Of necessity, Little Barney also had to deal with the metal fatigue and corrosion problems encountered in all varieties of the B/RB-66s. Although Douglas provided sufficient newly designed control surfaces to allow all needed substitutions, Little Barney was not completed until August 1959, a slippage of several months. The delay was caused by a contractor-labor dispute, which prevented Douglas from sending field teams to the Air Force as soon as expected. Still, the project's results were satisfactory, and "Big Tom," which succeeded Little Barney at the Mobile Air Materiel Area in Alabama, also proved successful.[14] The 2 projects were closely related, since both centered on the yearly IRAN program of the weapon system. TAC delivered 5 percent of its RB-66s to Mobile each month and, as a rule, received its aircraft back within 30 days. The arrangement, while it lasted, worked well. Meanwhile, there were other problems, and frustrating incertitudes would soon follow.

Flaws and Frustrations 1959–1961

TAC grounded all its RB-66s in February 1959, after discovering cracks in the aircraft's nose gear attaching lugs. The repair of this flaw as well as other design deficiencies was guaranteed to be corrected by the contractor. The Air Force returned all available spares to Douglas for rework, and modifications to strengthen the nose gear strut assemblies were done at field and depot levels. Three Douglas teams arrived at Shaw, where they worked on 24-hour schedules so that all aircraft resumed flying before March. But another vexatious problem arose in mid-year, putting a new burden on the

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[14] The managerial logistics support of the B/RB-66 program was transferred from the San Bernardino to the Mobile Air Materiel Area on 31 July 1959.

Big Tom project. The fuel tanks of all B/RB-66s had to be inspected, and most of them resealed, to prevent fuel leaks attributed to deterioration of the original sealant. When another sealant was applied, a different problem developed. Various areas of the resealed tanks started leaking under pressurization, which tended to indicate that the tanks were nearing the end of their useful lives.

In 1960, the long-awaited installation of K-47 cameras, having been canceled for lack of money, was reinstated.[15] However, the RB-66B's new K-47 camera system again became a cause of concern in early 1961. Camera magazines did not function properly. They could be fixed for $178,000 or replaced for $268,000, two expensive propositions considering the Air Force's continuing penury. In addition, while efficient for night photography, the cameras still needed to be upgraded for daytime operation, a modification finally approved in October.

Unrelenting Problems 1961-1963

Since its introduction into the TAC inventory, the RB-66B had failed to achieve the desired level of operational readiness, often due to maintenance and supply shortcomings. In fact, the same failings were experienced Air Force-wide by every version of the plane and persistent funding limitations did not help. While unwelcome by any command, support deficiencies made the Tactical Air Command's many tasks especially onerous. In the last months of 1961, TAC possessed an average of 20 RB-66s for combat crew training, but only 12 of them were flyable. Similar conditions compounded the difficulty of training replacement aircrews for all USAF RB-66 units, another responsibility of the command. Furthermore, B/RB-66 support problems might restrict TAC's ability to reinforce other major command units during contingencies. Although great improvements were realized in early 1962, the general support outlook was not optimistic. Subsystems of the RB-66 aircraft were past their normal life expectancy and were almost certain to cause further unexpected maintenance.

Planning changes, again intricately related to tight budgets, aggravated the overall situation. Previous phaseout schedules had spurred the end of the aircraft's IRAN program, but retention of the RB-66s was now programmed to extend through fiscal year 1965, because there was no replace-

[15] On the other hand, Headquarters USAF in 1960 also recommended that TAC drop its requirement for putting a high resolution radar on the RB-66Bs. The cost involved, about $100,000 per aircraft, seemed no longer justifiable in view of the RB-66B's near phaseout, then programmed to take place in fiscal year 1964.

ment. In 1962, this meant bringing back some kind of IRAN program, on a one-time basis, in view of the aircraft's forthcoming retirement. As approved by the Air Force, this $7.1 million project (About Time) covered 145 RB-66s, 32 of them belonging to TAC. The project was at once affected by fund shortages. To make sure that as many aircraft as possible would be repaired, without reducing the scope of the work to be performed, TAC agreed to a sizable commitment of its own resources.

In January 1963, a corrosion-induced failure of one aircraft's nose struts engendered a complete retrofit of the fleet by the Mobile Air Materiel Area. During the same period, overhaul of the RB-66's J71-A13 engines began. Done under contract at the Naval Air Station at Quonset Point, Rhode Island, this crucial task proved time-consuming, prompting TAC to wonder if some kind of arrangement enabling engine repair at Shaw AFB would not be more effective. On the other hand, Shaw had retained its full share of problems. Despite every effort, the overall maintenance of the RB-66s remained difficult. Parts shortages did not abate throughout the year, contributing to high cannibalization rates within the 363d Wing and 4411th Combat Crew Training Group of the Tactical Air Command.

Planning Changes 1964-1965

As of 30 June 1964, only 100 RB-66Bs remained in the Air Force inventory and within 12 months, this total had dipped to 79. Still, phaseout of the entire B/RB-66 fleet was becoming less likely. The Air Force's increasing involvement in Southeast Asia affected all planning. The primary question no longer seemed to be how long a given model's retirement would be postponed, but rather to assess how retained aircraft would cope with their extended commitments. Obviously, some modifications would be needed. Yet, experience showed that the best modifications would not necessarily work from the start. For example, 3 RB-66Bs had been equipped in 1963 with infrared sensors, electronic strobes, and side-looking radars, but the performance of the strobes and infrared sensors, as demonstrated during a 1964 exercise, did not satisfy TAC. In any case, retention of the RB-66s, however probable, could not be taken for granted. This posed another dilemma by preventing reinstatment of a formal IRAN program. Wanting to be ready for an early IRAN program, should the Department of Defense approve the aircraft's retention, Headquarters USAF in April 1965 directed a "minimum prudent work package for IRAN of RB-66 aircraft during FY 66." Developed by TAC and endorsed by Air Force Logistics Command, this program made allowances for the fact that previous work on the RB-66 consisted of a series of short-term actions, none intended to keep the plane in service for more than 2 additional years.

End of Production 1957

The October 1957 delivery of the last RB-66B reflected the end of the aircraft's production.

Total RB-66Bs Accepted 145

Acceptance Rates

The Air Force accepted 4 RB-66Bs in FY 55, 46 in FY 56, 87 in FY 57, and 8 in FY 58.

Flyaway Cost Per Production Aircraft $2.55 million

Airframe, $1,563,671; engines (installed), $696,034; electronics, $155,000; ordnance, $10,081; armament (and others), $166,137.[16]

Average Cost Per Flying Hour $715.00

Average Maintenance Cost Per Flying Hour $323.00

Subsequent Model Series B-66B

Other Configurations EB-66B and EB-66E

The EB-66Bs and EB-66Es came into being in the spring of 1966, when the prefix E was assigned to all versions of the B/RB-66s intended for electronic warfare.[17] However, neither of the 2 models was new. The Air

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[16] Including the costs of research and development and in-production engineering changes, but excluding the expenses of all-post production modifications.

[17] The prefix E symbolized a modified mission. It was given to all aircraft equipped with special electronic devices for employment in 1 or more of the following roles: electronic countermeasures; airborne early warning radar; airborne command and control, including

Force contingent of EB-66Bs comprised both modernized and re-equipped B-66Bs and RB-66Bs, with no distinction made between the 2 types. In both cases, original electronic countermeasures gear (electronic devices and chaff dispensers) had been upgraded, and sophisticated pieces of equipment added. Similarly, EB-66Es, the first of which did not reach Southeast Asia before August 1967, could be converted B-66Bs or RB-66Bs.[18] The EB-66E did, however, represent an improvement over the EB-66B. Although the "E" carried fewer jamming devices, its new tuneable transmitters enabled the electronic warfare operator to change frequencies during flight in order to jam several kinds of radar.

Southeast Asian Deployment — April 1965

First committed to the war in April 1965, long before the Department of Defense decided to postpone the entire program's phaseout, the RB-66Bs quickly demonstrated the limitations of their equipment which, in view of existing retirement plans, had never been modernized. There was an exception, however. Three of the early RB-66Bs, deployed to Southeast Asia, had been equipped with infrared sensors, an important asset to meet growing night reconnaissance requirements. Nevertheless, the 3 planes were old and were replaced in 1966 by modern infrared-equipped RF-4Cs. Meanwhile, a great many RB-66Bs were being modified to update nearly obsolete electronic countermeasures (ECM) equipment. Improved support also was being worked out, in order to raise the aircraft's safety and efficiency. In 1966, most active RB-66Bs became EB-66s,[19] but this did not spell the end of the aircraft modernization.

Modernization Efforts — 1966–1969

In mid-1966, the Air Staff directed that 26 RB-66Bs be fitted with

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communications relay; and tactical data communications link for all non-autonomous modes of flight.

[18] This lack of specific identification was actually logical, since all B/RB-66s were basically alike. Initial differences had reflected the aircraft's individual roles. In practical terms, the Air Force intended all along that the aircraft's makeup and load be adjustable to mission requirements.

[19] Throughout the years, small numbers of RB-66s remained or were brought back in the active inventory. In 1968, for instance, the war's demands and the redistribution of electronic warfare assets caused TAC to use 20 RB-66s for training worldwide replacement crews.

passive and active ECM systems. The first of the 26 modified aircraft (EB-66Es) reached the war theater on 30 August 1967, but did not perform as well as expected, forcing PACAF to defer plans to make similar improvements to another 13 EB-66Bs. When money became available, 6 additional RB-66Bs, withdrawn from storage, were brought to an upgraded EB-66E configuration. At the same time, the problems of the first 26 EB-66Es were corrected. In 1968, confronted by increasingly sophisticated enemy defenses, the Air Force began using all EB-66s in the jamming role. This pinpointed the need for further improvements, such as steerable antennas and modification of the aircraft's new communication jammer. The wisdom of spending extra money on such an aged aircraft was debatable. TAC's new Commander, Gen. William M. Momyer, arriving from Southeast Asia in mid-1968, also had strong reservations about the modernized EB-66's effectiveness as a standoff jammer. Because no sound alternative could then be worked out,[20] General Momyer concurred in the extended modernization of the EB-66s, even though the entire project was fraught with difficulties since no single electronic-countermeasures configuration would meet the specific goals of all contingencies.[21] Continued EB-66 improvement reinforced TAC's argument that the aircraft's engines had to be replaced, a change sought by the command since 1966. TAC's belief, fully shared by PACAF and USAFE, was not unfounded.[22] The J71-A-13 engine was limited in power and had become extremely expensive to operate because of the short time between overhauls. Air Staff support notwithstanding, the Department of Defense had disapproved TAC's first request on the ground that the limited number of EB-66s remaining in the inventory did not warrant the purchase of better engines. Although TAC subsequently underlined that additional electronic systems could not be fitted in the EB-66s because the J71s and the associated generator banks could not supply enough electrical power, the Department of Defense did not alter its decision.

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[20] In the fall of 1968, the Air Force Systems Command suggested that all EB-66 modernization programs be revalidated and that selection of an electronic warfare vehicle other than the EB-66 be reconsidered.

[21] The Air Staff had already told PACAF, TAC, and USAFE to review current planning and to develop alternate electronic countermeasures configurations to satisfy their individual requirements.

[22] The improved B/RB-66s (EB-66s) with their many new components had grown from some 70,000 to about 81,000 pounds. But the thrust of their engines had not changed. Obviously, the overworked J71 engines of the EB-66s soon began to consume fuel at a disturbing rate.

Modernization Reversal 1969

In May 1969, Gen. John P. McConnell, Chief of Staff of the Air Force, stopped the EB-66 modernization. Three of the primary factors accounting for the decision were cost, time involved, and Defense Department's denial of a new engine. The Air Staff made it known that remaining EB-66s would have to be maintained through normal processes for perhaps 5 more years.

Support Problems 1969-1972

Fatigue cracks in the compressor of the J71 engine became a problem of major importance. Since flight safety was at stake, most of the available funds went for engine repair, and little was left to invest in airframes and electronics. In these circumstances, maintenance of the EB-66s proved increasingly difficult. Reduction of the EB-66 inventory in late 1969 brought relief by allowing a realignment of the modification programs to match available funds. Nonetheless, critically needed alterations often could not be done.

Operational Status Mid-1973

By mid-1973, the EB-66 had truly become an old, underpowered aircraft that had been extended repeatedly beyond its programmed life span. Because of the small fleet's approaching phaseout, no IRAN program supported the aircraft, and a contract team performed substitute inspections of the EB-66s. TAC had planned all along to get rid of its EB-66s as soon as the aircraft's Southeast Asian commitments were over. Yet, no other electronic countermeasures aircraft was available. In mid-1972, the Air Staff had recommended that the EB-66s be replaced by ECM-equipped F-111s, a solution actively pursued by TAC. But the Department of Defense had yet to reach a decision in mid-1973, and TAC had to retain a minimum number of EB-66s, as did PACAF and USAFE.[23]

Perilous Incident 10 March 1964

One year before the first RB-66Bs were sent to Southeast Asia, one of the aircraft was involved in a potentially very dangerous situation. On 10

[23] The EB-66s left the Air Force inventory the following year.

March 1964, an RB-66B of the 10th Tactical Reconnaissance Wing, a unit of USAFE's Third Air Force, took off from Toul-Rosieres Air Base, France, on a flight scheduled to carry it into West Germany. Malfunction of the RB-66B's compass and the crew's failure to recognize the problem brought the aircraft over East Germany, where it was shot down. After seeing the enemy interceptors, the crew ejected, landed, and was taken prisoner. No one was seriously injured, and the 3 crewmen were released before the end of March. The RB-66B loss, however, because it closely followed a far more tragic incident,[24] took on added importance. Hence, on 10 March, within hours of the airplane's crash, Gen. Gabriel P. Disosway, USAFE Commander-in-Chief, informed his staff of the President's deep concern and of the crucial necessity of preventing such incidents in the future. On 14 March, General Disosway imposed a buffer zone which extended and widened the existing Air Defense Identification Zone in central Europe. Special permanent procedures, known as Wind Drift, were established for positive control of every type of aircraft in the buffer zone. General Disosway also demanded that crew responsibilities and air discipline be "hammered home" to all aircrews during pre-flight briefings. The Wind Drift rules became even more stringent in 1965, when Gen. Bruce K. Holloway assumed command of USAFE.

[24] On 28 January, a T-39 straying over East Germany had been shot down, resulting in the death of the 3 crew members.

B-66B

Manufacturer's Model 1327

Previous Model Series RB-66B

New Features

Increased design gross weight and the Western Electric K-5 bombing system were the most significant new features of the conventional swept-back wing, all-metal B-66B. Like the RB-66B, the B-66B carried a 3-man crew.

Basic Development August 1952

The bomber configuration, endorsed by the Air Staff in August 1952, occasioned further changes to the initial Air Force version of the experimental A3D. The airplane's design gross weight was raised to 78,000 pounds (8,000 pounds more than the RB-66B's), the bomb bay was lengthened 17.5 inches, the capacity of the aft fuselage fuel tanks was increased, and pylons were provided to support extra 500-gallon fuel tanks. The approved B-66B configuration also involved the installation of a bombing system and of bomb dropping devices. Finally, a detachable probe-drogue in-flight refueling system was added, and a further revision of the XA3D's hydraulic system was directed. Of necessity, since every effort was to be made to keep the bomber and reconnaissance versions as close to each other as possible, most B-66B requirements were incorporated into the RB-66As. Ensuing problems, resulting modifications, and reduction of the B-66B procurement did not alter the program's policy on interchangeability.

Contractual Arrangements 1952-1956

The B-66B procurement was initiated in August 1952, when Letter Contract AF 33(600)-16341 was amended to cover the purchase of 26 B-66Bs. The amendment in addition changed the terms of the letter contract of April 1952, which reverted to the cost-plus-fixed-fee type of agreement endorsed for the RB-66As. The amended contract of August 1952, like the initial RB-66A document, assured Douglas of a profit amounting to 6 percent of the aggregate contract cost. A similar contract, AF 33(600)-25669, started by an October 1953 letter contract, called for 75 B-66Bs, but was amended many times as a result of a program reduction in mid-1955. For the same reason, contract AF 33(600)-28368, the fourth and last procurement order signed on 24 September 1954 also underwent many changes.[25] By the end of 1955, only 55 B-66Bs were to be bought, but General Twining agreed in early 1956 that the single authorized wing of B-66Bs should acquire more planes to take care of normal attrition. The Air Force held the B/RB-66 program on a tight financial rein. The program's ceiling had been settled once and for all. Hence, the approved extra 17 B-66Bs were diverted from the RB-66B total. The Air Force also specified that any cost increases generated by the directed substitution would have to be absorbed by deleting additional RB-66Bs.

First Flight (Production Aircraft) 4 January 1955

The first official B-66B flight was accomplished on 4 January 1955, 7 other B-66Bs being accepted by the Air Force before the new tactical bomber was cleared for operational assignment. Besides participating in the usual testing program, the early B-66Bs were involved from the start in the crucial development of their future sophisticated components. For instance, flight testing of a prototype K-5 bombing system, tailored for the B-66B, was pursued actively during the early part of 1955.[26] These tests entered a new phase in March 1955, when high-altitude and high-speed trials began.

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[25] Contract AF 33(600)-25569 and AF 33(600)-28368 were renegotiated during 1956, the Air Force being convinced that the cost-plus-fixed-fee type of agreements, dictated by circumstances, had worked even more poorly than expected. Nothing could be done to revamp the early B/RB-66 procurement, since deliveries on the first 2 contracts were nearly complete. The Air Force nevertheless intended to straighten out the 2 remaining orders. The service believed that frequent and onerous cost overruns in any given program could be avoided, or at least minimized, if all parties were affected by the program's financial outcome. This was reflected in the 2 supplemental agreements signed in March 1957 by Douglas and the Air Force. Douglas exchanged its fixed fee for a target fee of about 5 percent (the incentive was plus or minus 10 percent on sums falling within 115 and 85 percent of each contract's target cost).

[26] The K-5 was greatly altered for its use with the B-66, but it was not a weapon system development. The system had to be fitted into the already established airframe configuration, not developed parallel with it. The equipment was procured by the contractor rather than furnished by the government. Douglas spent about $100 million in subcontracts with Western Electric, manufacturer of the K-5, and with Bell Telephone Laboratories, which took care of the developmental engineering.

The functional testing of a production model of the bombing system soon followed. As fully expected by the Air Research and Development Command's Armament Laboratory in mid-1955, the K-5 promised to give the Air Force ". . . an all-weather tactical bombing capabilty compatible with the mission requirements of the B-66."

Enters Operational Service — March 1956

The B-66Bs began reaching the Tactical Air Command in March 1956, about 1 year later than originally scheduled. However, once under way, deliveries were reasonably steady, 64 of the 72 B-66Bs on order being accepted by mid-1957. The Ninth Air Force's 17th Light Bombardment Wing, at Hurlburt Field,[27] Florida, remained sole recipient of the B-66Bs until September 1957, when TAC began to transfer its total contingent to the United States Air Forces in Europe.

Development Engineering Inspections — Fall 1956

Despite the importance of the electronic countermeasures program, nothing could be done about it when the B/RB-66 configuration started taking shape. Electronic countermeasures components were in early developmental stages, and technological incertitudes prevented the establishment of firm operational requirements. Nevertheless, after many tentative plans, the Air Force in October 1954 decided the process should be accelerated to acquire at least an interim electronic countermeasures capability. Hence, a multi-phase interim ECM program was set up early in 1955. Briefly stated, the program called for installation (during the aircraft production) of available parts of the APS-54 radar warning receiver and ALE-2 chaff dispensers. Three interchangeable types of jamming equipment were ordered, and interchangeable ECM tail cones were to be fashioned to carry some of the chaff equipment and antennas. Finally, provisions for ECM cradles were to be made in the bomb bay of the B-66B. Yet, even though some B-66Bs had already begun to reach TAC, configuration changes were still under consideration in the fall of 1956. Procurement of the B-66B had been reduced in mid-1955, but the aircraft had not been exempted from the ambitious electronic countermeasures program planned for the entire B/RB-66B fleet. During the second half of 1956, 2 development engineering inspections were held a few weeks apart. The first, in late September, covered

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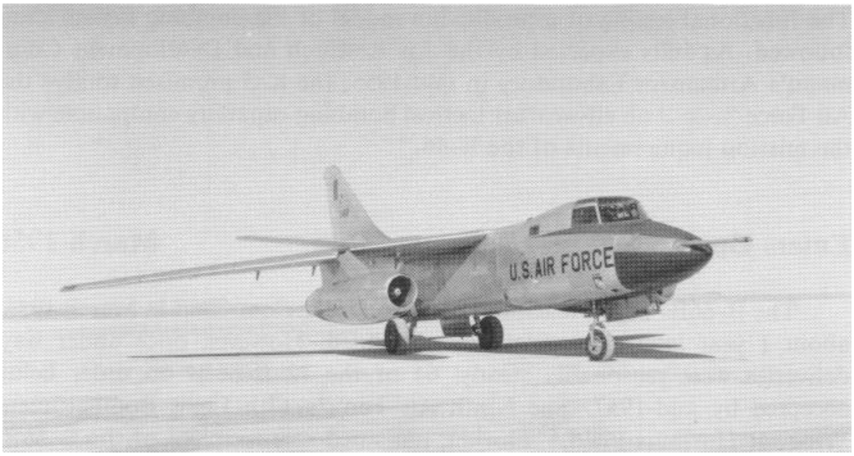
[27] An auxiliary field of Eglin AFB.



The B-66B featured the new K-5 bombing system and increased fuel capacity.

all-chaff and half-chaff electronic countermeasures cradle configurations of the B-66B. The second, held in early October, was concerned with the B-66B's entire electronic countermeasures installation. The 2 development engineering inspections were successful, the Air Force being satisfied by the apparent completeness and flexibility of the selected arrangements. However, the whole project was soon to encounter problems.

ECM Program Changes 1956–1957

Soon after the development engineering inspections of September and October 1956, the electronic countermeasures program ran into trouble. Major alterations would be needed to fit the required pieces of ECM equipment into the B/RB-66 airframes. Even if the Douglas production lines expedited the necessary modifications, full transfer of the B-66Bs to Europe and deployment of the several RB-66Bs destined for the Far East would have to be postponed. By the end of the year, it became clear that more unexpected changes would be needed, all of which affected tail cones and cradles. Included were substitution of various components, addition of some kind of apparatus to permit selective switching among jammers (a requirement previously overlooked), more powerful jamming signals, and new tail cone antennas.[28] Moreover, just the interim ECM program pro-

[28] The antenna changes eventually delayed the beginning of tail cone deliveries to March 1958, a slippage of about 1 year.

posed in March 1955 would be extremely costly—$40 million for a partial installation. In July 1957, Headquarters USAF decided that no B/RB-66Bs would be ECM-equipped during production. The Air Staff also cut down the procurement of cradles by one-third, to a total of 12, and reduced the tail cone purchase to 113, a decrease of 25. At the same time, the Air Force indicated that a modernization/IRAN program would catch the B/RB-66Bs that had not been modified to accommodate needed ECM equipment. In late 1957, 13 B-66Bs and 31 RB-66Bs were scheduled for such preparation.

Flight Testing 1955–1957

For all practical purposes, flight testing of the B-66B ended in January 1957, for the few tests yet to be completed were of minor importance. Overall test results were satisfactory, and the engineering improvements prompted by the testing program either had been or were being incorporated into the aircraft. The B-66B nearly met the Air Force procurement specifications. Noted performance decreases (10 percent in altitude, 12 percent in range, and 7 percent in low-altitude speed) might not be correctable, but the aircraft's flying characteristics were good. Thorough testing had demonstrated that the B-66B was especially well-adapted to low-level flight, could handle a variety of special weapons, and could be aerially refueled to 96,000 pounds.

Operational Problems 1956–1958

The positive qualities of the B-66B, flown by the 17th Bombardment Wing, were not in doubt, testing having ascertained the aircraft's basic soundness. Nevertheless, being practically identical to the RB-66B, the new tactical bomber shared the engine problems, Sta-Foam vicissitudes, and other early difficulties of the reconnaissance aircraft. The B-66B in addition had a few flaws of its own, which also remained uncorrected prior to the aircraft's overseas deployment.

Overseas Deployment 1958

Early in 1958, after a period of training, the squadrons of TAC's 17th Bombardment Wing were transferred to the 47th Bomb Wing (Tactical), a unit of USAFE's Third Air Force, with stations at Sculthorpe and Alconbury in the United Kingdom. While the 47th Wing's conversion from the obsolescent B–45[29] was a major operational gain, the B–66B's arrival was accompanied by serious maintenance difficulties. The flow of spare parts from the United States remained inadequate until August 1958, and shortages of electronic equipment and of such critical items as hydraulic pumps and oxygen regulators persisted throughout much of the year. In addition, the bomb shackles initially installed on the B–66B did not have a lock secure enough to prevent inadvertent bomb releases. This problem, though addressed from the start by TAC, was not being solved as fast as the Air Force would have liked. To save time, personnel of the 47th Wing installed the first new shackles developed by Douglas. Other B–66Bs were due to receive the improved shackles during the B/RB–66 overall modernization program. However, even the simplest plans could be affected by circumstances beyond USAF control. Although started as scheduled on 1 May 1958, the "Little Barney" overseas program taking place at the AMC's Air Depot at Chateauroux, France, was hindered significantly by French labor unrest. The B–66Bs shipped to Chateauroux for modernization (elimination of Sta-Foaming damages, engine retrofits, and the like) were often held for 52 days, almost twice the work time authorized for every aircraft. To speed up the B–66B's operational readiness, the Air Force decided to ship new shackles directly to the 47th Bomb Wing, which would enable the unit to install them promptly on the modified aircraft, finally back from Chateauroux.

End of Production — 1957

The October 1957 delivery of the last B–66B marked the end of production.

Total B–66Bs Accepted — 72

The 72 B–66Bs accepted by the Air Force reflected a reduction of nearly 50 percent from the maximum procurement once considered.

Acceptance Rates

The Air Force accepted 1 B–66B in FY 55, 27 in FY 56, 36 in FY 57, and

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[29] The B–45s were taken out of the combat inventory and transferred to USAFE bases in Europe and North Africa, where they were used for fire fighting training.

the last 8 in FY 58 (3 in July 1957, 1 in August, 3 in September, and 1 in October).

Flyaway Cost Per Production Aircraft $3.68 million

Airframe, $2,515,511; engines (installed), $664,034; electronics, $400,000; ordnance, $10,625; armament (and others), $95,300.[30]

Average Maintenance Cost Per Flying Hour $280.00

Subsequent Model Series RB-66C

Other Configurations EB-66B and EB-66E

The EB-66Bs and EB-66Es were reconfigured B-66Bs, identical to modified and similarly redesignated RB-66Bs. Like the former RB-66Bs, converted B-66Bs began to acquire "E" prefixes early in 1966.

Initial Phaseout Mid-1963

The Air Staff finally agreed to let USAFE retain its B-66Bs beyond the FY 61 inactivation date that had been established originally. Still, except for 13 specially equipped B-66Bs, the entire contingent was out of the operational inventory by mid-1963.

Special Modifications 1964-1965

From the start of the B/RB-66 program, the Air Force thought the B-66 light tactical bomber would also be used for ECM jamming. Hence, a pallet (or cradle), carrying jammers, chaff dispensers and other necessary gear, could be fitted in the aircraft's bomb bay, once the latter was stripped

[30] Including the costs of research and development and in-production engineering changes, but excluding the expenses of modifications added on after approval of a basic contract.

of its bombload and shackles.[31] Nevertheless, retention of 13 ECM-equipped B-66Bs would entail some work since the aircraft were not new. In April 1964, the Air Force Logistics Command began to develop a working agreement between USAFE's 42d Tactical Reconnaissance Squadron, the Mobile Air Materiel Area, and a Lear-Siegler contract team. The project, as settled, covered the IRAN program for each aircraft, including removal and inspection of all fuel cells and updating of the electronic countermeasures system of the aircraft, referred to as Brown Cradle. The Air Force estimated that to do the overall task properly would require some 3,400 manhours for each of the 13 Brown Cradle B-66Bs. Since USAFE did not want to part with more than 2 of the aircraft at one time, the B-66B's renovation and Brown Cradle modification extended well into 1965.

Southeast Asian Deployment — 1965-1966

USAFE retention of its updated Brown Cradle aircraft was short.[32] In late 1965, 5 of the modernized B-66Bs were deployed to Southeast Asia. In May 1966, the 42d Tactical Reconnaissance Squadron's remaining 8 Brown Cradle aircraft also departed for the war theater.

Reactivation — 1967

Eleven B-66Bs were reactivated early in 1967 and, after modification, were sent to Southeast Asia. Meanwhile, on-going testing to determine the aircraft's life expectancy proved satisfactory enough. Even though the B-66B shared the engine problems of the entire RB-66 fleet, additional B-66Bs were soon withdrawn from storage and modified for war service.

Operational Status — Mid-1973

Reactivated and modernized B-66Bs followed the operational pattern

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[31] Similarly, the RB-66's bomb bay, minus cameras and related equipment, could accommodate a cradle. In fact, by mid-1959 ECM tail cones had been authorized for USAFE's entire B/RB-66 contingent and for all of the PACAF RB-66Bs.

[32] The B-66Bs had no electronic intelligence capability, when configured as ECM aircraft. The USAFE Brown Cradle aircraft's intended role was to support the strike force by actively jamming enemy radars. The command recognized that its ECM B-66Bs might be vulnerable to enemy interceptors, but bitterly deplored deployment of the 13 aircraft to Southeast Asia.

of the RB-66Bs. Also known as EB-66s since early 1966, a few of the aircraft still lingered in the active inventory in mid-1973.

Milestones 1956–1957

On 12 August 1956, one of the Air Force's new subsonic B-66 jet bombers flew from Hawaii to California in 4 hours and 27 minutes, covering a distance of 2,690 miles at an average speed of more than 600 miles per hour.

In the fall of 1957, only 17 hours after being alerted in the United States, several B-66Bs, after crossing the Pacific as elements of a Composite Air Strike Force, were flying simulated bombing missions over the Philippines.

RB-66C

Manufacturer's Model 1328

Previous Model Series — B-66B

New Features

The RB-66C featured a reconfigured bomb bay, which housed electronic components and provided space for 4 additional crew members (electronic countermeasures operators or observers). The aircraft's design weight was 75,000 pounds (5,000 more than the RB-66B's and 3,000 pounds less than the B-66B's). Wingtip radar pods and a radome containing antennas for the various radars were the other significant new features of the RB-66C. As in the case of every B/RB-66 version, the basic 3-man crew of the RB-66C (pilot, navigator, and gunner) used upward ejection seats, the 4 additional ECM operators, downward ones.

Basic Development — 1953

Development of the RB-66's electronic intelligence version, although anticipated as early as 1952, did not begin until 1953. The aircraft's overall configuration was submitted to USAF Headquarters in early March and approved the following month. A more specific design was initiated in June, but the Air Force knew that the equipment required by the future aircraft's electronic reconnaissance role was not readily available. Production schedules, therefore, forecast an operational date of late 1956. Thus, despite the many problems that soon beset the entire program, the RB-66C practically escaped the production slippages of other and less sophisticated B/RB-66s.

Production Go-Ahead — 15 April 1953

On record, the Air Force endorsed production of the ferret RB-66C in mid-April. In actuality, the production decision was only firmed up several months later. And like preceding models, the RB-66C was nearly canceled in 1955, when the whole B/RB-66 program came under review. The RB-66C's initial procurement document was a purely developmental letter contract calling for "necessary implementation planning and design for the electronic reconnaissance version of the RB-66." This document, AF 33(600)-25669, was issued on 12 June 1953, but it took until August, when the fiscal year 1954 airplane program was released, for the Air Force to indicate a first requirement for 65 RB-66Cs.

Mockup Inspection — 14 January 1954

Inspection of the RB-66C mockup generated 31 change requests. The 14 January mockup inspection, held at Douglas's plant in Tulsa, Oklahoma, reflected a change of plan. Originally, all B/RB-66s (RB-66Cs, included) were to be produced in Long Beach, a sensible decision since 60 percent of the airframe parts were expected to be alike, and a similar commonality percentage would apply to tooling. However, the Douglas Long Beach plant was already manufacturing C-124s. Despite its 3,320,000 square feet of space, the plant was not large enough, nor did it have the engineering capability to accommodate the whole B/RB-66 program. By necessity, Tulsa was selected in 1953 to build all RB-66Cs, but this decision, like most long-range plans, was revised. The Tulsa plant ended manufacturing a great many wings for other B/RB-66 models, while Douglas eventually found it more economical and convenient to produce certain portions of the RB-66Cs in Long Beach.[33]

Program Change — July 1955

In mid-1955, the Air Force confirmed a heretofore tentative decision to reduce the RB-66C program of 72 aircraft by half. The 36 deleted RB-66Cs would be produced in the synoptic weather configuration.

First Flight (Production Aircraft) — 29 October 1955

The RB-66C's first official flight took place on 29 October 1955, TAC getting one of the new aircraft soon afterwards.

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[33] The Long Beach plant had been built during World War II to manufacture such airplanes as the A-20, A-26, C-47, C-74, and B-17. The United States government only owned 52 percent of the plant. In contrast, the Tulsa plant was totally owned by the government. It was also not as large as the Long Beach plant and was expected to stop manufacturing and modifying B-47s sometime in 1955.

Contractual Arrangements 1955–1956

Procurement of the RB-66C mirrored the turbulent history of the entire program. An October 1953 amendment to the letter contract of June 1953 became the prelude to several unusual arrangements. Again, because Douglas could not possibly come up with realistic fixed-price estimates, the contract, finalized in December 1953, covered Douglas's costs, plus a fixed fee of 6 percent. In another departure from preferred procurement methods, contract AF 33(600)-25669 covered 3 different models of the B/RB-66s. The rationale for this procedure was that 1 contract would be cheaper than 3, because it would permit co-mingling of common parts and the use of common tooling. In any case, as a result of the mid-1955 program reduction, the contract was altered in August 1956. The changes, however, did not specifically affect the RB-66Cs. Meanwhile, another RB-66C order had been processed in fiscal year 1955, when the fourth and last B/RB-66 contract was negotiated.[34] This contract, AF (33(600)-28386, was signed on 24 September 1954. It was another cost-plus-fixed-fee contract, carrying the same fee of 6 percent, as well as several types of B/RB-66s. This contract also underwent changes. In January 1956, the contract's total was reduced; in August, the procurement of some models was altered in favor of others, and the 36 RB-66Cs canceled in mid-1955 were formally deleted in December. Finally, as already noted, the terms of both contracts (the last 2 of a total of 4) were renegotiated, 2 new supplemental agreements being signed in early 1957.

Enters Operational Service 1956

TAC's initial RB-66C, received at Shaw AFB on February 1956, was assigned to the 9th Tactical Reconnaissance Squadron. Only a few more of the aircraft were delivered before mid-year, but by the end of December, more than half of the RB-66C contingent had reached the Air Force. The ferret RB-66C was the first weapon system of its kind. Its assignment also proved unique, as TAC from the start planned to equip certain squadrons with a mixture of RB-66Cs and of forthcoming and equally novel WB-66Ds.

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[34] At the time, only 1 RB-66A had been delivered, only 1 B-66B was partially shop-completed, and no work had been done on the RB-66C. Therefore, as far as prices were concerned, Douglas knew little more than it had the previous year. And obviously, the forthcoming production correction of airframe deficiencies was bound to complicate all cost estimates.

Engine Deficiencies 1956

As in the case of most B/RB-66s, some RB-66Cs were equipped originally with J71-A-11 engines. Hence, they too were hindered by engine malfunctions and demonstrated disappointing operational performance until retrofitted with more powerful J71-13s.

Grounding June 1956

The Air Force grounded on 14 June the 6 RB-66Cs it had already accepted from Douglas. The grounding was necessary because the aircraft's center of gravity was affected by the fuel level. The retrofit installation of a boost pump in the aircraft's forward tank solved the problem, but it took until mid-August to flight test the modification. The change was incorporated during the production of subsequent RB-66Cs.

Engineering Problem July 1956

An engineering difficulty, peculiar to the RB-66C, received special attention. The instability demonstrated by the first RB-66A had been corrected, but the wingtip radar pods featured by the RB-66C had created a new buffeting problem. In July, the Air Force Flight Test Center checked the effectiveness of a Douglas-devised modification, which attached a vane to the wingtip pod. The Air Force determined that the new device was fairly effective. Yet, it wanted a "buffet free airplane," not one so fitted as to bring buffeting to an "acceptable level." In late July, representatives from Air Research and Development Command, AMC, and the Wright Air Development Center met with Douglas and decided that the contractor's modification would do for a while, but that the root of the problem had to be eliminated. In short, better shaped pods had to be designed and tested. Following selection and production of a reconfigured pod, all 36 RB-66Cs would be retrofitted, which they were.

Overseas Deployments 1956-1957

The RB-66Cs arrived overseas shortly after TAC received its first aircraft. USAFE got most of its RB-66C quota in 1956. The 12 aircraft, one-third of the total procurement, went to the newly activated 42d Tactical Reconnaissance Squadron at Spangdahlem Air Base, West Germany.

PACAF in 1957 received 12 RB-66C electronic intelligence (ELINT) aircraft, which it assigned to the 67th Tactical Reconnaissance Wing's 11th Tactical Reconnaissance Squadron at Yokota Air Base, Japan. To various extents and regardless of location, the delivered RB-66Cs were to participate in the Little Barney and other modification programs, still to be applied to the preceding RB-66Bs and B-66Bs.

Special Testing — 1957

Testing of the electronic reconnaissance RB-66C was completed in November 1957. The employment and suitability tests, conducted by the Air Proving Ground Command, showed that the aircraft was capable of performing "peripheral reconnaissance during peacetime" without equipment modifications. However, major engineering changes would be needed, should the RB-66C be used in a combat environment.

End of Production — 1957

Delivery of 2 last RB-66Cs in June 1957 marked the end of the aircraft's production.

Total RB-66Cs Accepted — 36

Acceptance Rates

The Air Force accepted 6 RB-66Cs in FY 56, and 30 more in FY 57.

Flyaway Cost Per Production Aircraft — $3.06 million

Airframe, $2,138,445; engines (installed), $664,034; electronics, $155,000; ordnance, $13,722; armament (and others), $95,300.[35]

Subsequent Model Series — WB-66D

[35] The cost formula of previous B/RB-66s applied to the RB-66C and subsequent WB-66D.

Other Configurations — EB-66C

The EB-66C, so designated in 1966, when all B/RB-66 aircraft engaged in electronic warfare acquired the E prefix, was a modernized RB-66C. Even though the former RB-66C at the time was the only tactical electronic warfare vehicle in the Air Force, further improvement of the EB-66C was stopped in 1969. In short, all models redesignated as EB-66s underwent special modifications to improve their electronic warfare capabilities, but they needed additional changes which were not approved.

Canceled Modifications — 1959–1961

While the RB-66C participated, as needed, in the B/RB-66 program's overall improvement, proposals for special modifications were often denied. As equipped in 1959, the RB-66C could not provide a rapid count and location of enemy radars. The addition of a Baird Remote Control Sextant[36] would help, but TAC's request was turned down by the Modification Review Board of the Mobile Air Materiel Area, because of fund shortages. Also, the expensive equipment was not readily available. If approved, it would have reached the aircraft too late to justify its cost, since the RB-66C was expected to begin leaving the inventory about mid-1963. In 1961, TAC again pointed out that the airborne system of the RB-66C had never been modernized,[37] and that manually operated equipment produced data which required hours of processing.

Cuban Crisis — October 1962

Operational deficiencies, observed during the Cuban missile crisis of 1962, vindicated TAC. In the next years, continuing reconnaissance operations around Cuba further demonstrated the validity of the modifications that had been sought by the command. Meanwhile, during the first months of the crisis, TAC's RB-66s (a mixture of RB-66Bs and RB-66Cs) flew many extra hours, and soon began to participate in numerous exercises.[38]

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[36] An instrument that would provide a look-down altitude capability.

[37] TAC's deep concern led it to suggest that perhaps a single USAF organization, properly equipped, should provide electronic intelligence for the entire Air Force.

[38] The Tactical Air Command had been engaged in RB-66 electronic warfare since 1956, but emphasis had been on electronic reconnaissance. It took until 1960 for TAC to begin sending RB-66 crews to Europe to gain experience in electronic warfare operations.

New facts came to light. The RB-66C required more maintenance. Electronic countermeasures were most important during contingency operations, and the reconnaissance wing did not have enough trained personnel to maintain the system and to take care of the problem-ridden APD-4 antenna. TAC believed a pure training program was not required; instead technical support was needed to better indoctrinate a minimum of personnel on corrosion, interference, and other problems with the RB-66C's antenna. Activities prompted by the October crisis also served the useful purpose of testing a special RB-66B. The aircraft's recently installed infrared and KA-18 components were expected to provide reconnaissance information on troop and heavy equipment in forested areas.

Planning Changes 1963-1964

The Air Force's decision to retain its electronic intelligence gathering force, pending availability of ELINT RF-4Cs,[39] caused a first postponement of the RB-66C phaseout. The recent Cuban Crisis and its on-going impact, the growing threat in Southeast Asia, and the confirmed RB-66C shortcomings induced other changes. To begin with, TAC organized the USAF Tactical Air Reconnaissance Center (TARC). Located at Shaw AFB and due to serve as a worldwide focal point for tactical reconnaissance programs, TARC swiftly proved its worth. Although partially manned, TARC, in 1963 alone, tested an in-flight film processing magazine; the RS-7 infrared sensor; the KA-18A Sonne or continuous strip camera, and the KA-52A panoramic camera. The new center also ascertained how quickly electronic intelligence signals could be located and fixed. Finally, it tested a special navigation system for the Army; a portable film processor, and a TACAN antenna for the RF-101.[40] During the same period, minimum but significant modifications of the RB-66C were being devised.

Urgent Modifications October 1964

Several RB-66Cs were modified, beginning in October 1964. The

[39] Slippage of a sensor being tested by the Navy was a primary problem. TAC attached great importance to the new ELINT sensor, which the RF-4C was expected to carry in a pod.

[40] The RF-101 was due to remain the principal intelligence gathering weapon system until replaced by the RF-4C, another McDonnell production. The RF-101 went through several modernization programs between 1962 and 1967, while the RB-66C asserted itself as the only USAF electronic warfare vehicle.

changes attempted to upgrade the aircraft's electronic countermeasures equipment, so it could cope with various types of enemy missiles. A subsequent but related modification, tested under Project Sea Fast, seemed to work fairly well, which meant that the RB-66Cs were at least prepared to enter the war.

Southeast Asian Deployment 1965

Like the RB-66Bs, TAC's RB-66Cs first went to Southeast Asia in April 1965. Soon the command's entire meager RB-66C contingent was committed to the war effort, leaving the command no other immediate alternative than to request 5 RB-66Bs for training aircrews. Of necessity, TAC's temporary duty RB-66C personnel carried out most electronic warfare operations in Southeast Asia during the whole of 1965.[41]

Other Modifications 1965–1968

As the Vietnam War escalated and enemy defenses grew, more modifications, the improvement of old and new components, and additional EB-66Cs (so redesignated in 1966) were needed. Big Sail, a priority modification started in 1965, hoped to reduce fighter losses by raising the EB-66C's efficiency against increasingly sophisticated enemy radars. Soon all USAFE EB-66Cs were included as backup for additional so-called Big Sail types of commitments. But the war demands did not abate. Although the Big Sail modification did work, TAC and USAFE asked the Air Staff that the EB-66C fleet be further updated for electronic warfare. Other modifications were made as unexpected problems arose. For instance, electromagnetic interferences with other aircraft systems demonstrated before long that the EB-66C needed a different jammer. TARC tested the new modification as part of the tactical electronic warfare system improvement.

Towards the end of 1966, the Center again got involved in a crucial task. The EB-66Cs in Southeast Asia often had to mask electronically the strike aircraft entering and leaving areas defended by deadly SA-2 surface-to-air missiles. Two jamming techniques could be used by the EB-66Cs, too few in number and increasingly vulnerable. Borrowing a B-52 from the Strategic Air Command, TARC helped determine which of the 2 B-66C techniques

[41] Electronic warfare officer training was started at Shaw AFB in March 1966.

was the safer and more efficient. In mid-1967, Secretary of Defense Robert S. McNamara explained to members of the 90th Congress that the RB/EB-66s, although not new, could satisfy adequately the Air Force's interim electronic countermeasures requirements. Mr. McNamara admitted that significant modifications would be needed to update the aircraft currently operational, as well as those being reactivated. While all of the Secretary's tentative plans did not materialize, the EB-66Cs were further improved. Among many important aircraft modifications, most noteworthy was the installation of steerable antennas in the EB-66Cs.[42] This change, begun in the spring of 1968, enabled electronic warfare officers to focus a plane's jamming energy against a specific radar transmitter.

Additional Commitments 1968–1969

Seizure of the USS *Pueblo* by North Korea prompted the immediate deployment of USAF forces. As part of the buildup, TAC had to send 6 EB-66s (4 EB-66Es and 2 EB-66Cs) to provide standoff ECM support to the strike units in the event of hostilities. The EB-66s departed the United States on 29 January 1968 and reached Kunsan, South Korea, on the 31st. However, before the end of February, priority requirements in Southeast Asia dictated relocation of the Kunsan EB-66s to Itazuke Air Base, a development TAC did not like. The command, during the previous year, had already pointed out to the Air Staff that any plan to replace Southeast Asian EB-66C losses with assets from the Shaw training pool would seriously affect the training of electronic warfare officer replacements. Nonetheless, TAC's predicament was to get worse. Early in 1968, crew training began to falter, as did the testing of ECM equipment and concepts, and TAC asked that all RB-66s be retrieved from storage and modified. In July, when most ECM modification programs neared completion, Secretary McNamara designated all EB-66s for dual-basing,[43] but TAC's reactivation request again proved futile. Meanwhile, since the total requirement for EB-66s far exceeded the number of aircraft available, other major air commands had problems. Because PACAF desperately needed a continuous flow of crew replacements, this command was the first to recommend in March 1968 that

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[42] The EB-66E never carried this device, probably because the modification would have required the further installation of direction-finding equipment to tell the operators where to aim the new antenna.

[43] Dual-basing basically meant that a tactical combat unit, at a tenant location separated from its area of responsibilty and parent command, would deploy to a predesignated base within its area of responsibility, prior to or during hostilities.

8 EB–66s, programmed for Southeast Asia, be temporarily diverted to TAC. As for USAFE, after losing all its EB–66 resources to the Vietnam War, it flew inferior EB–57s pending activation of the 39th Tactical Electronic Warfare Squadron at Spangdahlem Air Base, West Germany. This interim arrangement lasted until April 1969, when 16 EB–66s finally became available to equip the new squadron.

Program Extension 1970–1974

Scheduled to phase out around 1970, the EB–66C's operational life was again extended. Still, like other EB–66s, the aircraft would no longer be modernized and would have to be maintained through normal processes. In 1969, decreased air activities in Southeast Asia promised relief and TAC expected the return of some of its resources. Meanwhile, the command found it difficult to support the new Spangdahlem squadron of EB–66s. During the same period, preliminary results of on-going structural tests showed that the B/RB–66 or EB–66 airframe could accumulate safely perhaps as many as 13,000 hours of flying time.[44] Hence, TAC once more asked that additional aircraft be removed from storage. Since its request again was turned down, the command reiterated that contingency support commitments would have to be scaled down. In mid-1971, the overall EB–66 program called for TAC to reduce combat crew training and to end it 1 year later. In the meantime, PACAF would handle the training of EB–66C crews until TAC received the EB–66s, due to leave Spangdahlem. Then, TAC would resume training of EB–66C and EB–66E personnel, while continuing to take care of all contingency operations. Clearly, both the Air Staff and TAC trusted that additional EB–66s would not have to be sent to Southeast Asia. However, B–52 support needs in November 1971, and problems with some of the war theater aircraft required the commitment of 2 TAC EB–66Cs. Moreover, a new contingent of EB–66s had to be deployed in mid-1972, when the enemy drive intensified and Strategic Air Command B–52Gs entered the war. Nevertheless, the B/RB–66 saga of nearly 2 decades was coming to an end.

Operational Status Mid-1973

In mid-1973, few EB–66Cs remained in the inventory. As foreseen by

[44] The flight loads and analytical study phases of the aircraft's fatigue life program were practically completed in May 1969, when testing of the aircraft's components began. The thrust-deficient and worn-out J71 engine obviously was excluded from the testing program.

TAC, without enough money for proper support, many EB-66s had been lost to attrition. Deactivation of Shaw AFB's 39th Tactical Electronic Warfare Training Squadron, the last Air Force unit to use any type of the old B/RB-66 aircraft, would take place in early 1974. While in Southeast Asia, the 39th had received the Outstanding Unit Award for its contributions during the Linebacker II operations of December 1972.[45]

[45] See B-52, p 278.

WB-66D

Manufacturer's Model 1365

Previous Model Series — RB-66C

New Features

The WB-66D was identical to the RB-66C, except that the bomb bay housed electronic weather equipment in lieu of ECM components. The pressurized crew compartments also were alike, but the WB-66D only required a crew of 5—pilot, navigator, gunner, and 2 weather observers. In contrast to other B/RB-66s, all WB-66Ds were equipped from the start with J71-A-13 engines.

Production Decision — 1 August 1955

Production of the WB-66D was made official on 1 August 1955, soon after the procurement deletion of 36 RB-66Cs had been confirmed. Contract AF 33(600)-28368, the fourth and last B/RB-66 contract, was amended accordingly on 12 December 1956.

Mockup Inspection — 21 June 1956

The inspection team was actually confronted by a dual task, because Douglas displayed 2 configurations of the WB-66D synoptic weather reconnaissance aircraft. The first of the 2, referred to as the interim WB-66D, contained the weather equipment of the time; the second configuration, or best model, provided for and described the more sophisticated equipment expected for use within 2 or 3 years. The inspection prompted 47 change requests, 27 of which were considered of priority importance. Yet the AMC mockup board did not seem excessively concerned. Confirming this optimistic appraisal, the Air Force announced in November that both the interim and ultimate WB-66Ds would be purchased, with the understanding that the interim aircraft would be retrofitted with more modern weather equipment as soon as feasible.

Testing 1957

Douglas testing of the WB-66D ended with satisfactory results in late September 1957. Ensuing functional testing by the Air Force failed to uncover any significant problems and was practically completed before the end of the year.

Enters Operational Service 16 June 1957

The spring delivery of 3 interim WB-66Ds to Shaw AFB's 9th Tactical Reconnaissance Squadron was an important milestone for the Tactical Air Command. The synoptic weather mission, which covered a large geographical area simultaneously, was a relatively new development within the command. Theoretically, a few modified T-33 trainers (produced by Lockheed and commonly known as T-Birds) constituted TAC's weather reconnaissance fleet. In reality, these planes awaited delayed equipment kits. Because of the obsolescence of the WB-26s, TAC flew the partially equipped T-33s to gather high-altitude weather information, relying essentially on the data observed by the aircraft's back-seat weatherman. Although the early WB-66Ds did not meet all of TAC's needs, their arrival did signify a long overdue operational improvement.

Overseas Deployments 1957-1958

Except for 4 aircraft delivered in FY 1957, all WB-66Ds were accepted by the Air Force during FY-58. While the first deliveries went to the Tactical Air Command, WB-66D deployments to PACAF and USAFE closely followed. PACAF's 12 WB-66Ds were assigned to the 67th Tactical Reconnaissance Wing; USAFE's equal lot, to the 66th.

Program Shortcomings 1957-on

The WB-66Ds received by 3 of the Air Force's major air commands fell short of meeting the requirements set up for either the interim or ultimate version of the aircraft. Little more than a year had elapsed since the

WB-66D mockup inspection, but many events had taken place. Unexpected developmental setbacks, the procurement slippage of weather components much simpler than those under preliminary development, fiscal restrictions, and the high cost of on-going B/RB-66 modifications, all had caused the Air Force to lessen its weather reconnaissance objectives. In March 1957, while realizing that the ideal weather airplane would not materialize in the foreseeable future, the Air Force still hoped that the so-called interim WB-66D could gain, through post-production modifications, a few of the ultimate features that had been planned for the aircraft. In August 1957, even this more modest planning became uncertain, as deliveries of the proposed components could no longer be assured before 1960, or later. As feared, the Air Force on 30 October 1957, had to cancel the purchase of 5 future components. In their place, the Air Materiel Command would attempt to expedite the procurement of radiosonde sets,[46] MG-3 data computers, and AMQ-7 temperature and humidity devices. As time would show, this still remained a tall order.

Operational Deficiencies 1958-1959

TAC quickly took advantage of the eagerly awaited WB-66Ds. First received in late June 1957, the aircraft began flying regularly scheduled weather reconnaissance tracks on 1 September. Despite equipment problems, the superiority of the WB-66D over reciprocating engine aircraft or the T-33s was immediately apparent. To some extent, the WB-66D could determine weather conditions regardless of surroundings, and it soon started probing vast areas of hitherto unsampled overwater skies. This meant that weather briefings became more accurate, and that overseas deployments would face fewer weather hazards. Nevertheless, the WB-66D was still unable to transmit meteorological data automatically by radio. In mid-1959, the retrofit of key components kept slipping. For example, testing of the dropsonde receptors and dispensers was unsatisfactory. Ensuing live tests, conducted at Shaw AFB, only confirmed that the WB-60D's radiosonde system needed further improvement. In several drops, the dropsonde struck the aircraft on ejection and failed to transmit.

End of Production 1958

The Air Force took delivery of the last 2 WB-66Ds in January 1958, marking the end of the aircraft's production.

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[46] Radiosonde sets are airborne meteorographs, with associated components, that automatically transmit meteorological data by radio.

Total WB-66Ds Accepted 36

Acceptance Rates

The Air Force accepted 4 WB-66Ds in FY 57, and all others in FY 58 (5 each month from July 1957 through December 1957, and 2 in January 1958).

Flyaway Cost Per Production Aircraft $1.91 million

Airframe, $1,313,373; engines (installed), $270,000; electronics, $138,784; ordnance, $15,160; armament (and others), $174,983.

Average Maintenance Cost Per Flying Hour $448.00

Subsequent Model Series None

Other Configurations X-21A and EB-66C

X-21A. In the late fifties, the Air Force gave Northrop a contract to convert 2 WB-66Ds. The purpose of the conversion was to test a new laminar flow control system developed by Northrop. Design of the conversion was started in August 1960, and modification of the Douglas-built aircraft began in 1961. Designated X-21A, the first modified WB-66D flew in April 1963, and testing of the laminar flow control system over sections of the wings was underway by 20 May 1963. Conversion of the second WB-66D was completed in August of the same year.

EB-66C. A number of WB-66Ds, withdrawn from storage after 1966, were brought up to the EB-66C configuration.

Phaseout 1960–1964

The WB-66D phaseout started in 1960, when USAFE and PACAF got rid of their weather reconnaissance aircraft. At the time, the Air Staff endorsed TAC's request to retain its small WB-66D contingent for a few more years. Nonetheless, by July 1965, all WB-66Ds were out of the Air Force's active inventory.

Reactivation 1966

In October 1966, press accounts began to give the EB-66s credit for neutralizing surface-to-air missile radars as well as much of the enemy's radar-controlled but conventional anti-aircraft weaponry. Less publicized throughout the years were the Air Force's difficulties in satisfying recurring or unforeseen demands with too few aircraft. Late in 1966, Secretary McNamara at long last approved the reactivation of 9 WB-66Ds and the modification of each aircraft to the EB-66C configuration. Even though some of the reactivated and modernized planes acquired slightly different components, all EB-66Cs remained basically alike and all played important roles. For that matter, the entire fleet of EB-66Bs, EB-66Es, and EB-66Cs, as well as their heroic crews, were highly praised for their combat contributions.[47]

[47] Like most other aspects of the electronic warfare effort, the EB-66's effectiveness could not be evaluated in terms of missions flown and fighter-bombers lost. There were no valid supporting statistics, but the aircraft became quickly known for its outstanding usefulness. Despite unrelenting engine problems, its performance was also well rated.

Program Recap

The Air Force accepted a grand total of 294 B/RB-66s—5 RB-66As, 145 RB-66Bs, 72 B-66Bs, 36 RB-66Cs, and 36 WB-66Ds. Early production difficulties, and deficiencies identified late in 1954, accounted for the program's reduction—48 aircraft less than initially ordered. The same reasons delayed deliveries to the using commands by about 1 year, and TAC did not receive its first RB-66B until January 1956. Still only 4 years elapsed between the production go-ahead and the aircraft's service introduction. And once in the inventory, the often-modified aircraft earned their keep far longer than anticipated.

TECHNICAL AND BASIC MISSION PERFORMANCE DATA

B/RB-66 AIRCRAFT

Manufacturer (Airframe)	Douglas Aircraft Company, Long Beach, Calif., and Tulsa, Okla.
Manufacturer (Engines)	Allison Division of The General Motors Corporation, Detroit, Mich.
Nomenclature	All-weather Night Photographic Aircraft; Light Tactical Bomber; Electronic Reconnaissance Aircraft.
Popular Name	Destroyer

	RB-66B	B-66B	RB-66C
Length/Span (ft)	75.2/72.5	75.2/72.5	75.2/72.5
Wing Area (sq ft)	780	780	780
Weights (lb)			
Empty	43,476	42,549	44,771
Combat	49,440	57,800	65,360
Takeoff[a]	83,000	83,000	83,000
Engine: Number, Rated Power per Engine, & Designation	(2) 10,200-lb st J71-A-13	(2) 10,200-lb st J71-A-13	(2) 10,200-lb st J71-A-13
Takeoff Ground Run (ft)			
At Sea Level[b]	6,750	6,750	6,750
Over 50-ft Obstacle[b]	9,350	9,350	9,350
Rate of Climb (fpm)	3,260	3,260	3,180
Combat Rate of Climb (fpm) at Sea Level	4,840	5,000	4,320
Service Ceiling (ft) at Combat Weight (100 fpm Rate of Climb to Altitude)	40,900	41,500	37,700
Combat Ceiling (ft) (500 fpm Rate of Climb to Altitude)	38,900	39,400	35,500
Average Cruise Speed (kn)	456	456	436
Maximum Speed at Optimum Altitude (kn/ft)	548/6,000	548/6,000	533/8,000
Basic Speed at Altitude (kn/ft)	496/36,089	498/36,089	477/35,000
Combat Radius (nm)	805	794	947
Total Mission Time (hr)	3.57	3.49	4.38
Armament	2 20-mm M-24A-1	2 20-mm M-24A-1	2 20-mm M-24A-1
Crew	3[c]	3[d]	7[e]
Maximum Bombload (lb)	4,084 (photoflash bombs & photoflash cartridges)	15,000 (E-53s, T-36s T-54E2s T-55E5 bombs)	Not Applicable

Abbreviations		
fpm	=	feet per minute
kn	=	knots
nm	=	nautical miles
st	=	static thrust

[a] Limited by gear strength.
[b] Using maximum takeoff power.
[c] Pilot, photo-navigator, and gunner.
[d] Pilot, bombardier-navigator, and gunner.
[e] Pilot, navigator, gunner, and 4 electronic countermeasures operators

Basic Mission Note

All basic mission's performance data based on military-rated power, except as otherwise indicated.

Combat Formula: Radius and Electronic Countermeasures Basic Missions
RB-66B and B-66B—Warmed up, took off and climbed on course to optimum cruise altitude at military power. Cruised out at maximum-range speeds increasing altitude with decreasing airplane weight to a point 15 minutes from target. Dropped external fuel tanks when empty. Ran-in to target at normal power, dropped bombload, conducted 2-minute evasive action and 8-minute escape to normal power. Climb to cruise altitude was conducted during the 8-minute escape operation. Cruised back to base at maximum-range speeds, increasing altitude with decreasing airplane weight. Range-free allowances included 5-minute normal-power fuel consumption for starting engines and take-off, 2-minute normal-power fuel consumption at combat altitude for evasive action, and 30 minutes of maximum-endurance fuel consumption at sea level plus 5 percent of initial fuel load for landing reserve

Formula: Ferry Mission
RB-66B and B-66B—Warmed up, took off and climbed on course to optimum cruise altitude at maximum power (military power in the B-66's case). Cruised out at maximum-range speeds increasing altitude with decreasing airplane weight until all usable fuel was consumed. External tanks were dropped when empty. Range-free allowances included 5-minute normal-power fuel consumption for starting engines and take-off and 30 minutes of maximum-endurance fuel consumption at sea level, plus 5 percent of initial fuel load for landing reserve.

Combat Formula: Radius and Electronic Countermeasures Basic Missions
RB-66C—Warmed up, took off, and climbed on course to optimum cruise altitude at military power. Cruised out to turn-around and cruised back at maximum-range speeds, increasing cruise altitude as airplane weight decreased. Dropped external tanks when empty. Range-free allowances included 5-minute normal-power fuel consumption for starting engines and take-off, and 30 minutes of maximum-fuel consumption at sea level, plus 5 percent of initial fuel load for holding and landing reserve.

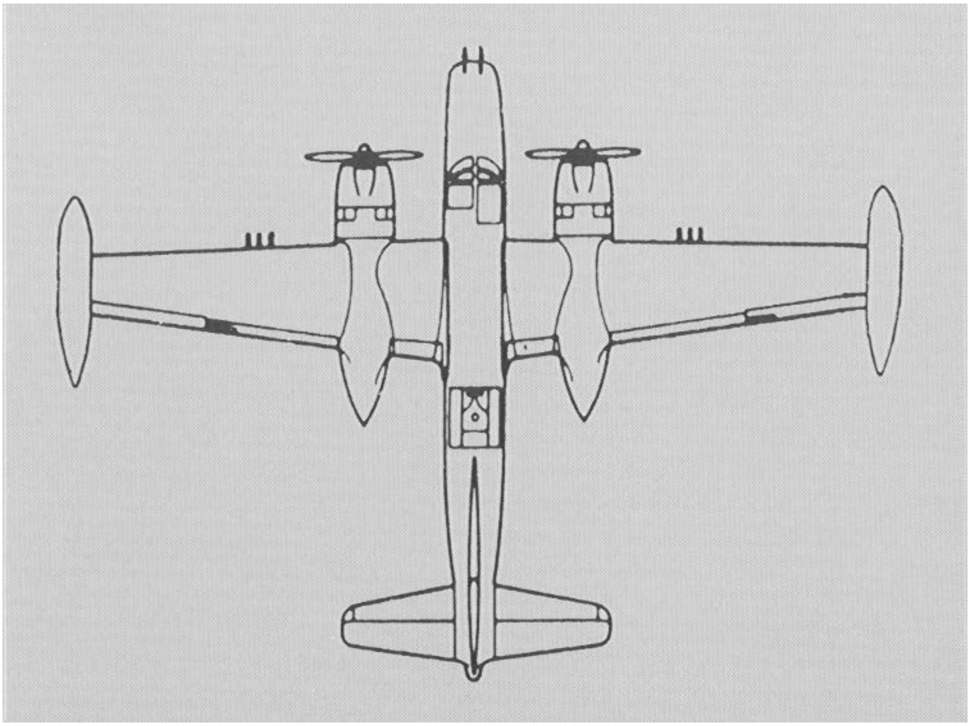
Formula: Range Mission

Warmed up, took off, and climbed on course to optimum cruise altitude at military power. Cruised at maximum-range speeds, increasing cruise altitude as airplane weight decreased, until all usable fuel less reserve was consumed. Dropped external tanks when empty. Range-free allowances included 5-minute normal-power fuel consumption for starting engines and take-off, and 30 minutes of maximum-endurance fuel consumption at sea level plus 5 percent of initial fuel load for holding and landing reserve.

Appendices

Appendix I

World War II Bombers in the Postwar Period



Appendix I
World War II Bombers in the Postwar Period

In 1945, the Army Air Forces had a fair selection of bombers in its operational inventory. But after World War II came to a close, only a few types were retained. Included were the Boeing B–17 Flying Fortress, the Consolidated B–24 Liberator, the Douglas A–24 dive bomber, the North American B–25 light bomber, the Douglas A–26 Invader, and the Superfortress—Boeing's new B–29.

Retention, however, did not necessarily entail significant post-war activity, be it in an aircraft's original configuration or any other mode. The handful of famed B–17s flown by the Strategic Air Command, when it was formed in 1946, were only used for reconnaissance, and no longer appeared on the command's rolls after 1949. The few B–24s, converted to train B–29 gunners, saw little service after the end of the war. Some of the Douglas A–24 dive bombers, redesignated F–24s in 1948 when the attack designation was officially dropped, remained active until 1950. Yet, their sole purpose was to test dive-bombing tactics for fighter-bombers. Similarly, after 1945 hundreds of B–25s served merely as trainers or staff transports, most of them having left the Air Force inventory by late 1959. The Douglas A–26 (redesignated as the B–26 in 1948) and Boeing B–29 fell in a different category. Both returned to combat. The B–29, in addition, briefly served as an instrument of deterrence—a post–World War II role of major importance.

B–26 Invader
Douglas Airplane Company

Navy Equivalent: JD–1

Basic Development — November 1940

Development of the B–26 Invader, initially known as the A–26, originated in November 1940, when the Army Air Corps's Experimental Engineering Section at Wright Field, Ohio, gave first priority to the Douglas Airplane Company for designing and developing a new plane. But, as evidenced by official requirements, the so-called new design drew a great deal from the A–20 Havoc.[1] The A–20 was a Douglas production, developed in 1937 from Model A–7: a 1936 original design for a high-performance attack bomber.

Initial Requirements — 1940

Official Army requirements, as spelled out by the Air Corps, called for a new plane that would be faster and structurally stronger than the A–20. Additional defensive armament over the A–20 and shorter takeoff and landing distances, were also part of the requirements. The Air Corps wanted the new plane eventually to replace the A–20, the Martin B–26 Marauder, and the North American B–25 Mitchell.

Contractor Proposal — 1941

In early 1941, Douglas proposed to manufacture 2 XA–26s, one a night-fighter adaptation of the other, and to schedule such a thorough series

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[1] The A–20 was put into production for foreign air forces in 1938 and became the most-produced of all the "attack" aircraft procured by the United States Army Air Corps. The A–20 was the first type of aircraft flown by American crews in the European theater during World War II.

of wind tunnel tests of the experimental planes that mass production could follow almost immediately. Mockup inspections would take place during the spring.

Contractual Arrangement 1941

The Chief of the Army's Materiel Division did not endorse the developmental contract, submitted in March 1941, because overall costs seemed unreasonable. At Douglas's request, the contract was rewritten to cover costs, plus a fixed fee. Finally signed on 2 June 1941, the revised contract (W535 ac-17946) covered 1 XA-26 and 1 XA-26A (the XA-26's night fighter version) at an estimated price of $2.08 million. Excluded from this sum was Douglas's fixed fee, which was set at $125,000. Soon afterwards, a change order provided for an additional experimental plane. Designated the XA-26B, this third configuration would incorporate a 75-millimeter cannon.

Mockup Inspections April 1941

As planned by Douglas, inspections of the XA-26 mockups were held in April 1941. Representatives of the Wright Field Production Engineering Section were particularly impressed by the apparent versatility of the future plane.

Production Decision 31 October 1941

The decision to go ahead with mass production of the A-26 became official on 31 October 1941, when Contract V535 ac-21393 was approved. Even though none of the experimental planes had been flown, the production contract covered 500 A-26s for a total cost of $78.2 million.

First Flight (XA-26) 10 July 1942

The first of the 3 XA-26s, ordered in the summer of 1941, was not initially flown until 10 July 1942. The other 2 experimental planes were flown on the heels of the first one.

Program Refinement — August 1942

Testing of the 3 XA-26s, as well as the experience already gained from combat in Europe and the Pacific area, prompted the Army Air Forces to decide that the 500 aircraft, covered by the production contract of June 1941, would be patterned on the third experimental plane: the XB-26B ground attack configuration that featured a 75-mm cannon nose, primarily intended to destroy tanks. In short, a heretofore uncertain Army Air Forces gave priority to ground attack over the multi-purpose light bomber requirements of 1940. Yet, the aircraft's versatility was not overlooked. Two hundred additional noses, each with six .50-caliber guns, would also be procured. Each of the latter noses could be installed in about 24 hours by field personnel.

Production Delay — 1943

Delay of the XA-26's first flight clearly indicated that, at best, mass production would not begin before July 1943, a significant slippage from the original time estimate. Lack of tooling was a primary factor, but shortages of engineers were equally damaging. Hence, the Wright Field Production Division directed Douglas to transfer at least two-thirds of the personnel listed on the C-74[2] project to the A-26. Also, no engineers were to be utilized for the improvement of crew comfort, or any other endeavors, unless specifically authorized by Wright Field. Finally, no other armament studies were to be made until the A-26 production's stage was more advanced. In January 1943, despite these stringent directives, Douglas informed the Army Air Forces that the new production schedule would not be met. The contractor indicated that October appeared to be a more likely date for production to begin.

Additional Procurement — 17 March 1943

A second production contract, W535 ac-34433, covering the procurement of 500 additional A-26s was approved on 17 March 1943. Total cost was $109.1 million. Included in this total was the purchase of 167 bombardier-observer nose sections that could also be quickly substituted for

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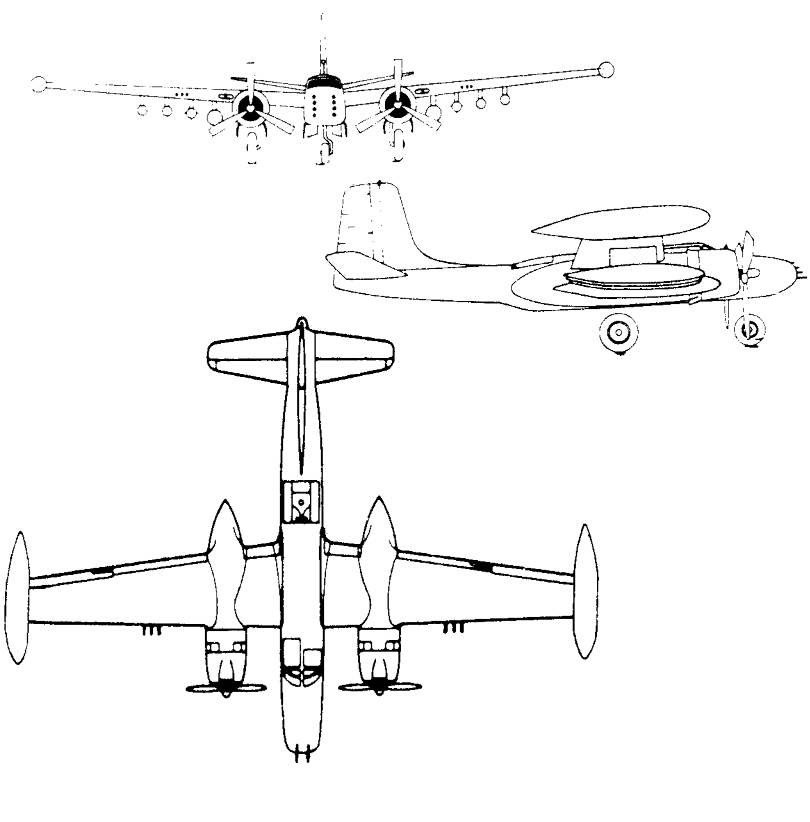
[2] The Army Air Forces recognized that it needed a long-range heavy transport aircraft during the early days of World War II. However, the first C-74 (Model 415A, a development of the Douglas DC-4) was not delivered before October 1945. Hence, 36 of the 50 C-74s on order were canceled.

The B-26, originally developed as an attack bomber during World War II, served in both the Korean War and the Southeast Asian conflict.



the A-26's 75-millimeter cannon nose. While the first 500 A-26Bs would come from the Douglas Long Beach plant in California, the new order was to be manufactured in Tulsa, Oklahoma. Obviously, time was important.

New Production Slippages 1943-1944

Although the Army Air Forces took delivery of a few A-26Bs in the fall of 1943, production again slipped. In early 1944, production was practically at a standstill, a situation which did not satisfy Gen. Henry H. Arnold, Commanding General of the Army Air Forces. Various excuses were offered, such as the shortage of machinery for making wing spars. Another valid reason was the number of modification requests, which was clearly excessive.

In March 1944, when only 21 A-26s had been delivered, General Arnold bluntly expressed his increasing dissatisfaction. "One thing is sure," said General Arnold, "I want the A-26s for use in this war and not the next war." Maj. Gen. Oliver P. Echols, Assistant Chief of Air Staff for Materiel, Maintenance, and Distribution, blamed the continuing delays on Douglas's apparent lack of interest or "little desire to manufacture the plane," and explained that the Materiel Command all along had urged the contractor to place orders for tools and to find qualified subcontractors. In defense of Douglas, the Western Procurement District, Los Angeles, California, stressed that the A-26 wing was entirely different from that of any other airplane; that delivery schedules were set before design and tooling problems were solved; and that there had been on occasions as many as 35 change orders a day on the A-26.

The divergence of opinion did not deter General Arnold. He insisted that something drastic had to be done to ensure that, as initially intended, B-25s, B-26s, and A-20s would be replaced by A-26s. As a first step, he placed additional A-26 orders.

New Production Orders 29 March 1944

Existing production problems were not allowed to affect the programmed procurement of additional A-26s. On 29 March 1944, the Under Secretary of War approved 2 supplemental agreements to the production contracts already in force. The extra A-26s, 2,700 of them, were expected to cost about $300 million.

Special Features

The A-26 had a 70-foot wing span, compared to the 61-foot span of the

30-percent-lighter A-20. Greater care had been applied to simplify the manufacturing and maintenance of the A-26 structure. Moreover, the fuselage of the all-metal, semi-monocoque A-26 allowed the 3 crewmen to exchange positions, an advantage the A-20 did not offer.

A most unusual feature of the A-26 was the aluminum alloy monocoque engine mount, which was a combination of structure and cowling, thereby reducing weight and easing engine installation. Another special feature was the Douglas-devised slotted wing flap, which had a lower pitching movement for a given lift coefficient than the Fowler flap. Finally, the engines were cooled with a new type of high entrance velocity cowling.[3] This cowl induced less aerodynamic resistance and lowered the temperatures of the engines.

Unexpected Setback — May 1944

Improvement of the A-26 production flow, recently achieved, did not last long. New complications arose in May 1944, when the A-26 wing failed during the static tests of one of the aircraft. Douglas was told to redesign the wing, if necessary, and was required to increase its strength by 10 percent.

Combat Testing — 1944

The A-26 entered combat testing in mid-1944, when 4 of the aircraft assigned to the Fifth Air Force began operating in the Southwest Pacific. Lt. Gen. George C. Kenney, Commanding General of the Far East Air Forces, grounded the planes after less than 175 hours of total flying time and stated shortly afterwards, "We do not want the A-26 under any circumstances as a replacement for anything." Ironically, about 4 years before, as a colonel in charge of the Wright Field Production Division and a strong proponent of attack aviation, Kenney had strongly urged the aircraft's development. General Kenney's statement and his mid-1944 decision to ground the planes appeared justified. A-26 production had slipped badly; the B-25s and A-20s that the A-26s would replace had proven satisfactory; and the canopy of available A-26s was poorly designed. A new canopy was needed to improve visibility. Without it, pilots could not safely fly the formations required for low-level tactics. While the Wright Field Production Division agreed that the A-26 could not replace current types of light and medium

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[3] The new cowl had been developed by the National Advisory Committee for Aeronautics and the Douglas Airplane Company.

bombers, Maj. Gen. Hoyt S. Vandenberg, Commanding General of the Ninth Air Force, was much less critical than General Kenney. The few A-26s introduced in the European theater towards the end of the summer were performing well. Undoubtedly, the aircraft's marginal visibility needed attention. But new productions were seldom free of problems, and General Vandenberg thought the A-26 was a satisfactory replacement for the B-26s and A-20s in Europe.

Final Procurement 1944–1945

Regardless of the mixed reports generated by the performance of the early A-26 (A-26As or A-26Bs), the Army Air Forces' plans to re-equip all B-25, B-26, and A-20 units with A-26s were reaffirmed in November 1944. In December, 2 more contracts were approved, and in April 1945 both of the new agreements were supplemented, bringing to 4,000 the total of new A-26s ordered since mid-1944. However, the German surrender on 8 May 1945 prompted a re-evaluation of military requirements. Production which had been scheduled to increase to 400 A-26s per month was cut to 150. The procurement orders of 1944 and 1945 were canceled.

Modifications and Appraisals 1944–1945

Douglas adopted several long-standing suggestions by General Arnold: engineering personnel at Long Beach established closer liaison with the Tulsa plant; extra well-qualified personnel were placed in the 2 plants; and the number of stations in the production lines was raised. These production changes facilitated modifications of the aircraft, which were designed to improve its effectiveness. An all-purpose gun nose was devised and the faulty nose landing gear redesigned. A-26s (redesignated as A-26Cs) that came off the production lines after January 1945 featured an enlarged, raised canopy which provided increased visibility.

The Ninth Bombardment Division was first in pointing out that once pilots were familiar with the A-26, they liked it better than any other plane they had flown. Even General Kenney eventually agreed that improved A-26s—particularly the A-26 with the 8-gun nose—were proving to be highly satisfactory replacements for the A-20s and B-25s. Deficiencies such as canopy frosting, faulty brakes, and the like were still being corrected. However, substantial progress was achieved swiftly.

End of Production 1945

The A-26 production was completed in 1945, but the last aircraft was delivered in early 1946.

Total A-26s Accepted 2,451

The Army Air Forces accepted a grand total of 2,451 A-26s. More than 4,000 A-26s, ordered before the end of World War II, were canceled. The first 9 of the 2,451 produced by Douglas were built in El Segundo, California. The remainder, consisting of A-26Bs and A-26Cs, was manufactured in Long Beach and Tulsa. The Tulsa plant produced 1,086 of the 1,091 A-26Cs.

Flyaway Cost Per Production Aircraft $242,595

Airframe, $143,747; engines (installed), $47,302; propeller, $14,583; electronics, $11,045; ordnance, $4,740; armament (and others), $21,178.[4]

Subsequent Model Series None

The A-26C turned out to be the last A-26 model and was practically identical to the A-26B, except for its Plexiglass "bombardier" nose, which permitted more accurate bombing from medium levels. Initially delivered in 1945, the A-26C joined the A-26B in combat service during the last stages of the war in the Pacific.

The A-26D, a development of the A-26B, was designed with more engine power and more guns. But the 350 A-26Ds, ordered in April 1945, were included in the mass cancellation that followed the end of hostilities in the European theater.

Redesignation June 1948

In June 1948, after the Martin B-26 Marauder was withdrawn from service, the Douglas A-26 dropped its prefix ("A" for attack) and became the B-26, a designation more representative of its actual role as a standard light bomber for the new United States Air Force and the Tactical Air Command in particular.[5]

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[4] All modification costs included. No cost breakdown was available. The figure applied to the A-, B-, and C-models alike, being most likely an average of the total cost and the overall number of aircraft.

[5] The Air Force gained its independence in September 1947; the Tactical Air Command had been created in March 1946 from the wartime Ninth and Twelfth Air Forces.

New War Commitments 1950–1953

The outbreak of the Korean conflict on 25 June 1950 catapulted the Douglas B–26 back into combat. Initial targets, selected to prevent reinforcement of the enemy forces, included North Korean troop concentrations, tanks, guns, supply elements, railway yards and bridges south of the 38th parallel. Immediate results were disappointing because bad weather and darkness curtailed the B–26's effectiveness. Engine failures and various mechanical deficiencies were additional handicaps. Moreover, as the war continued, other problems became obvious.

The World War II B–26 was limited in radius of fire and its speed could no longer cope with the air and ground fire of the enemy's modern equipment. The B–26 had no electronic countermeasures capability and could not carry many types of new armament and control and guidance systems.

Almost from the very beginning of hostilities, the Far East Air Forces gained air superiority against an enemy offering little or no daylight air opposition to strategic or tactical operations. But the night hours presented a different situation. Commanders were forced to utilize a part of their available day force for night operations, and the 3d Bombardment Wing's B–26s, more readily usable for night duty, acquired new importance.

Refurbished B–26s sustained significant losses during the war as their tasks increased. Yet, despite their limitations, the obsolete B–26s compiled a distinguished combat record. The first combat strike into North Korea was flown in 1950 by a B–26 crew. On the evening of 26 July 1953, 1 day before the Korean armistice agreement was signed, a B–26 dropped the last Air Force bombs of the Korean conflict in a ground-radar-directed close support mission.

Special Modifications 1952–1954

The B–26's ineffectiveness in Korea, especially during night attacks directed by radar, prompted special modifications. In 1952, the Air Staff decided that several B–26s of the Tactical Air Command would be fitted with more sophisticated electronic equipment. In 1953, some B–26s, already brought up to the reconnaissance configuration, were given additional components to perform electronic reconnaissance and weather reconnaissance missions. Nevertheless, the usefulness of the outmoded B–26 was declining. Too many configurations—16 different ones in the United States, and about 14 in the Far East and Europe—had created supply and maintenance problems of terrific proportions. In mid-1953 the Air Staff approved a last modification to attempt standardizing most B–26s into a few basic configurations.

Phaseout 1954–1958

With the advent of the Martin B-57, B-26s began leaving the Air Force's active inventory in late 1954. The last of the B-26s were withdrawn from service in Air Force Reserve and Air National Guard units in 1958.

Reactivation 1961

President John F. Kennedy's policy that the major task of U.S. advisors in Southeast Asia was to prepare the Republic of Vietnam Armed Forces for combat raised the tempo of training and resulted in the delivery of additional equipment to the South Vietnamese. Fixed-wing aircraft were in short supply, so B-26s were taken out of storage and modified for special combat missions in Southeast Asia.

Return to Combat 1961–1969

Reactivated B-26s began reaching South Vietnam in the fall of 1961. Once in the theater, they accomplished a variety of tasks ranging from standard bombing operations and close air support attacks to visual and photo reconnaissance missions. In mid-1962, the B-26's role in the conflict was further expanded. Several of the aircraft, already equipped for reconnaissance, received additional modifications in order to perform night photo operations and some intelligence gathering duties.

Specially modified for service in Vietnam, the B-26K featured permanent wing tip fuel tanks and various bomb and rocket pods.

Keeping the weary B/RB–26s flying was a challenge. Despite changes and improvements, the aircraft actually belonged to a type that had been declared obsolete during the Korean War, 10 years earlier. The combination of old age, hard usage, and the operating conditions of Southeast Asia made maintenance of the B–26 force increasingly difficult. The aircraft were becoming more vulnerable to enemy ground fire, and most B/RB–26s were subject to flight restrictions to avoid undue wing stress. Just the same, losses occurred that were directly attributable to structural fatigue. In August 1963, a B–26 crashed after 1 of its wings broke off. Then, a B–26 wing failed during a combat flight in February 1964. All B/RB–26s were immediately grounded and withdrawn from Southeast Asia soon afterwards. Yet, this action did not end the aircraft's war involvement.

Forty B–26s returned to the war zone in mid-1966 as B–26Ks. The modifications for the K-model, accomplished by the On-Mark Engineering Company, Van Nuys, California, were extensive. The $16 million On-Mark contract, initiated in 1962, involved much more than a facelifting of the old aircraft—nearly a complete transformation. The B–26K differed from the basic aircraft in that both turrets had been removed; R–2800–52W engines replaced the B–26's R–2800–79s; the wings had been reinforced by the addition of steel straps both on the top and bottom of the spars; the propellers, wheels, brakes, and rudder had been changed; permanent wing tip tanks had been added; instrument panel and electronics were new; 8 wing pylons had been included; and a myriad of minor changes incorporated.

In short, the B–26K was a tactical bomber for special environments, mounted with rocket pods, guns pods, or bomblet dispensers, and capable of being readily fitted with photographic reconnaissance components and other sensors. The B–26K was redesignated A–26A soon after it reached the war theater.[6] The rejuvenated aircraft promptly proved to be an effective hunter and destroyer of trucks and other vehicles, its loitering capability enabling it to locate and attack an enemy often concealed by jungle or weather. Most A–26As stayed in Southeast Asia for nearly 3 years, the last combat mission being flown in November 1969.

Final Phaseout 1970–1972

In 1970, regardless of designations, none of the old B–26s remained in the Air Force's active inventory; and none remained with the Air National Guard after 1972.

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[6] The attack category, dropped some 20 years earlier, was re-endorsed in the early sixties, when some aircraft were specifically earmarked for the attack role during limited war and counterinsurgency operations.

TECHNICAL AND BASIC MISSION PERFORMANCE DATA

B-26 AIRCRAFT

Manufacturer (Airframe)	Douglas Aircraft Co., El Segundo, Long Beach, Calif., and Tulsa, Okla.
Manufacturer (Engines)	The Pratt and Whitney Aircraft Div. of United Aircraft Corp., East Hartford, Conn.
Nomenclature	Light Bomber
Popular Name	Invader

	B-26B	B-26C	B-26K[a]
Length/Span (ft)	50.8/70.0	51.3/70.0	52.1/71.5
Wing Area (sq ft)	540	540	540
Weights (lb)			
Empty	22,362 (actual)	22,690 (estimate)	25,130 (actual)
Combat	31,775	29,920	30,809
Takeoff	41,811	39,416	37,000
Engine: Number, Rated Power per Engine, & Designation	(2) 2,000-hp R-2800-79	(2) 2,000-hp R-2800-79	2 2,500-hp R-2800-52W
Takeoff Ground Run (ft)			
At Sea Level	3,900	3,390	4,075
Over 50-ft Obstacle	4,820	4,180	4,800
Rate of Climb at Sea Level	1,060	1,220	1,380
Combat Rate of Climb (fpm) at Sea Level	2,515	2,745	2,050
Service Ceiling at Combat Weight (100 fpm Rate of Climb to Altitude)	19,200	20,450	28,600
Combat Ceiling (500 fpm Rate of Climb to Altitude)	21,800	23,100	24,400
Average Cruise Speed (kn)	200	196	147
Max Speed at Optimum Altitude (kn/ft)	322/10,000	323/10,000	281/15,000
Combat Radius (nm)	839	775	606
Combat Target Altitude (ft)	Sea Level	Sea Level	Sea Level
Total Mission Time (hr)	8:8	8:23	8:48
Crew	3[b]	3[c]	[d]
Armament	16 .50-cal guns & 14 5-in HVAR	12 .50-cal guns & 14 5-in HVAR	8[e] .50-cal M3 guns & 18 rockets (LAU-3A, -32A/A, -59A)
Maximum Bombload (lb)	6,000	6,000	6,000 (various types, M1A2, MK-82, BLU-10A/B, -27B, CBU-14A, -22A, -25A, etc.)

Abbreviations		
fpm	=	feet per minute
hp	=	horsepower

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[a] The B-26K, a modified B-26B or B-26C, was redesignated A-26A in 1968. The aircraft was used primarily for special air warfare and reconnaissance. In the latter role, the B-26K/A-26A carried the F-492 camera, including a split-vertical F-477, a panoramic KA-56, and a K-38A reconnaissance camera.

[b] Pilot-radio-operator, gun-loader-navigator, and gunner.

[c] Pilot-radio-operator, bombardier-navigator, and gunner.

[d] The normal crew included pilot and navigator or flight mechanic. For reconnaissance, the aircraft carried a pilot, navigator, and photo systems operator.

[e] Some of the aircraft had 14 guns: 8 in the nose and 6 in the wing leading edge.

B–29 Superfortress
Boeing Airplane Company

Manufacturer's Model 345

Basic Development 1937

The B–29's development stemmed from the Boeing XB–15, a long-range bomber first flown on 15 October 1937,[7] and from a March 1938 design study of a pressurized version of the B–17 with a tricycle undercarriage. Since the Army had little money to purchase the existing B–17, Boeing developed the new pressurized model on its own. This was Model 334A, the B–29's direct ancestor. A mockup of Model 334A, also built at Boeing's expense, was completed in December 1939.

Initial Requirements 1938–1939

By September 1938, Nazi Germany had incorporated Austria into the Third Reich and seized part of Czechoslovakia. President Franklin D. Roosevelt therefore ordered a survey of the manufacturing capacity of the United States aircraft industry. According to Maj. Gen. Henry H. Arnold, then acting head of the Army Air Corps, the President believed that an air force was "the only thing that Hitler understands" and was determined to build up America's air power so it could defend the nation and the Western Hemisphere against any aggressors. On 4 January 1939 (still prior to the outbreak of World War II), President Roosevelt asked the Congress for $300 million to buy several types of military aircraft. On 3 April, Congress authorized the Army to purchase 3,000 new aircraft and raised the Air Corps authorized ceiling to 5,500. The Air Corps used some of the appropriated funds to finance subsequent work on the B–29. Later in the year, it specified that the future B–29 would need a range of 4,000 miles.

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[7] Plans for the 5,000-mile range bomber were drawn up at Wright Field, Ohio, in 1933. In 1943, following modification, the single XB–15 was briefly used as an experimental transport.

Revised Requirements — February 1940

Boeing first thought it could satisfy the Army Air Corps's slightly altered requirements with design 341, an 85,000-pound bomber with the specified 4,000-mile range. But events had been moving swiftly. Although the United States would not enter World War II before 11 December 1941, the war in Europe was already raging, bringing to light new requirements. According to the revised requirements of February 1940, the new bomber visualized by the Army Air Corps would need armor plate, fuel tank sealing, and greater fire power than anticipated. Boeing consequently altered its plans. Competing with other contractors,[8] it answered the Army's revised requirements on 11 May 1940, with design 345, a still larger bomber with a gross weight between 100,000 and 120,000 pounds. Approved by a board of officers headed by Col. Oliver P. Echols, Chief of the Army Air Corps's Materiel Division, Model 345 became the experimental B-29—so designated on 24 August.

Initial Procurement — 1940

Procurement of the XB-29 started in June 1940, when some of the aviation money that had been appropriated by the Congress was used to pay for further study and wind tunnel tests of Model 345. Satisfactory results quickly assured the experimental project of more than $3.6 million to cover the construction of 2 XB-29s and 1 static test article. The development contract (W535 ac-15429) that necessarily ensued was signed on 6 September and amended on 14 December. The amendment provided extra funds to increase the number of flyable XB-29s to 3.

Production Decision — 1941

Although the experimental B-29 was yet to be flown, the Army in May 1941 notified Boeing of a forthcoming order for 14 service test B-29 prototypes and 250 B-29s that would be built in new government-owned facilities at the Boeing Wichita plant. Robert A. Lovett, Assistant Secretary of War for Air, confirmed the May decision in September, when the production contract was signed. In February 1942, the Army informed Boeing that the urgently needed B-29s would also be built in several new

[8] See B-50, pp 162-163.

plants by other manufacturers, namely the Bell Aircraft Corporation and the Glenn L. Martin Company. By September, 1,000 additional B-29s were under contract, and total production nearly reached 4,000.[9] The end of the war, in August 1945, prompted the cancellation of over 5,000 extra B-29s, still on order in September of the same year.

First Flight (XB-29) — 21 September 1942

The first experimental B-29 (Serial No. 41-002) made its initial flight on 21 September 1942; the second XB-29 (Serial No. 41-003), on 30 December.

Testing — 1942-1948

Boeing pilots test flew the first XB-29 for a total of more than 559 hours, accumulated in 417 flights. Army Air Forces (AAF) pilots completed more than 16 hours, but the number of flights they made was not recorded. On 18 December 1942, upon completion of its 19th flight, the first XB-29 encountered some difficulties. Two tires blew during landing, causing slight damage to the landing gear doors and to some wing flaps. A more significant incident ensued. On 28 December the Boeing test crew had to stop an altitude performance flight as soon as the plane reached 6,000 feet. Failure of the number 1 engine's reduction gear proved to be the problem. To correct this condition, Boeing replaced the nose section of all engines with noses having floating bushings which had passed 150-hour tests.

No accidents marred the first XB-29's operational life. The plane was sent to the 58th Bombardment Group, Wichita, Kansas, for accelerated testing and was loaned to Boeing in November 1943 to undergo the various flight tests required by the basic development contract. Testing ended in the spring of 1948, the first XB-29 being returned on 11 May.

The second XB-29 did not fare well, having flown only 7 hours in 10 flights when it was entirely destroyed on 18 February 1943. The plane was descending for an emergency landing at Boeing Field, Seattle, Washington,

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[9] Development, plant exchanges, and the many problems inherent to the production of a revolutionary bomber in the midst of a world war have been well documented. Informative accounts may be found in Peter M. Bowers, *Boeing Aircraft Since 1916* (Fallbrook, Calif., 1966), pp 275-293; Gordon Swanborough and Peter M. Bowers, *United States Aircraft Since 1908*, rev ed (London, 1971), pp 97-108; and *Wings* 3 (Oct 73), 10-39. For a more comprehensive treatment of the new bomber, see Carl Berger, *B-29: The Superfortress* (New York and Toronto, Canada, 1970). Mr. Berger was a former Senior Historian of the Office of Air Force History.

but crashed into the Frye Meat Packing Plant, located 3 miles from the end of the Boeing Field runway, killing the 11-man crew,[10] 19 employees of the packing plant, and a Seattle fireman, and seriously injuring 12 persons. The accident, caused by fire which spread throughout the plane, was not attributed to any mechanical failure. Leakage of gasoline and a backfire were the likely factors.

Special Features 1944

Construction of the B–29 was thoroughly conventional. As standardized by Boeing and the aircraft industry during the pre–World War II decade, the new bomber had an all-metal fuselage with fabric-covered control surfaces. On the other hand, and in spite of being a further development of the B–17, the B–29 was a radically different airplane, featuring significant aerodynamic innovations. Included were a high-aspect ratio wing mid-mounted on the circular-section fuselage; huge Fowler flaps that increased the wing area by 19 percent when extended,[11] and also raised the lift coeficient; a dual wheel retractable tricycle landing gear; flush riveting and butt jointing to reduce drag (the landing gear lowered contributed 50 percent of the resistance); and pressurized compartments for the usual crew of 10.

For defensive armament, the B–29 was equipped with non-retractable turrets mounting ten .50-caliber machine guns and one 20-millimeter cannon (which was dropped from later models). All turrets were remotely operated by a General Electric central fire-control system. The B–29 also had an extensive radio and radar equipment that included a liaison set, radio compass, marker beacon, glide path receiver, localizer receiver, IFF (identification friend or foe) transformer, emergency rescue transmitter, blind bombing radar (on many aircraft), radio countermeasures, and static dischargers.

Another special—and for a while greatly troublesome—feature of the B–29 was the brand new, but fire-prone, 18-cylinder Wright R–3350–23 engine. The 4 engines were mounted by 4-bladed Hamilton constant-speed, full-feathering propellers, 16 feet, 7 inches in diameter. In addition, instead of the traditional single unit, each engine made use of 2 turbo-superchargers.

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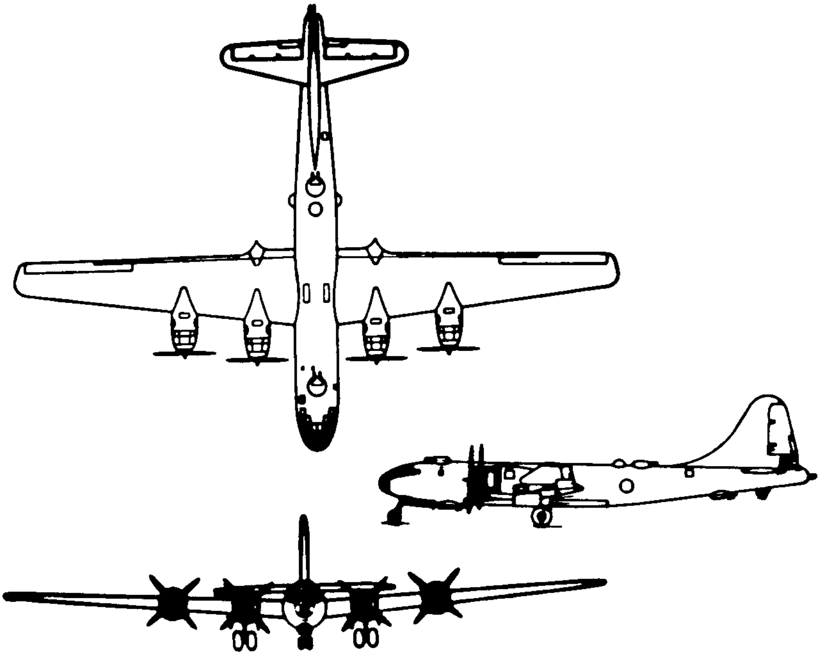
[10] Included in the crew casualties was Eddie Allen, America's most distinguished test pilot at the time.

[11] This arrangement reduced takeoff and landing distances to correspond to those of the B–17 and B–24 bombers. Nevertheless, the heavy B–29 generated extensive construction, as existing landing strips could not be used unless reinforced.

A Boeing B-29, equipped with 4 Wright engines.



Production Problems 1942–1944

The cumulative effect of the B-29's many new features caused more than the normal quota of "bugs" attendant to the production of a new plane. This was compounded by several factors. First, the B-29 was urgently needed. Secondly, troubles with the R-3350 engine hampered testing to the point that all flight operations were suspended until September 1943,[12] even though production models of the already greatly modified B-29 kept on rolling off the line. Also, the many subcontracts for equipment and sub-assemblies, generated by the rushed B-29 procurement, could not keep pace with the aircraft production. Many components, as they became available, did not fit the aircraft coming off the production line without having been modified to accommodate them.

Such a multitude of difficulties called for drastic action. The AAF's solution was to set up centers where the B-29s would be fitted with their indispensable components. But the AAF's lack of experience with the new bomber, as well as the shortage of ground equipment and tools, defeated the centers' initial efforts. The AAF then requested the assistance of Boeing and other contractors. Production personnel, mostly Boeing technicians from Wichita and Seattle, were brought to the centers to reorganize the AAF's modification programs and to help with the work. A first lot of 150 B-29s was successfully modified between 10 March and 15 April 1944, in a record period of time later referred to as the "Battle of Kansas."

War Commitments 1944–1945

B-29s of the Twentieth Air Force entered the war in June 1944 (less than 3 years after the experimental plane's first flight) with a "shakedown" raid on Bangkok, Thailand. The real air offensive against the Japanese Empire started in the same month, when 60 B-29s bombed steel mills and shipping facilities at Yowata in Japan proper. In the months that followed, XX Bomber Command B-29s from bases in China and India struck some of the enemy's most important targets in such major industrial cities as Nagasaki, Palembang, Singapore, Rangoon, Bangkok, and Tokyo. By November 1944, Tokyo was being raided regularly by the XXI Bomber Command, based at Isley Field, Saipan.

Early B-29 raids were hardly effective, their intensity being held down by inclement weather, logistical problems, and technical difficulties—espe-

[12] By mid-1943, 2,000 engineering changes had been made to the R-3350 engine, first tested in early 1937. Approximately 500 of these changes required tooling modifications.

cially engine troubles. Despite the progress in resolving these problems, overall results of the high-altitude precision attacks conducted by the new B–29s throughout 1944 were disappointing.[13] Aircraft losses, due to enemy defenses, high fuel consumption, or engine failures, remained excessive.

In January 1945, replacing Maj. Gen. Haywood S. Hansell, Jr., Maj. Gen. Curtis E. LeMay was put in charge of the XXI Bomber Command. The new Commanding General, under pressure from General Arnold and Brig. Gen. Lauris Norstad, Chief of Staff of the Twentieth, became convinced within a few months that low-altitude incendiary bombing was feasible and would be more productive, since the B–29s at low altitude would not have to carry so much fuel and, therefore, would be able to carry more bombs. Ensuing events demonstrated the validity of the low-level bombing tactics initiated by General LeMay. In a single raid on 9–10 March 1945, B–29s loaded with incendiary bombs destroyed one-fourth of Tokyo. By June, Japan's 6 most important industrial cities were in ruins, paving the way for a forthcoming planned invasion of the enemy territory—an endeavor which, even under the best circumstances, would cause a great many U.S. casualties. But the costly invasion of Japan proved unnecessary.

On 6 August 1945, the Enola Gay, a B–29 that had been secretly modified to carry a weapon also developed with the utmost secrecy, dropped the world's first atomic bomb on Hiroshima. Bock's Car, another modified B–29, dropped a second bomb on Nagasaki 3 days later. Being, at the time, the most terrifying weapon ever devised, the atomic bomb made its point. The use of only 2, Little Boy and Fat Man, as the bombs were named, in addition perhaps to the Soviet entry into the war, compelled the Japanese Emperor to accept the Postdam requirement for unconditional surrender, which was signed on 2 September 1945.

End of Production — 10 June 1946

The end of World War II prompted the cancellation of over 5,000 B–29s, still on order in September 1945. However, several B–29s well along in production were completed. For all practical purposes, production did not end before June 1946, the last B–29 being delivered on the 10th.

Total B–29s Accepted — 3,960

The AAF accepted a grand total of 3,960 B–29s: 3,943 B–29s, 3 XB–29s

[13] High winds over Japan adversely affected bombing; occasionally, operational activities were reduced to only a few days during an entire month.

(including the experimental plane which crashed before delivery), and 14 B–29 prototypes.[14] Actually, B–29s, B–29As, and B–29Bs made up the production total. The B–29 and B–29A were alike and barely differed from the B–29B. The B-model was about 2,000 pounds lighter than the A, had an extra 150 feet in service ceiling, and a slightly longer range.

Flyaway Cost per Production Aircraft $639,188

Airframe, $399,541; engines (installed), $98,657; propellers, $10,537; electronics, $34,738; ordnance, $3,977; armament (and others), $91,738.[15]

Subsequent Model Series None

The B–29C designation was intended for a later model, due to use improved R–3350 engines, but the project was canceled. Featuring many improvements, including new Pratt & Whitney R–4360 engines, the B–29D was redesignated before procurement.[16]

New Planning 1945–1946

The end of the war did not diminish the importance of the atomic-capable B–29. The 509th Composite Group, activated in December 1944 and to which Enola Gay and Bock's Car belonged, was brought back intact to the United States. The group was then assigned to the 58th Wing of the Fourth Air Force of the Continental Air Forces, which became the Strategic Air Command (SAC) in March 1946.[17] Just the same, immediate post-World War II efforts to create a full-scale atomic program were entangled in the confusion of demobilization, the transition from a 2- to a 3-service

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[14] The post-World War II records of the Army Air Forces and those of the prime contractor did not match, Boeing reporting that 3,974 B–29s were delivered: a discrepancy of 14 aircraft.

[15] Available records failed to reveal if the cost of modifying some B–29s to carry and deliver the first atomic bombs was prorated in the final figure.

[16] See B–50.

[17] Actually, the Headquarters, Continental Air Forces, was redesignated Headquarters, SAC. Some of the air forces under Continental Air Forces went to the Tactical Air Command and to the Air Defense Command.

military system, the question of atomic custody, and the belief that atomic bombs would not be extensively used in the future.

Despite the generally conservative attitude toward the atomic bomb in late 1945 and much of 1946, the AAF remained aware of the need to keep delivery capability up to date. A first step in that direction was the creation of a 3-squadron atomic striking force as part of the 58th Bombardment Wing. Other early plans were affected by various opinions. Shortly after the Nagasaki raid, Gen. Carl Spaatz, Commanding General of the U.S. Strategic Air Forces in the Pacific, pointed out that the atomic bomb had such a wide range of destruction that its use should primarily be intended against industrial areas. Smaller areas could be handled better, and at a much cheaper cost, by the normal type of bomb. In short, General Spaatz believed that wasting atomic bombs on small targets would be "like using an elephant gun on a rabbit." The words of General Spaatz, who was to become in September, 1947, the first Chief of Staff of the new United States Air Force, were not to be forgotten. In the meantime, however, they brought to mind another troublesome factor.

As early as 1945, it was obvious that any major war in the forseeable future would be against Russia. Using the atomic bomb as a weapon of psychological terror was one thing; the atomic strategic doctrine advocated by General Spaatz was another. Since the Soviet Union's industry was scattered in the Soviet Union's heartland, the general's strategy called for bombers capable of covering immense distances. Even from bases in Europe, the range would be very great. To further this strategy,[18] the AAF decided in January 1946 that atomic-capable B-29s would be equipped with new Pratt & Whitney R-435-57 engines. This change should improve reliability, while increasing range and speed.

Special Modifications 1946–1947

Modification of the original lot of B-29s, earmarked to carry the first atomic bombs, had been a slow and difficult task, even though most of the work centered on the aircraft bomb bay. At first, several of the designated aircraft were modified by hand. Changes in specifications were frequent, since scientists continued to improve their own designs for the new atomic bombs; the modification process grew more complex as new technological developments swiftly accrued.

Early in 1946, 22 of the 509th Composite Group's B-29s were at the Oklahoma City Air Materiel Depot for installation of the MX-344 radar

[18] See B-36, pp 11-14.

computer, more easily removable engine cowlings, and other miscellaneous items, which would further improve the performance of the newly, or soon to be, re-engined planes. By April 1947, 46 atomic-capable B–29s had received the latest special modifications, and work had begun on 19 others. However, only 24 of the 46 modified planes were operational, 20 being flown by the 509th and 4 by the testing section. Four of the other remodified B–29s had been destroyed, 1 was used as a mockup for further standardization of past modifications, and the remainder were being stripped of the equipment previously added to allow the aircraft to carry the original bombs.

Because of the advent of the B–50 (an improved B–29 known as the B–29D until December 1945), no additional modifications were programmed after May 1947. Yet, the atomic-capable B–29s would not immediately become obsolete. They were capable of carrying some of the latest atomic bombs and could be used for combat in an emergency. They undoubtedly could ferry atomic weapons from the United States to forward bases, as called for by the latest plans. In any case, obsolete or not, as growing international tensions were aggravated by the Korean conflict and the production of new atomic-capable aircraft slipped, 180 of the thousands of B–29s left from World War II had to be reactivated and modified for the atomic task.[19]

Overseas Deployments 1946–1952

While a handful of B–29s were earmarked for the atomic role, and various kinds of reconfigured B–29s became directly involved in the support of these special aircraft, a great many B–29s, left over from the war, remained the mainstay of the medium bombardment force until 1952.[20] There were good reasons for the aircraft's retention. The postwar period witnessed drastic budgetary restrictions; developing and producing any aircraft was a time-consuming task, and the impact of new technology was bound to lengthen this task.[21]

In 1946, SAC's only bomber was the B–29—148 of them. Despite the shortage, B–29 rotational tours of duty in Europe and the Far East were

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[19] See B–50, pp 173–174.

[20] The heavy B–29 was reclassified as a medium bomber on 17 September 1947. For details, see B–36, p. 21.

[21] As aircraft systems became increasingly more complex, their production time rose by several orders of magnitude. Thus, while it took 200,000 manhours to assemble the B–17, the B–29 and B–36 required approximately 3 million manhours each. With the advent of the jet-powered B–52, production time again rose dramatically, to more than 7 million manhours.

started in that year. By 1948, the SAC B-29 fleet had been increased to 486 aircraft, and the oversea rotation of B-29 units had been intensified. In late June, when the Berlin Blockade began, extra B-29s were immediately deployed to England and Germany. The rest of the SAC force was put on 24-hour alert.

New War Commitments 1950-1953

On 25 June 1950, when the North Korean armies crossed the 38th parallel, the 19th Bombardment Group, the only Far East bombardment unit available for the air counter-offensive was immediately moved from Guam to the more strategically favorable location of Okinawa. Reinforcement, obviously needed, was provided swiftly. On 3 July, Gen. Hoyt S. Vandenberg, USAF Chief of Staff, ordered the 22d and 92d Bomb Groups to deploy their B-29s to the Far East to carry out conventional bombing operations north of the 38th parallel. Once in the Far East, SAC's 22d and 92d Bomb Groups joined the 19th Bomb Group of the Far East Air Forces (FEAF) to form the FEAF Bomber Command (Provisional), which was organized on 8 July. The bomber command's first strike took place on 13 July, when 50 B-29s hit Wonsan, an important North Korean port. But additional B-29s were still needed, and SAC again quickly managed to comply.

By late September 1950, the strategic bombardment offensive was finished. The FEAF Bomber Command had destroyed all significant strategic targets and enemy airfields in North Korea, establishing in the process that the Strategic Air Command's mobility concept was valid and practicable. This was an important lesson of the Korean War. Another, of a controversial nature, was demonstration of the strategic bomber's versatility. Because the early ground situation was desperate, many B-29s were initially diverted from the strategic mission to direct support of the ground forces. Despite adverse weather conditions, the B-29s blasted successfully such tactical targets as trucks, tanks, troop bivouacs, supply dumps, and the like.

The Air Force met the immediate demand for additional bombers in Korea in large part by withdrawing B-29s from storage. While commercial contractors removed the planes and made them combat ready, Air Materiel Command depots overhauled engines and accessories. The command also set up a production line at the Sacramento Air Depot, California, to recondition B-29s returned from the Far East for necessary repairs.

Late in 1950, 2 bomb groups were allowed to return to the United States. Other SAC B-29s, plus 1 squadron of B-29s that had been converted for the reconnaissance role, remained in the Far East, under the operational control of the FEAF Bomber Command, until the fighting ended on 27 July

1953. Except for FEAF's own B-29s, which had been raised to wing level, the FEAF Bomber Command was composed entirely of SAC units and was commanded by SAC personnel. Of course, combat losses occurred.[22] Yet, they were relatively low when compared to the bomber command's achievements. Through the 3-year conflict, B-29s flew 21,328 effective combat sorties, including 1,995 reconnaissance sorties and 797 psychological warfare sorties. The B-29s dropped 167,000 tons of bombs on various targets, ranging from front-line enemy troop emplacements to airfields on the banks of the Yalu River. The 98th and 307th Bomb Wings, also elevated from group level, and the 91st Strategic Reconnaissance Squadron were included in the South Korean Presidential Unit Citation that was bestowed upon the FEAF Bomber Command (Provisional).

Immediate Phaseout 1954

The increasing availability of B-36s, B-47s, and B-50s, spelled the B-29's end. On 4 November 1954, SAC's last B-29 bomber, an A-model, which had been assigned to the 307th Bomb Wing, Kadena Air Base, Okinawa, was retired to the Air Force aircraft storage facility at Davis-Monthan AFB, Arizona.

Other Configurations KB-29M, KB-29P, RB-29, TB-29, VB-29, and WB-29[23]

KB-29M: In 1948, 92 B-29s were sent to the newly reopened Boeing Wichita Plant for conversion to hose-type tankers, subsequently known as KB-29Ms. This project was urgent, being directly associated with the build-up of the atomic forces. The bomber's serious range limitations had called for special arrangements. There was an extensive forward base network, encompassing airfields in Alaska, Canada, England, West Germany, Spain, North Africa, Okinawa, and Guam. But the use of overseas staging bases was a troublesome expedient.[24] A better solution was to

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[22] The B-29 was exceptionally vulnerable to the MiG-15, even at night.

[23] Other designations were applied or allocated to reconfigured or due to be reconfigured B-29s, but such designations were dropped, as the reconfigured aircraft (usually a single model) fulfilled their special purposes, or were not used because the projects for which they had been designed were canceled.

[24] See B-50, p 11 and p 15.

develop inflight refueling systems that would give to the SAC bombers the intercontinental striking range they still lacked.

The first such system was featured by the K–29M, which was fitted with British-developed hose refueling equipment. The British system involved trailing a hose from the tanker to the receiver and transferring fuel practically by means of gravity. The receiver aircraft (listed as B–29MR, in the B–29's case) also required modifications, but they were relatively minor. In contrast, the tanker modifications were extensive. Each bomb bay was fitted with a separate jettisonable tank holding approximately 2,300 gallons of fuel. These tanks were connected to the aircraft's normal fuel system so that fuel from it could also be transferred to the receiver bomber. The KB–29M's inflight refueling system required that the tanker and receiver fly in formation, with the tanker above and ahead trailing a cable referred to as the hauling line. The receiver trailed a line of its own from its refueling receptacle. Called the contact line, this line was so equipped that it could hook the tanker's trailing line and lock the two lines together. The receiver operator then caught the lines, separated them, secured them, pulled the tanker's refueling hose and put it into the receptacle of his bomber. The

The forward compartment of the B–29 housed the bombardier (front), pilot (left), and co-pilot (right).

whole procedure, obviously, was perilous from the start, and the KB-29Ms, after reaching the inventory in late 1948, were replaced within a few years.

KB-29P: The hose refueling system had many disadvantages, especially in the lengthy time required to make contact, the slow rate of fuel transfer, and the very limited airspeed imposed by the hoses. Boeing therefore soon developed on its own an aerodynamically controlled swivelling and telescoping arm, known as the "Flying Boom." Essentially, this system consisted of a telescopic pipe, which was lowered from the tanker, and connected to a socket in the receiver aircraft. The system was entirely controlled by an operator in the tanker, and the fuel transfer was made with the aid of a pump. B-29s so equipped were designated KB-29Ps. The first of 116 KB-29Ps reached SAC's 97th Air Refueling Squadron on 1 September 1950, the total contingent being delivered by the end of 1951. In spite of the increasing availability of the much faster KC-97,[25] SAC retained many of its KB-29Ps until 1957. The Tactical Air Command gave up its last KB-29s in the middle of that year.[26]

RB-29: Nearly 120 B-29s were converted to the reconnaissance configuration and redesignated as RB-29s. Some of these aircraft, known as F-13s during World War II, were first fitted with fairly primitive photographic equipment: 3 K-17Bs, 2 K-22s, and 1 K-18 camera. After 1948, when the RB-29 designation came into being, the converted bombers began acquiring more sophisticated components. The RB-29s were assigned to the 91st Strategic Reconnaissance Squadron, which like other SAC units played a crucial role during the Korean conflict. The RB-29s followed the phaseout pattern of the bombers from which they derived. The same reasons prompted their retirement.

TB-29: Some B-29s, fitted with additional trainee or instructor stations, recording equipment, and related types of apparatus, were used for training and identified as TB-29s.

VB-29: A few B-29s, after being internally refurbished, were used for the transportation of key personnel.

WB-29: Some B-29s were modified to carry meteorological equipment

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[25] Outfitted with an improved version of the flying boom and additional air-refuelable tanks, the 4-engine, propeller-driven KC-97 could fly fast enough to match the B-47's minimum speed. Manufactured by Boeing, the KC-97s began reaching SAC in July 1951.

[26] The urgent conversion of B-29s to the tanker configuration had been dictated by the initial deficiencies of the growing atomic forces. When more efficient, atomic-capable bombers and better tankers became available, the KB-29P's flying boom system was adapted to fighters and other bombers, which had their receptacle fitted in a variety of positions. This allowed other forces to make use of the KB-29Ps, when the allocation of improved tankers was still at a premium.

and used on weather-reconnaissance flights. Designated as WB-29s in1948, these aircraft were the last B-29s to phase out of the regular Air Force.

Final Phaseout 1959

Regardless of configuration, no B-29s appeared on any Air Force roll after 1959.

Milestones 1951

On 6 July 1951, despite its rudimentary equipment, a KB-29M refueled 4 RF-80 aircraft flying a reconnaissance mission over North Korea. On 14 July, a KB-29P, outfitted with the boom-type system, refueled 1 RB-45C on a combat mission over North Korea. These were the first air refueling operations conducted over enemy territory under combat conditions.

Items of Special Interest Mid-1944

Early engine problems delayed the B-29's entrance into World War II. The much-needed and initially few bombers were piloted by some of the WASPs (Women's Air Force Service Pilots),[27] themselves a new phenomenon of the war and restricted to non-combat operations.

The technological importance of the American-made B-29 was quickly confirmed. One of the bombers, after crash-landing in Soviet territory during World War II, was not returned, even though Russian authorities promptly returned the unharmed crew. The reason soon became obvious, as Russia developed her own version of the B-29, known as the TU-4. In 1951, foreign observers in Russia saw a derivative version of the TU-4 with turboprop engines.

[27] The title WASP was the designation for the women pilots of the Army Air Forces.

TECHNICAL AND BASIC MISSION PERFORMANCE DATA

B-29 AIRCRAFT

Manufacturer (Airframe)	Boeing Airplane Co., Seattle and Renton, Wash., plus Wichita, Kans.
Manufacturer (Engines)	The Wright Aeronautical Corp. (a division of the Curtiss-Wright Corp.), Wood-Ridge, N.J.
Nomenclature	Medium Bomber
Popular Name	Superfortress

	B-29
Length/Span (ft)	99.0/141.2
Wing Area (sq ft)	1,736
Weights (lb)	
Empty	71,500 (actual)
Combat	101,082
Takeoff	140,000
Engine: Number,	
Rated Power per Engine	(4) 2,200-hp
& Designation	R-3350-57 or -57A
Takeoff Ground Run (ft)	
At Sea Level	5,230
Over 50-ft Obstacle	7,825
Rate at Climb (fpm) at Sea Level	500
Combat Rate of Climb (fpm) at Sea Level	1,630
Service Ceiling at Combat Weight (100 fpm Rate of Climb to Altitude)	39,650
Combat Ceiling (500 fpm Rate of Climb to Altitude)	36,250
Average Cruise Speed (kn)	220
Max Speed at Optimum Altitude (kn/ft)	347/30,000
Combat Radius (nm)	1,717 (with max bombload)
Combat Target Altitude (ft)	30,000
Total Mission Time (hr)	15:35
Crew	11[a]
Armament	5 turrets (mounting 12 .50-cal guns)
Maximum Bombload (lb)	20,000

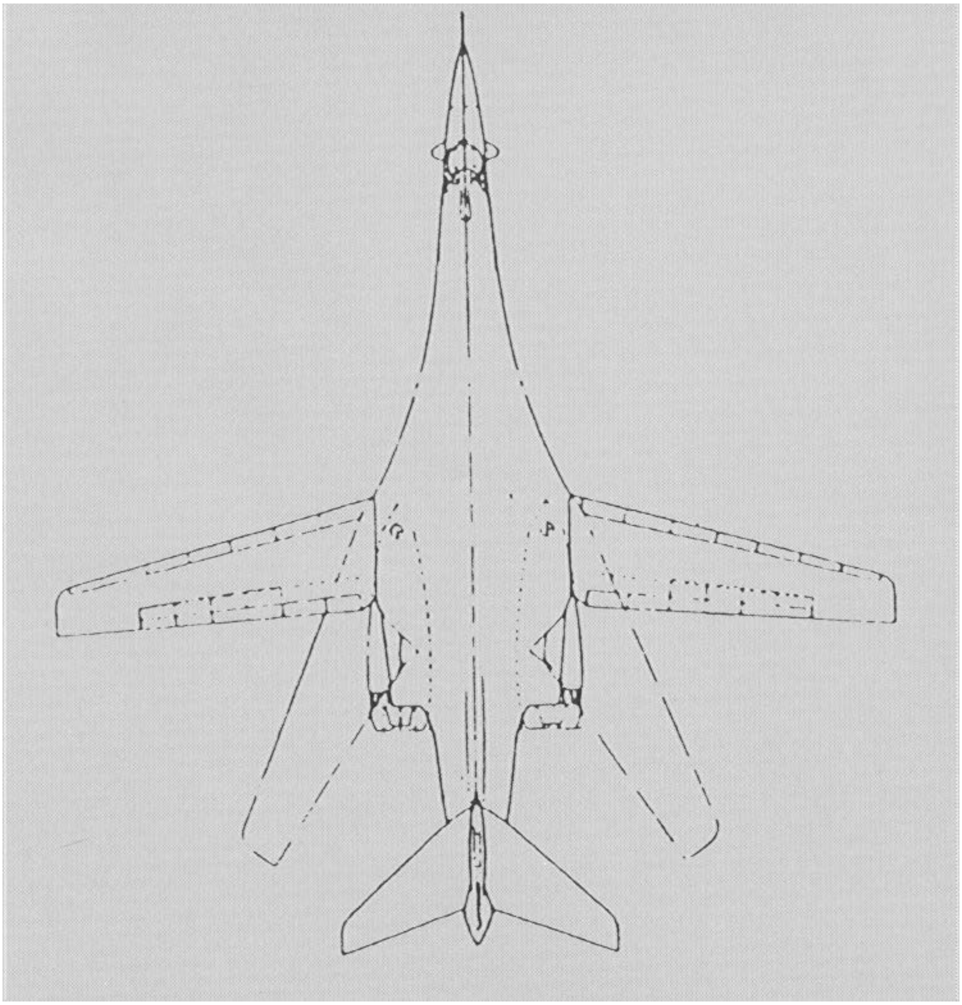
Abbreviations

cal	=	caliber	kn	=	knots
fpm	=	feet per minute	max	=	maximum
hp	=	horsepower	nm	=	nautical miles

[a]The crew of 11 were in 3 pressurized compartments linked by crawl-spaces. The standard crew had 5 officers: a pilot, co-pilot, flight engineer, bombardier, and navigator. These, plus the radio operator, normally worked in the forward compartment, while the one aft housed gunner-mechanics, and a radar operator. The tail gunner was alone in the smallest compartment.

Appendix II

Post-World War II Experimental and Prototype Bombers



XB-35
Northrop
Aircraft, Incorporated

Manufacturer's Model N-9M

Basic Development 1923

The origin of the B-35 may be traced as far back as 1923, when John K. Northrop, then an engineer with the Douglas Aircraft Company, became interested in the possibilities of a "flying wing" design. However, more than a decade would pass before the young engineer's efforts showed tangible results. In August 1939, John Northrop became President and Chief Engineer of Northrop Aircraft, Incorporated, a totally independent concern primarily interested in the manufacture of military aircraft. Less than a year later, the N-1M, as Northrop called his initial "flying wing," took to the air.[1] It was the world's first pure all-wing airplane, and high-ranking officials of the Army Air Corps were soon impressed by the flight characteristics of the spectacular research vehicle. The Army Air Forces (established in June 1941) applied the designation XB-35 to the N-1M's military variant, which was subsequently ordered.

Military Characteristics 1941

On 27 May 1941, the Army Air Forces (AAF) asked Northrop to provide studies of the flying wing as it related to requirements for a bomber with a range of 8,000 miles, a minimum cruising speed of 250 miles per

[1] The N-1M's first flight occurred on 3 July 1940. In 1945, following completion of its test program, Northrop sent the airplane to the Army Air Forces for display in the Wright-Patterson Museum, Dayton, Ohio. The Air Force eventually transferred the N-1M to the Smithsonian Institution, which stored it at Silver Hill, Maryland.

hour, a service ceiling of 40,000 feet, and a bombload of 10,000 pounds. Such characteristics were far less demanding than the preliminary ones of April 1941, which led to production of the Convair B-36.[2] The revised characteristics of August 1941, slightly more ambitious than the May characteristics, were again submitted to Northrop and other potential manufacturers of conventional, long-range bombers. Contrary to expectations, by year's end only 2 models were contemplated for production before the Boeing B-29: the Northrop XB-35 and the Convair XB-36. The first was extremely unconventional, aerodynamically; the second was unconventional, but strictly from the weight, propulsion, and size standpoint. Although the AAF deplored the lack of choice offered by its experimental heavy bombardment program, several years would go by before comparable bombers would appear on the drawing boards.[3]

Initial Procurement 1941

The Northrop proposal submitted to the AAF in September 1941 was immediately followed by contractual negotiations. In a departure from standard practices, the initial procurement of the flying wing was preceded by a purchase order for engineering data, model tests, and evaluation of reports on the N-1M that had been flight-tested since June 1940. Also included was the purchase of the first N-9M, a 1/3-scale flying mockup of the future B-35. The entire order, approved by Secretary of War Henry L. Stimson on 3 October 1941, was covered by Contract W535 ac-21341 which was signed on the 30th.[4]

Procurement of the first full-scale flying wing, endorsed by Maj. Gen. Henry H. Arnold, Chief of the AAF, on 9 September 1941, came under Contract W535 ac-21920 on 22 November. At the contractor's request, the contract, estimated at $2.9 million, was of the cost-plus-fixed-fee type because, as pointed out by Northrop Incorporated, development of the XB-35 was a large project, involving funds in excess of those available to the company for experimental purposes. In addition, Northrop anticipated that materiel and labor costs would rise significantly before November 1943, when the XB-35 was scheduled for delivery. Besides providing for the first XB-35, Contract W535 ac-21920 included 1 XB-35 mockup, engineering

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[2] See B-36, pp 5-7.

[3] See B-52, pp 205-211.

[4] Available records did not reveal the cost of Contract W535 ac-21341, an oversight which by the end of the costly flying wing program proved immaterial.

data, plus an option clause covering the purchase of 1 additional XB-35. This option was exercised on 2 January 1942. Northrop quoted a delivery date of April 1944 for the second XB-35, also known as the back-up article. Estimated extra costs were set at $1.5 million.

Additional Procurement 1942

Another cost-plus-fixed-fee contract (W535 ac-33920) was approved on 17 December 1942. It called for the construction and testing of 13 service test models of the XB-35, designated YB-35s. Counting spare parts and the contractor's fee, the contract's cost was expected to reach $22.7 million. The AAF's approval of this YB-35 prototype contract followed by a few months the purchase of 2 additional N-9Ms, a fourth and last N-9M being ordered in mid-1943.[5]

Special Features 1942

The huge XB-35's most noticeable features were its size and shape. Otherwise, the 4-engine aircraft was not so unusual. Its cantilever wings of aluminum-alloy were constructed in 1 piece, straight-tapered, and swept back. On the other hand, the XB-35 also featured some distinctive internal characteristics. It offered 8 spacious bomb bays, and the crew compartment and various systems bays were fully pressurized. In addition, the future B-35 would provide 6 beds and a small galley to allow 6 of the aircraft's 15 crewmen to rest during long missions.

First Flight (N-9M) 27 December 1942

As a military variant of the N-1M, the N-9M was similarly built and consisted primarily of a welded steel tube center section and an external covering of wood. As a research model of the XB-35, the 60-foot wing-span N-9M closely resembled the future full-size "flying wing." Two Menasco C654 engines aboard the N-9M, instead of the 4 Pratt & Whitney R-4360s earmarked for the XB-35, were the main difference between the 7,100-pound scaled-down model and the experimental bomber, originally planned. Actually, the N-9M was expected to allow Northrop to more accurately

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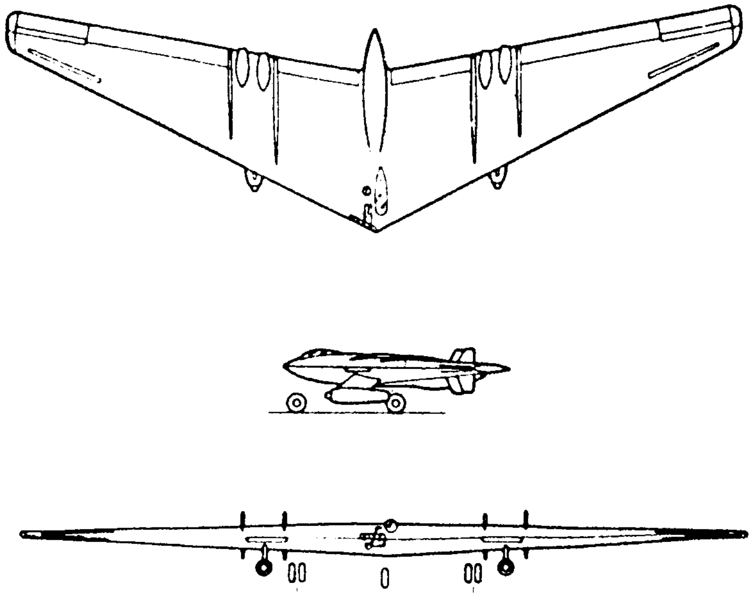
[5] Retained records did not itemize the costs of the additional N-9Ms. However, such costs were included in the XB-35 program's total amount.



The Northrop XB–35, with its 4 engines at the rear.

predict the flight characteristics of the upcoming XB-35, a purpose which presumably would also save money and time. Nevertheless, the N-9M's first flight on 27 December 1942 was about 3 months behind schedule. Nearly all of the N-9M's ensuing flight tests were shortened by mechanical failures of one kind or another, most of them involving the Menasco engines that also equipped the next 2 N-9s.

The initial N-9M crashed on its 45th flight, killing its Northrop test pilot. The crash on 19 May 1943, after the model had only accumulated some 22 hours of flying time, was closely followed by the second N-9M's first flight. During the maiden flight of the second model, on 24 June 1943, the small aircraft's cockpit canopy was lost shortly after takeoff, but a successful landing was made.[6] Meanwhile, other difficulties had begun to compound the AAF's many problems.

Preliminary Difficulties 1942–1943

The multitude of requirements generated by World War II complicated from the start the Army Air Forces' many tasks. While all sorts of weapons were urgently needed, shortages of material and manpower resources could not be immediately resolved. National priorities, regardless of their careful selection, hampered the timely progression of some aircraft programs and nearly stopped the development of crucial experimental projects. Two cases in point were the Convair B-36 and the Northrop B-35, the latter presenting the AAF with a peculiar situation. Northrop, located in Hawthorne, California, while sharing the industry's shortage of engineers, also lacked adequate production facilities. The Materiel Command's efforts to borrow engineers from other West Coast manufacturers to assist the young corporation had been totally unsuccessful, and the possibility of enlarging the Hawthorne plant was non-existent.

By the end of 1942, it seemed that Northrop's problem was solved as negotiations, instigated by the AAF, were being concluded between Northrop, Incorporated, and the Glenn L. Martin Company. In short, Northrop had indicated that it would be satisfied to fabricate only the experimental and prototype B-35s. The Martin production contract for 400

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[6] Slightly different N-9M's were still being tested late in 1945, even though a total of 150 flights had been accomplished. Flights of the remaining models averaged considerably less than 1 hour each. This time limit was shared by the N-9MB, the fourth N-9, bought to replace the lost N-9M and powered by 2 Franklin 0-540-5 air-cooled engines.

B-33s had been canceled on 25 November,[7] and this actually meant that the B-35 could be produced, in lieu of the deficient B-33, at Martin's spacious Baltimore plant in Maryland. This change would also allow Northrop and the AAF to benefit from Martin's engineering talent and experience in the design of large, long-range transport airplanes. But this optimistic outlook was to prove deceptive.

Other Problems 1943–1944

Hampered by mechanical failings, the N-9 flight test program prevented the acquisition of reliable flight data through 21 September 1943, when the N-9MB, last of the N-9s, initially flew. Engines excepted, the N-9MB included all latest design features of the XB-35, but the model's flight testing did not help the XB-35's cause. By the end of November, test results indicated that the XB-35's range would most likely be 1,600 miles shorter than anticipated and that the bomber's highest speed would be at least 24 miles per hour below previous estimates. Such disappointing prognostics were not overlooked. General Arnold[8] himself began to question the merits of the extensive B-35 production plans.

Production of 200 B-35s, as planned in November 1942, was formalized on 30 June 1943 by Contract W535 ac-24555, which called for delivery of the first "flying wing" by June 1945. But Martin had already begun to lose personnel to the draft before the contract was signed. In mid-1943, projected delivery rates were reduced by 50 percent, and Martin pointed out that changes requested by Northrop amplified the many risks shrouding the aircraft's manufacture. In August, Martin reiterated its concern for the shortage of engineers and the project's uncertainties, adding that perhaps further production expenditures should be postponed. By March 1944, the Baltimore plant still lacked tooling, and Martin had rescheduled delivery of the first B-35 to 1947. Not surprisingly, the AAF's headquarters canceled the Martin production contract on 24 May 1944. The decision, however, did not spell the end of the "flying wing." In November, the Air Technical Service Command's Engineering Division reported that the XB-35 project seemed worthwhile "even if the B-35 never becomes operational."

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[7] By that time, Martin knew that a production contract for 200 B-35s was forthcoming. Furthermore, the company had many other commitments. In fact, it had to refuse to make a study of the long-range, heavy bombardment airplane, as suggested by the AAF in October 1942.

[8] General Arnold had received his fourth star in March 1944.

Program Changes 1944-1945

In December 1944, some 6 months after the Martin production contract was nullified, modification requests began to alter the B-35 development contract. The AAF decided that Northrop would build the first 6 B-35 prototypes (YB-35s) on the XB-35's pattern, with certain exceptions affecting individual aircraft. Soon afterward, Northrop was authorized to build 2 of those 6 prototypes as all-jet models, a change so important that it actually marked the beginning of a new program.[9] In 1945, after 2 YB-35s had been added to the first YB-35 lot to replace the 2 earmarked for jet-conversion, the AAF told Northrop to manufacture the remaining 5 airplanes to more advanced specifications, a directive that automatically entailed the aircraft's redesignation as YB-35A.

In the meantime, Northrop, like Martin, had its share of problems. The poor showing of the N-9 and the impact of the war had not helped the experimental program. In 1941, Northrop believed the first XB-35 could be delivered in November 1943. But by May 1944, the best estimate for the XB-35's first flight was August 1945, another optimistic prediction that would not materialize.

First Flight (XB-35) 25 June 1946

The initial flight of the first XB-35, from Hawthorne to Muroc Army Airfield, California, took place at long last on 25 June 1946 and lasted 45 minutes. Two AAF test pilots, after maneuvering the first XB-35 during its initial and second flights, termed the experimental flying wing "satisfactory, trouble-free." Yet, once again, this encouraging appraisal was to prove wrong.

Grounding 1946-1948

Gear box malfunctions and propeller control difficulties prompted the XB-35's grounding on 11 September 1946, less than 3 months after the aircraft's first flight. Flying was not resumed until February 1948, after many modifications had taken place that affected the aircraft's engineering as well as the entire experimental program.

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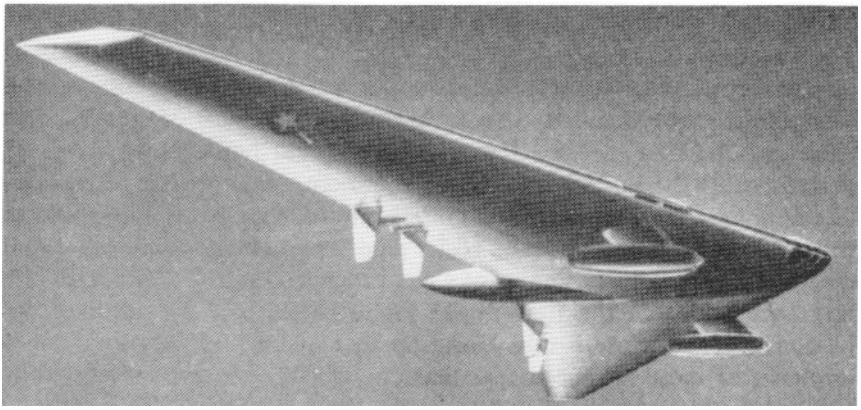
[9] See YB-49, this appendix, p 536.



The all-jet prototype YB-35A.

Testing 1946–1948

The first XB-35 underwent only about 24 hours of testing, all of which were accumulated in 19 contractor flights. The second XB-35, also covered by Contract W-535-ac-21920 of November 1941, fared even worse. First flown on 26 June 1947 (a slippage of 3 years), the plane was tested for approximately 12 hours. As in the first XB-35's case, Northrop pilots did the testing. Only 8 flights were accomplished.

Modifications 1947–1948

Since most of the serious troubles encountered during testing were attributed to the XB-35's dual-rotation propellers and gear boxes, significant modifications were undertaken. In February 1948, flights of the first XB-35 were resumed, this time with single-rotation propellers and simpler gear boxes installed. The new installation began to operate without exhibiting any particular mechanical difficulties, but test pilots immediately reported considerable vibration and reduced performance. Moreover, the modified XB-35's landing gear doors still failed to close after gear retraction, a malfunction that had plagued the 1947 tests.

Cost Overruns 1947–1948

The cost of the first XB-35 had initially leaped from an estimated $2.9 million to a substantial $14 million, and other financial setbacks were on the way. In February 1947, Northrop reported that the 2 all-jet prototypes

(YB-49s) and the first 6 YB-35s (built to XB-35 specifications) were either complete or nearing completion. However, the originally allocated $23 million would cover construction of only 3 or 4 of these aircraft. An additional $8 million would probably finance completion of these 8 planes, and $16 million would make it possible to complete all 13 (counting the 5 YB-35As included in the program changes of 1945). On 28 May 1947, $12 million was approved for cost overruns—$4 million below Northrop's estimate. At the end of January 1948, Northrop again reported that an additional $4.4 million would be required to complete all 13 aircraft.

Program Review — June 1948

By mid-1948, the XB/RB-35 program had started to show definite signs of an approaching demise. To begin with, a propeller-driven bomber could not match the performance of jet bombers already in development and nearing the production stage. In addition, the "flying wing" in its mid-1948 configuration was less stable than a conventional wing-fuselage aircraft, and thus made an inferior bombing or camera platform. The factor that kept the program alive was the multi-million dollar investment in the aircraft's development, with no tangible gain for the operational forces. Such failing most likely accounted for the Air Force's decision to get a reconnaissance version of the jet-equipped YB-35s, first ordered in 1945. The decision, as formalized in June 1948, called for the production of 30 aircraft, due to be known as RB-49As.[10] As it turned out, the RB-49 project, like other "flying wing" ventures, proved unsuccessful. In the meantime, and again because of the money involved, the Air Force continued to attempt rescuing the original XB-35 program. For example, a study was underway in mid-1948 to determine the feasibility of producing the B-35 for the air-refueling role.

Other Proposals — July-December 1948

Proposals for conversions and modifications of the experimental B-35s increased during the second half of 1948. Both contractor and Air Force still hoped that a tactical or strategic mission could be found for the aircraft. Yet, the odds were not encouraging. In August, Northrop indicated that existing experimental contracts could be completed with the funds already allotted if no further changes were made, but Air Materiel Command promptly

[10] See this appendix, pp 541-542.

pointed out that such a procedure would be self-defeating. Changes were necessary, the command insisted, to solve the vibration problems created by the single-rotation propellers. Also, the XB-35's intricate exhaust system caused tremendous maintenance difficulties, and the cooling fans of the R-4360 engines were beginning to fail due to metal fatigue. The only solution, the Air Materiel Command believed, was to convert every B-35 prototype to a 6-jet configuration.

By the end of 1948, modification plans had evolved further. Five YB-35s and 4 YB-35As were to be equipped with Allison J35-A-17 jet engines (6 per aircraft), fitted with cameras, redesignated RB-35Bs, and used for reconnaissance. In addition, 1 YB-35A was earmarked for static tests, a second YB-35B, after being re-engined with 6 Allison jets, was to serve as a reconnaissance prototype for the B-49 program, and a third jet-converted YB-35A would be fitted to serve as a test bed for the T-37 turboprop engine being developed by the Turbodyne Corporation, a Northrop subsidiary. Referred to as the EB-35B, the test-bed aircraft (last of the 13 prototypes included in the B-35 experimental program) would be capable of carrying 2 T-37 engines, although only 1 would be initially installed. Finally, a flexible-mount gear box would be fitted in the second XB-35 to try stopping the vibrations caused by the aircraft's single-rotation propellers. All this, the Air Materiel Command calculated, could probably be done with an additional $13 million.

Total Development Costs — $66 million

By the end of fiscal year 1948, development costs of the experimental B-35 had reached $66,050,506.[11] More than one-third of this amount had been spent on the first contract (535-ac-21920). This cost-plus-fixed-fee contract, as amended in January 1942, gave the Air Force 2 XB-35s for a final sum of $25,632,859, some $21 million more than originally estimated by the AAF. The remaining $40,417,647 covered the second and last cost-plus-fixed fee contract (535-ac-33930) which, as supplemented by Change Order No. 11, totalled $24,417,647, excluding cost overruns of $12 and $4 million, approved respectively in April 1947 and April 1948.

Program Cancellation — November 1949

Faced with a $13 million modification proposal at a time when money

[11] Including $1,644,603, which paid for conversion of 2 YB-35s to 6-jet-equipped B-49 prototypes.

was especially scarce, Air Force enthusiasm for the B-35 conversion program fell sharply. In August 1949, the 2 XB-35s and the first 2 YB-35s were scrapped. And while the decision did not signify the official end of the program, its fate was determined soon afterward. In November, the Air Staff canceled plans to convert remaining YB-35s and YB-35As, pointing out that no requirements existed that a "flying wing" could fulfill as efficiently as more conventional aircraft.

Total XB/YB-35s Accepted 15

Two XB-35s and 13 YB-35s were paid for and also accepted, in theory. In actuality, the Air Force hardly took possession of the B-35 lot. Some of the aircraft were diverted to the B-49 program, and most others, although finally completed, were immediately scrapped.

Final Disposition 1950

Scrapping of the remaining YB-35 types started in December 1949 and ended in March 1950, when the disassembling of the EB-35B test-bed began.

TECHNICAL AND BASIC MISSION PERFORMANCE DATA

YB-35B AIRCRAFT[a]

Manufacturer (Airframe)	Northrop Aircraft, Inc., Hawthrone, Calif.
Manufacturer (Engines)	Designed by the General Electric Co.; built by the Allison Div. of the General Motors Corp.
Nomenclature	Long-Range Bomber
Popular Name	Flying Wing

Length/Span (ft)	53.1/172
Wing Area (sq ft)	4,000
Weights (lb)	
Empty	82,807
Combat	125,715
Takeoff	175,000 (limited by structural strength)
Engine: Number, Rated Powers per Engine,	(6) 4,900-lb st
& Designation	J35–A–19
Takeoff Ground Run (ft)	
At Sea Level	4,280
Over 50-ft Obstacle	5,380
Rate of Climb (fpm) At Sea Level	1,500 (at takeoff weight, with max power)
Combat Rate of Climb (fpm) at Sea Level	3,050 (with max power)
Service Ceiling (100 fpm Rate of Climb to Altitude)	30,200 (takeoff weight/normal power)
Combat Ceiling (500 fpm Rate of Climb to Altitude)	36,200 (with max power)
Max Speed at Optimum Altitude (kn/ft)	381/35,322 (max power)
Combat Radius (nm)	1,300 with no payload, at 337 kn
Total Mission Time (hr)	7:9
Crew	4
Armament (provisions for)	(20) .50-cal guns
Max Bombload (lb)	40,000

Abbreviations

cal	=	caliber
fpm	=	feet per minute
kn	=	knots
max	=	maximum
nm	=	nautical miles
st	=	static thrust

[a]Estimates only.

XB-42 and XB-42A Mixmaster
Douglas
Airplane Company,
Incorporated

Basic Development 1943

Studies made by Douglas in early 1943 marked the start of the official development of the XB-42, first known as the XA-42.[12] The radically new design was another example of the evolutionary process, although it incorporated features of the slightly smaller A-20 and A-26 airplanes, also manufactured by Douglas.

Requirements 1943

Requirements for the XA-42 (formally redesignated as the XB-42 on 25 November) stemmed from the Army Air Forces's recurring need during the war years for smaller, more efficient, more economical, speedier, and longer-range tactical bombardment aircraft. Acquisition of the XA-42 was related to that of the B-29. The Army Air Forces (AAF) wanted modern light bombers to avoid using costly strategic bombers in strictly tactical applications.[13]

Initial Procurement 25 June 1943

The design proposal, submitted by Douglas in April 1943, impressed

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[12] In 1939, the "attack aviation" category was replaced by a "light bombardment" one, even though the "A" designation was kept throughout the war. One reason for the change came from Gen. H. H. Arnold's belief that it was more efficient and safer to fight the enemy with light bombers, and their carefully selected bombloads, than to rely on the machine guns of the attack-type aircraft.

[13] A few B-29s were flyable in June 1943, but the aircraft would not be ready for combat before 1944. Moreover, even though production was stopped in late 1945, the average unit cost of the B-29 reached over $600,000 (a high price in 1940-1945 dollars).

the AAF favorably, and Letter Contract W535-ac-40188 was approved on 25 June. This document, calling for 2 experimental models and a static test article, was logged by the Materiel Command[14] under Project MX-392 as a purely experimental endeavor. And, as it turned out, plans for manufacturing production models of the airplane did not go beyond the discussion stage.

Additional Requirements — September 1943

In September 1943, just a few months after approval of the XB-42 project, the AAF asked if jet engines could be added to 1 of the experimental aircraft covered by the contract of June 25th. In October, the Materiel Command recommended that jet engines be installed in the XB-42 static test article, if the contractor thought that a satisfactory all-jet airplane would result. Douglas quickly pointed out that development of a practically new aircraft would take time and that modifying 1 of the XB-42s would be much faster. But the AAF's interest in jet propulsion was increasing, and the development and production of new jet bombers were strongly favored. Hence, the XB-42 modification devised by Douglas, although approved by the AAF in December 1943, would not get underway before 1945, 1 year after the aircraft's first flight.

Special Features — 1944

Clean aeronautical lines and the novel engine-propeller arrangement were the most striking features of the all-metal, cantilever, mid-wing XB-42 monoplane. The 2 Allison liquid-cooled, reciprocating engines were mounted inside the fuselage in order to eliminate the drag of large nacelles. Pusher-type propellers were located in the empennage to do away with thrust disturbances. Twin shafts, similar to those in the Bell P-39 fighter, connected the propellers to the forward-located engines.

First Flight (XB-42) — 6 May 1944

Designed and constructed in the record time of less than a year, the XB-42 was first flown by Douglas on 6 May 1944. As a safety measure, the

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[14] Soon to be discontinued, as AAF Air Technical Service Command came into being.

aircraft's initial flight originated from and was conducted over Palm Springs Army Air Base, California. Even though the XB-42 was the first AAF bomber during World War II to substitute pusher for the conventional tractor-propulsion, a change requiring the development of radically different propellers,[15] the 22-minute flight proved uneventful.

Contract Changes 1944-1945

In routine fashion, the letter contract of June 1943 was replaced on 11 February 1944 by a definitive contract carrying the same identification (W535 ac-40188). The definitive contract, however, included a new provision covering the development of an all-jet version of the XB-42, later identified as the XB-43.[16] On the other hand, no official mention was made of the approved XB-42 modification until 23 April 1945, when a contract change notification authorized conversion of the first XB-42 to the XB-42A configuration.

Testing 1945-1947

Flight testing of the first XB-42 proved, on the whole, disappointing. In test flights, conducted between May 1944 and March 1946, stability of the airplane was satisfactory, but controls were inadequate. During development, the XB-42 had taken on considerable extra weight over that foreseen in the design proposal and, as a result, did not meet the Douglas guarantees either for maximum speed at altitude, or for range. Even more frustrating was the excessive vibration from the engines and propellers and from the bomb-bay doors when open.

Testing of the second XB-42, first flown on 1 August 1944, was another disappointment, mainly because its combat capability was no better than that of the first model. The plane did have slightly improved speed and range, however, as demonstrated in a coast-to-coast flight in November 1945 in which it covered 2,295 miles in 5 hours and 17 minutes. In any case, testing ended abruptly. The second XB-42 was completely destroyed on 16

[15] Built by Curtiss-Wright, the 13-foot propellers needed perfecting. However, further development was stopped when it became obvious that production of the XB-42 was out of the question.

[16] See this appendix, p 516.

December 1945, in an accident near Bolling Field, D.C. Failure of the landing gear and fuel starvation were the accident's major causes.

The XB-42 flight testing program was extensive, but the second aircraft's premature loss prevented completion of a number of special tests. Douglas tested the first XB-42 for some 129 hours, accumulated in 154 flights. The contractor test-flew the second, short-lived aircraft for more than 65 hours, accrued in 57 flights. The Air Force put in 14 hours of flight tests on the first XB-42, and 51 hours on the second one. The modified XB-42 (XB-42A) was flight tested by Douglas for approximately 17 hours that were reached in 22 flights. The Air Force test-flew the XB-42A only once, for 1 hour. The flight met the contractual acceptance requirements.

Modifications 1946-1948

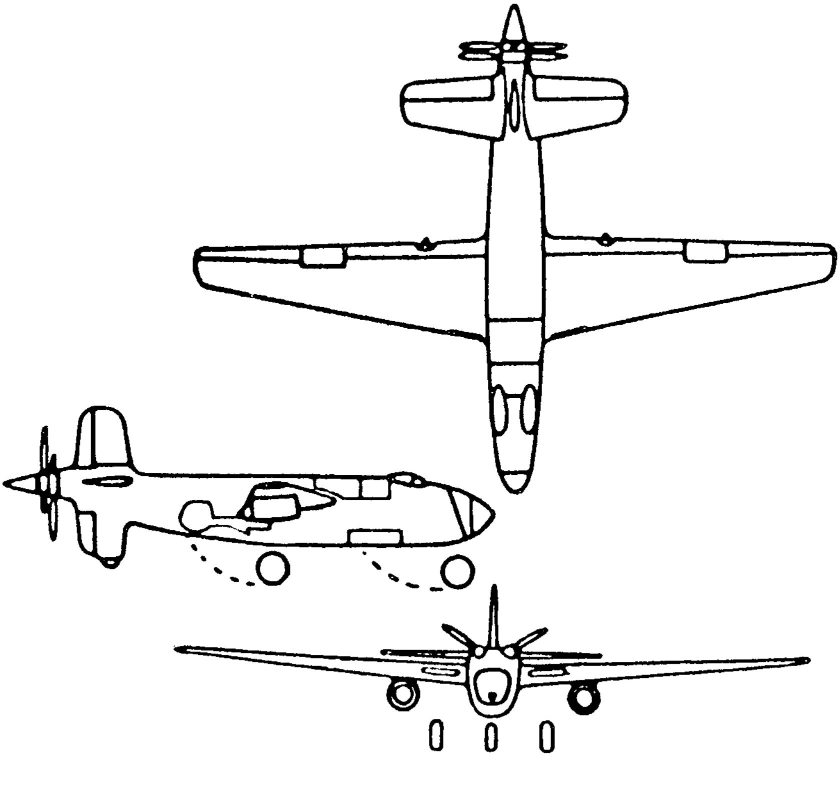
Douglas was authorized to begin work on the XB-42 conversion in April 1945, but the modifications were immediately postponed because the Bureau of Aeronautics could not speed delivery of the Westinghouse 19XB-2A Navy-type jets due to be fitted on the aircraft (1 unit under each wing). Testing therefore went on until March 1946, when the aircraft's left engine failed in flight. The XB-42 was then returned to the Douglas plant in Santa Monica, California, where a new landing gear, plus internal and external fuel tanks were to be installed in addition to the auxiliary turbojet engines.

During the latter part of 1946 and early in 1947, after the forging problems of the Westinghouse turbojets were solved, Douglas advanced the factory completion date of the programmed modifications several times, consequently delaying the important vibration tests.

The first flight of the XB-42A on 27 May 1947, from Santa Monica to Muroc Army Airfield, California, was marred by the obvious drag of the XB-42A's new turbojets. In ensuing flight tests at Muroc, both the Allison engines and added jets proved unsatisfactory. To make matters worse, the vibration tests, only started in mid-1947, were stopped on 15 August, when the XB-42A made a hard landing in the tail-low position, damaging the lower vertical stabilizer and lower rudder. The contractor wanted to resume testing as soon as possible, but the Air Materiel Command[17] decided that the new jet nacelles also needed modifications, and the aircraft was flown back to Santa Monica late in 1947. In the ensuing months, although it appeared that the Air Force still wanted a perfected XB-42A, Douglas

[17] The Air Materiel Command replaced the Air Technical Service Command on 9 March 1946. For details, see B-36, p 13.

The XB-42 featured a novel engine-propeller arrangement.



became increasingly convinced that further studies and engineering to reduce weight, eliminate vibration, and bring the modified plane up to guaranteed performance would not be economical.

Program Cancellation — August 1948

Convinced by the Douglas argument, the Air Force in August 1948 decided to cancel the remainder of the XB-42A modification program, and to accept the aircraft "as is." The decision also marked the end of the entire B-42 experimental project.

Total XB-42s Accepted — 2

The first XB-42, after being conditionally accepted on 24 September 1946, became the XB-42A which was finally accepted on 19 August 1948. The second, ill-fated XB-42 was accepted and delivered on 8 December 1945.

Total Development Cost

Both the XB-42 and XB-43 (also developed by Douglas) were procured under the same contract (W535 ac-40188) at a total cost of $13,682,095, including the contractor's fixed fee of $227,775. The $13.7 million settlement figure, recorded by the Air Force Contract Audit Office on 30 November 1947, did not provide a breakdown of the amount expended on each project. A portion of the XB-42A modifications was the object of another contract (W33-038-ac-14525), signed on 31 March 1947. The contract's relatively small amount (about $300,000) was most likely covered by the audit of November 1947.

Final Disposition — November 1948

The Air Force thought the modified XB-42A, with its clean aeronautical lines and other novel features, was a true museum piece and kept it at the National Air Museum Storage Activity in Park Ridge, Illinois, pending completion of additional space at the Smithsonian Institution in Washington, D.C. In April 1959, the fuselage of the XB-42A was moved to the Smithsonian's Suitland Annex, in Silver Hill, Maryland.

TECHNICAL AND BASIC MISSION PERFORMANCE DATA

XB-42 AND XB-42A AIRCRAFT[a]

Manufacturer (Airframe)	The Douglas Aircraft Company, Inc., Santa Monica, Calif.
Manufacturer (Engines)	Allison Division of General Motors Corp. (V-1710-129); Westinghouse Electric and Manufacturing Co. (XJ-30).
Nomenclature	Light Bombers
Popular Name	Mixmaster

	XB-42	XB-42A
Length/Span (ft)	53.6/70.6	53.6/70.6
Wing Area (sq ft)	555	555
Weights (lb)		
Empty	20,888	Not Available
Combat	Not Available	33,000
Takeoff	35,702	35,000
Engine: Number, Rated Power per Engine, & Designation	(2) 1,460-lb st V-1710-129	(2) 1,460/lb st V-1710-137 & (2) 1,600-lb st XJ-30
Takeoff Ground Run (ft) Over 50-ft Obstacle	6,415	3,540
Rate of Climb (fpm) at Sea Level	1,050 (mil power)	Not Available
Service Ceiling (ft)	29,400 (takeoff weight/normal power)	35,500 (takeoff weight/normal power)
Maximum Speed	386 mph	385 knots (estimate)
Combat Range	1,800 miles	Not Available
Combat Cruising Radius (nm)	Not Available	495
Crew	3	5
Armament	6 .50-cal guns	None
Maximum Bombload (lb)	8,000	4,000[b]
Maximum Bomb Size (lb)	2,000	4,000

Abbreviations

cal	= caliber
fpm	= feet per minute
mil	= military
mph	= miles per hour
st	= static thrust

[a]From Flight Test Reports only.
[b]Space and structural provisions for 8,000 lb.

XB-43
Douglas
Aircraft Company,
Incorporated

Basic Development — September 1943

The XB-43 was essentially a jet version of the unconventional XB-42, officially developed by Douglas in early 1943. The XB-43 did not reach the drawing board before 1944, but the project's development started in September 1943.

Requirements — 1943-1944

General requirements for a jet bomber of the XB-43 type arose during World War II, as a result of the development of German jet fighters. Also, the Air Corps needed an aircraft that could destroy military targets on land and sea in support of air, ground, or naval forces. Specific requirements were defined in 1944. The Army Air Forces (AAF) wanted the XB-43 to have a gross weight of 40,000 pounds; a maximum speed of 420 miles per hour at an altitude of 40,700 feet; and a range of 1,445 miles, at the same high altitude, with an 8,000-pound bombload.

Initial Procurement — 1944

A letter supplement to the XB-42 contract (W535 ac-40188) authorized on 14 January 1944 the initial procurement of 2 XB-43s. A formal supplemental agreement, approved on 31 March, set the estimated cost of the 2 experimental planes at $2.7 million and the contractor's fixed fee at about $107,000. The reason for such hurried transactions was to introduce tactical jet bombers swiftly into the operational inventory. As early as December 1944, the AAF seriously considered placing the XB-43 in production. Accordingly, the Air Technical Service Command asked Douglas on 30 December to submit a production proposal without delay.

Special Features 1944–1945

The XB-43 was the first American bombardment airplane to be powered exclusively by jet engines: TG-180 turbojets (later J35s), designed by the General Electric Company. Otherwise, except for the absence of the dual-rotating propeller at the rear of the empannage, the XB-43 had retained the XB-42's appearance and structural design.

Development Slippage 1944–1945

Early engineering problems with the pioneer J35 power plant hampered the XB-43's development. To begin with, General Electric only shipped the first J35 engine to Douglas in December 1944. Then, numerous changes in piping, wiring, and sheet metal work were necessary to make the engine suitable for flight. By March 1945, and in spite of the assistance of General Electric technicians, Douglas had spent more than 3,000 manhours to solve problems connected with the first engine. Moreover, subsequent engine deliveries, due since October 1944, were delayed until July 1945.

Program Change 1945

While the B-43 experimental program was assured from the start, the production program, which once appeared very promising, did not materialize. The Air Technical Service Command recommended in March 1945 the immediate procurement of 50 B-43s, but the Douglas production schedule for a preliminary lot of 13 test service airplanes proved unsatisfactory. Contrary to expectation, the planes would not be available for testing ahead of the B-45 and B-46 prototypes.[18] In addition, and probably of greater import, the proposed B-43 test aircraft would not meet the performance requirements that had been previously established. The AAF therefore opted to cancel all B-43 production plans. Air Technical Service Command notified Douglas of the AAF decision on 18 August 1945, specifying that the projected procurement of the 13 test aircraft was also nullified.

First Flight 17 May 1946

The XB-43 made its first flight on 17 May 1946. As in the XB-42's

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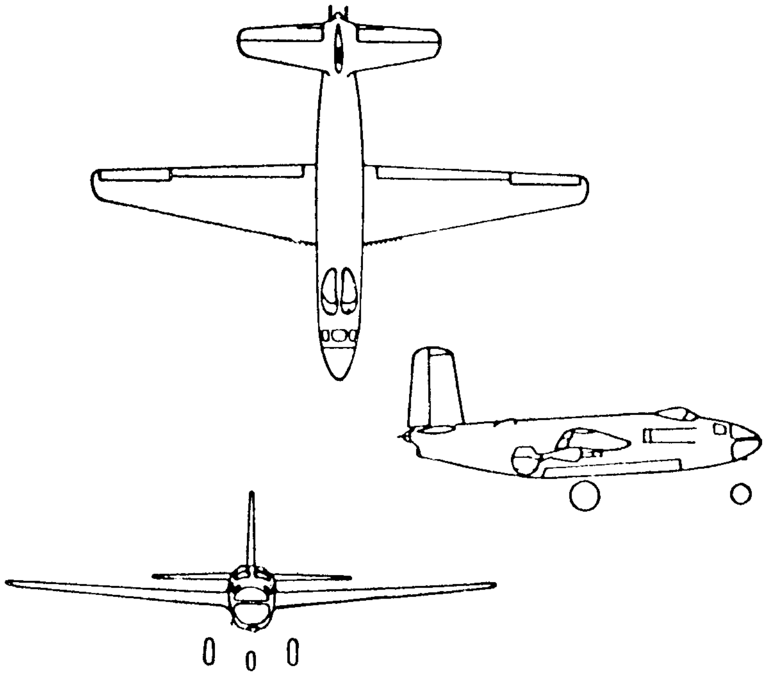
[18] As it turned out the XB-43 flew almost 1 year before the XB-45. In any case, the small XB-43 could hardly be compared to the much heavier B-45 and B-46 experimental aircraft, except for the fact that all such projects centered on jet propulsion.



A Douglas XB–43, the first American jet-propelled bomber.

case, because of the experimental status of the aircraft, the 8-minute flight was made from a military installation. The XB-43 had been dismantled at the contractor's plant in Santa Monica, California, and moved to Muroc Army Airfield, where it was reassembled. The AAF had invoked the War Powers Act to override the state's objections to having the disassembled airplane trucked over the public highway.

The first official flight of the second XB-43, on 15 May 1947, lasted 20 minutes and took place between Hughes Field in Culver City, California, and Muroc. After being fitted with special instruments, the second XB-43 had been trucked to Hughes Field where Douglas tested its ground handling and flight characteristics. To control costs, the AAF had informed Douglas that the second XB-43's flight test time was not to exceed 5 hours, without special authorization.

Continuing Problems 1946–1947

General Electric's labor difficulties and similar problems at the General Motors Corporation's Chevrolet Division, where most J35 engines were being built, continued to slow Douglas's progress. For example, in January 1946, no one knew with any certainty when the J35s earmarked for the second XB-43 would be available.

However, Douglas's engineering setbacks were not confined to the XB-43's power plant. One early problem, stemming from the difficulty encountered in obtaining positive nose wheel door operation, involved the pressurization of the entire nose section and nose wheel well. This problem was solved, but only by default. In January 1946 Douglas requested, and the AAF granted, permission to eliminate this pressurized area because the original requirement which called for the installation of a nose cone had been deleted. A second serious engineering problem was the tendency of the XB-43's plexiglass nose to crack under temperature extremes. The substitution of costly metal units, $5,000 each, was first considered. In November 1947, however, the Air Force decided that the difficulty could be corrected by installing wooden noses, much cheaper and adequate for a plane earmarked for testing, but no longer due to reach production.

Testing 1946–1948

While both XB-43s were used extensively for testing purposes, flight testing of each aircraft was relatively short. Douglas test-flew the first XB-43 for over 9 hours, accumulated in 28 flights; the AAF only test-flew it for about 4 hours, reached in 3 flights. Testing of the second XB-43 was even shorter. Douglas flew it for less than 8 hours, gained in 17 flights; the Air Force test-flew it once, for 1 hour.

Total XB-43s Accepted 2

The first XB-43 was accepted on 27 February 1947; the second, on 27 April 1948.

Total Development Costs

The Air Force Contract Audit Office on 30 November 1947 recorded the cost of the XB-42, XB-42A, and XB-43 programs at $13.7 million, and did not provide a breakdown of the amount spent on each program.[19] However, retained data on the XB-43 project set the program's tentative cost at $6.5 million. Although estimated, the figure appeared creditable.

Final Disposition 1951-1953

ARDC used the first XB-43 for a variety of tests until February 1951, when an accident ended the aircraft's testing career, which by then had reached almost 400 hours in flight. The second XB-43, after being assigned to the Air Materiel Command's Power Plant Laboratory, went to Muroc where it served as a test-bed for the General Electric J47 (TG-190) engine. Supported by the spare parts retrieved from the first XB-43, the second model also paid back its investment, totaling more than 300 hours of flight time before leaving the Air Force inventory in December 1953. The second XB-43 then went to the National Air Museum of the Smithsonian Institution.

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[19] See XB-42, this appendix, p 514.

TECHNICAL AND BASIC MISSION PERFORMANCE DATA

XB-43 AIRCRAFT

Manufacturer (Airframe)	The Douglas Aircraft Company, Inc., Santa Monica, Calif.
Manufacturer (Engines)	Designed by the General Electric Co.; built by Chevrolet Div. of General Motors Corporation
Nomenclature	Light Bomber
Popular Name	None

Length/Span (ft)	51.4/71.2
Wing Area (sq ft)	563
Weights (lb)	
Empty	22,600
Combat	35,900
Takeoff	40,000
Engine: Number, Rated Power per Engine, & Designation	(2) 3,820-lb st J35
Takeoff Ground Run (ft) Over 50-ft Obstacle	7,080 (contractor's guarantee)
Rate of Climb (fpm) at Sea Level (mil power)	2,470 (contractor's est)
Service Ceiling (ft)	41,800 (combat weight/mil power)
Average Cruise Speed	365 kn
Maximum Speed (mil power)	437 kn (contractor's est)
Combat Cruising Radius	470 nm
Crew	3
Armament	None
Maximum Bombload (lb)	8,000[a]
Maximum Bomb Size (lb)	4,000[a]

Abbreviations	
cal	= caliber
fpm	= feet per minute
kn	= knots
max	= maximum
nm	= nautical miles
st	= static thrust

[a]Space and structural provisions only.

XB-46
Consolidated Vultee Aircraft (Convair) Corporation

Manufacturer's Model 109

Basic Development — 1944

The XB-46's development originated in 1944, when the War Department called for bids and proposals on an entire family of jet bombers, with gross weight ranging from 80,000 to more than 200,000 pounds.[20] Consolidated Vultee Aircraft (Convair) Corporation answered the War Department's requirements with the design study of a 90,000-pound, jet-propelled bomber. The design, submitted and accepted in November 1944, was labeled by the Army Air Forces (AAF) as the XB-46.

Initial Procurement — 17 January 1945

The AAF initiated the XB-46's procurement with Letter Contract W33-038 ac-7674, which was approved on 17 January 1945. This first document covered preliminary engineering, wind tunnel, model, tests, mockup, and data that were to be based on the contractor's proposal of November 1944.

Definitive Development Contract — 12 February 1945

The letter contract of January was supplemented on 12 February by a definitive contract of the standard cost-plus-fixed-fee type. This contract followed by 1 week completion of the XB-46's first mockup inspection. As was usually the case, the contract satisfied the inspection board's essential

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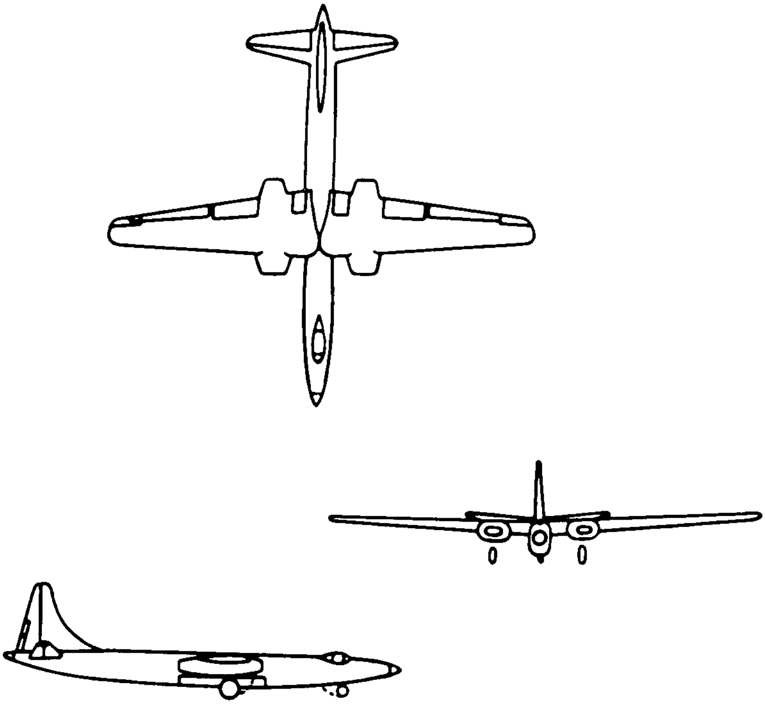
[20] See B-45, pp 62-65, and B-47, pp 101-102.

Long, thin wings and a teadrop canopy were special design characteristics of the XB-46.



recommendations. In short, 3 experimental B-46s were ordered and required to incorporate the necessary changes identified by the board. A supplemental agreement on 3 March provided for data and spare parts for the 3 XB-46s. Because of fiscal restrictions, the AAF also altered the terms of the basic contract, changing it to the fixed-price type.

Near-Cancellation — November 1945

By the fall of 1945, the AAF had become particularly interested in a Convair jet attack design, identified as the XA-44. The AAF actually considered canceling the XB-46 in favor of the XA-44, since there was not enough money for both projects. The contractor, however, firmly believed a better solution would be to complete 1 XB-46 in a stripped but flyable condition and to develop 2 XA-44s in lieu of the 2 other XB-46s remaining under contract. Although the AAF ratified the suggested substitution in June 1946, the XA-44 program did not materialize.[21] Similarly, the special testing of a TG-180 engine, due to be installed in a B-24J airplane as an added requirement related to the XB-46 development, was also subsequently abandoned.

Special Features — 1947

A distinguishing feature of the XB-46 was the tail turret, designed by the Emerson Electric Company Also, the pilot rode in a fighter-style cockpit with a teardrop canopy.[22] In other respects, despite its extremely thin wings and long, oval fuselage, the graceful airplane did display a few conventional features. Its wings were straight, and it was powered by 4 J35 axial flow engines, which were paired in low-slung nacelles, 1 on each side of the fuselage, a typical arrangement.

First Flight — 2 April 1947

The XB-46's first flight on 2 April 1947, from San Diego, California,

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[21] AAF support of the XA-44 did not last long. The program was ended in December 1946, when the design was converted to a light bomber design and redesignated the XB-53. The XB-53 project was given up soon afterwards. The XA-44 program was reinstated in February 1949, but only for a short while.

[22] The XB-46's cockpit design was selected for study by other aircraft manufacturers.

to Muroc Army Airfield lasted over 1 hour and a half. The contractor's test pilot praised the functioning and handling of the airplane which, as completed, contained only the equipment considered necessary to prove its air-worthiness and handling characteristics.

Testing 1947

The basic flight tests (Phases I and II) of the single XB-46 (Serial No. 45-59582) were concluded in September 1947, within 5 months of the aircraft's first flight. Convair test pilots accumulated more than 26 hours of testing in 16 flights; the AAF's pilots, about 101 hours in 46 flights. Although stability and control were for the most part excellent, engineering problems included engine troubles as well as difficulties with the spoiler clutch installation and with the lateral control surfaces when the aircraft flew at high speeds. All in all, the XB-46 appeared to meet the contractor's only guarantee—that it would be safe for experimental test purposes.

Total XB-46s Accepted 1

The Air Force accepted the sole XB-46 on 7 November 1947 and took delivery of the aircraft on the 12th.

Program Cancellation August 1947

The B-46 program was officially canceled in August 1947, several months before the experimental aircraft was formally accepted and exactly 1 year after the AAF had endorsed the immediate production of the North American XB-45. Still, only a small quantity of B-45s would be bought because, in the final analysis, the performance characteristics of the XB-47, being developed by the Boeing Airplane Company, were sure to exceed those of the future B-45 and of the unfortunate B-46. The AAF selected the XB-45 over the XB-46 for a number of reasons. Weight was one of them. Being at the time slightly heavier than the XB-45, the XB-46 could not be expected to match the future B-45's performance. Another factor against the XB-46 was the size of the necessary radar equipment. Most likely, the installation of such equipment would have required an extensive modification of the aircraft's thin fuselage.

Total Development Costs **$4.9 million**

As agreed upon in mid-1946, completion of only 1 stripped version of the XB–46 was intended to provide "a very realistic approach to the problem of development with relatively low cost." Just the same, when completed 1 year later, the experimental program nearly reached the $5 million mark.

Final Disposition **February 1952**

Like most strictly experimental airplanes, once accepted by the Air Force, the XB–46 participated in a variety of extra tests such as noise measurements, tail vibration investigations, and the like. Additional stability and control tests were also conducted at West Palm Beach AFB, Florida, between August 1948 and August 1949. However, after 44 hours of flight, these tests were stopped because "maintenance difficulties, aggravated by lack of spare parts, required a prohibitive number of manhours to keep the aircraft in flying condition." Actually, no additional testing was done on the airplane for almost a year. The XB–46 was flown to nearby Eglin AFB in July 1950, where its pneumatic system was tested at low temperatures in the base's climatic hangar. Completion of the climatic tests in November 1950 marked the bomber's end, since the Air Force had no more use for it. Except for its nose section, which was sent to the Air Force Museum at Wright-Patterson AFB, Ohio, on 13 January 1951, the XB–46 was scrapped on 28 February 1952.

TECHNICAL AND BASIC MISSION PERFORMANCE DATA

XB-46 AIRCRAFT

Manufacturer (Airframe)	Consolidated Vultee Aircraft Corp., Fort Worth, Tex.
Manufacturer (Engines)	Designed by the General Electric Co.; built by the Chevrolet Div. of the General Motors Corp.
Nomenclature	Medium Bomber
Popular Name	None

Length/Span (ft)	105.8/113
Wing Area (sq ft)	1,285
Weights (lb)	
Empty	48,000
Combat	75,200
Takeoff	94,400
Engine: Number, Rated Powers per Engine, & Designation	(4) 3,820-lb st J35-C3 (axial flow-11 stage)
Takeoff Ground Run (ft)	
At Sea Level	2,000[a]
Over 50-ft Obstacle	4,000[a]
Rate of Climb (fpm) at Sea Level	2,400 (at design takeoff of 91,000 lb)[a]
Combat Rate of Climb (fpm) at Sea Level	3,000 (at target weight of 75,200 lb)[a]
Service Ceiling (ft)	40,000 (guaranteed by contractor)
Combat Ceiling (ft)	36,500[a]
Average Cruise Speed (kn)	381
Max Speed at Optimum Altitude (kn/ft)	425/40,000[a]
Combat Radius (nm)	603
Total Mission Time (hr)	Not Available
Crew	3 (pilot, co-pilot, & bombardier-navigator)
Armament	2 .50-cal machine guns (space and structural provisions for APG-27 remote control with optics & radar sighting)
Maximum Bombload (lb)	22,000 (in various loads)
Maximum Bomb Size (lb)	22,000

Abbreviations	
cal	= caliber
fpm	= feet per minute
kn	= knots
nm	= nautical miles
st	= static thrust

[a]Contractor's estimates only.

XB-48
Glenn L. Martin Company

Manufacturer's Model 223

Basic Development 1944

The XB-48, like the more fortunate XB-45, originated in 1944, when the War Department concluded that jet propulsion was promising enough to warrant extension of the program, thus far centered on fighters and light bombers, to heavier aircraft with gross weights ranging from 80,000 to more than 200,000 pounds.[23] Realizing that such an ambitious project could be fraught with difficulties, Army Air Forces (AAF) headquarters informed the Materiel Command and Air Services Command on 10 August[24] that in the beginning contracts for jet bombers of the medium and heavy categories would have to be let on a phased basis so that they could be readily terminated upon completion of any one stage of development. This cautious procedure was formalized on 15 August.

Military Characteristics 1944–1945

On 17 November 1944, the AAF issued military characteristics calling for a bomber with a range of 3,000 miles (minimum acceptable, 2,500); a service ceiling of 45,000 feet and a tactical operating altitude of 40,000 feet (minimums acceptable, 40,000 and 35,000 feet, respectively); and an average speed of 450 miles per hour with a high speed of 550. These characteristics were amended on 29 January 1945 to reemphasize that such aircraft needed

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[23] See B–45, pp 353–363.

[24] About 2 weeks later the 2 commands merged to form the AAF Technical Service Command, which was redesignated Air Technical Service Command on 1 July 1945. This organization became the Air Materiel Command on 9 March 1946.

to carry specific types of bombs, including the conventional M-121, a 10,000-pound "dam-buster" developed during World War II.[25]

Initial Procurement 1944-1945

In accordance with the AAF's endorsement of "phase" contracts and based on the military characteristics of November 1944, a Martin proposal, submitted to the Air Technical Service Command on 9 December 1944, led to Letter Contract W33-038 ac-7675. Approved on 29 December, this initial document covered certain engineering services and completion by 1 May 1945 of 1 mockup of Martin's Model 223, designated XB-48 by the Air Technical Service Command. Tentative costs were set at $574,826. The letter contract of December 1944 was replaced on 27 March 1945 by a definitive contract, which reduced estimated costs to $569,252, including Martin's fixed-fee of $16,500.

Final Procurement 13 December 1946

Procurement of the XB-48 overcame many vicissitudes. In June 1945, 2 months after inspection of the XB-48 mockup, Martin submitted a proposal for 1 stripped and 1, 2, or 3 complete XB-48s. Accompanying cost figures, however, were immediately questioned. To Air Technical Service Command's surprise, it was soon ascertained that the estimated cost of $80.09 per pound for the XB-48 compared favorably to the $105.68 for the XB-45, but the AAF remained dissatisfied because the XB-48's engineering lagged behind the XB-45 and XB-46. Despite these concerns, the XB-48 project survived, and the initial contract was supplemented many times while negotiations went on. In March 1946, the contractor introduced a new proposal and offered to furnish 1 stripped and 1 complete XB-48 for about $10 million. This proposal was made on a fixed-price rather than a cost-plus-fixed-fee basis in order to conform to the policy set forth by the Air Technical Service Command in December 1945 on the procurement of

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[25] The M-121, sometimes called the "Earthquake" bomb, was more often referred to as the "Grand Slam" bomb, a totally misleading nickname. Actually "Grand Slam" was the code name of a highly classified modification project strictly concerned with atomic matters. The "Grand Slam" modifications would allow the Convair B-36 to carry atomic bombs, which the Air Force believed might weigh more than 40,000 pounds. Since the 10,000-pound M-121, when properly dropped, could inflict the damage of a 40,000-pound bomb, curiosity and rumors most likely explained the ensuing confusion. As a matter of fact, the "Grand Slam" designation was also loosely applied to other conventional bombs of the M-121 category.

experimental airplanes. Just the same, the Martin proposal of March 1946 had to be revised, and negotiations were not consummated until the end of the year. The final contract (W33-038 ac-13492), approved on 13 December 1946, superseded Contract W33-038 ac-7675 which, as amended, had reached an estimated future cost of $10.9 million.[26] For the same amount, the new contract promised 2 XB-48s, spare parts, and a bomb-bay mockup. Also, the first XB-48 was to be flight tested and delivered by 30 September 1947; the second one, by 30 June 1948. Finally, all wind tunnel tests were to be completed by 1 January 1947.

Program Slippage 1947-1948

Development and testing of the 2 XB-48s were delayed by engine difficulties. General Electric turbojet engines were installed, the first XB-48 being powered by 6 J35-GE-7 (TG-180-B1) engines; the second, by 6 J35-GE-9s (TG-180-C1s). Since the engines were in an even more experimental stage than the airplanes, it took time to get them to operate properly. Also, like every new engine, the J35s were in short supply. Still, the first XB-48 would go through 14 engines during its first 44 flights.

Special Features 1947-1948

The sleek, all-metal, high-wing XB-48 presented many special features, the most outstanding one being the tandem bicycle landing gear necessitated by the airplane's wings, too thin to house conventional landing gear with bulky retracting mechanisms.[27] Other novel features were the number of engines, 6 as compared to 4 on the other proposed medium bombers; the turbojet engine's installation, encased in pods (3 under each wing) in a lift section with air ducts between the pods; and also adjustable tail pipes on the engines. The 3-crew arrangement was also unusual. The pilot and co-pilot were seated in tandem under a canopy-type inclosure, similar to that found in high-speed fighter planes, while the bombardier-navigator was seated in the aircraft's nose. The XB-48 had retractable bomb-bay doors, a feature that sprang from the fact that all new medium and heavy bombers had to be

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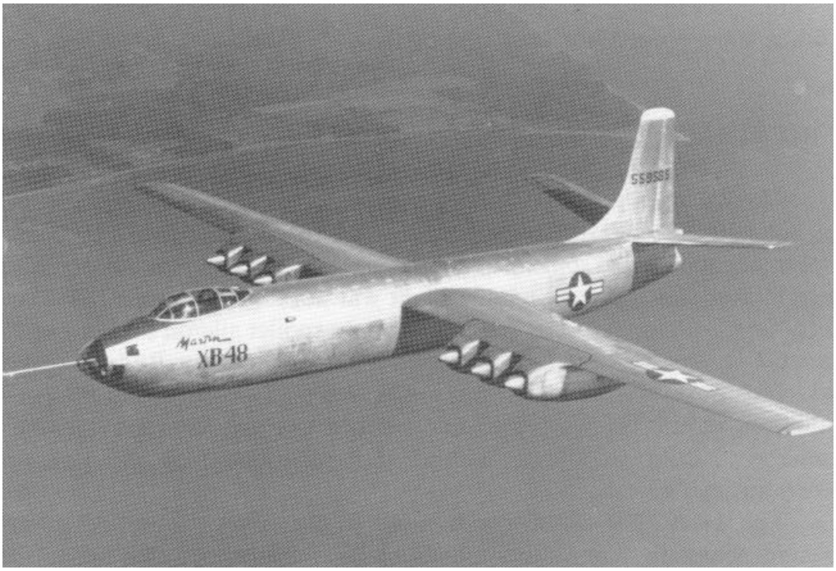
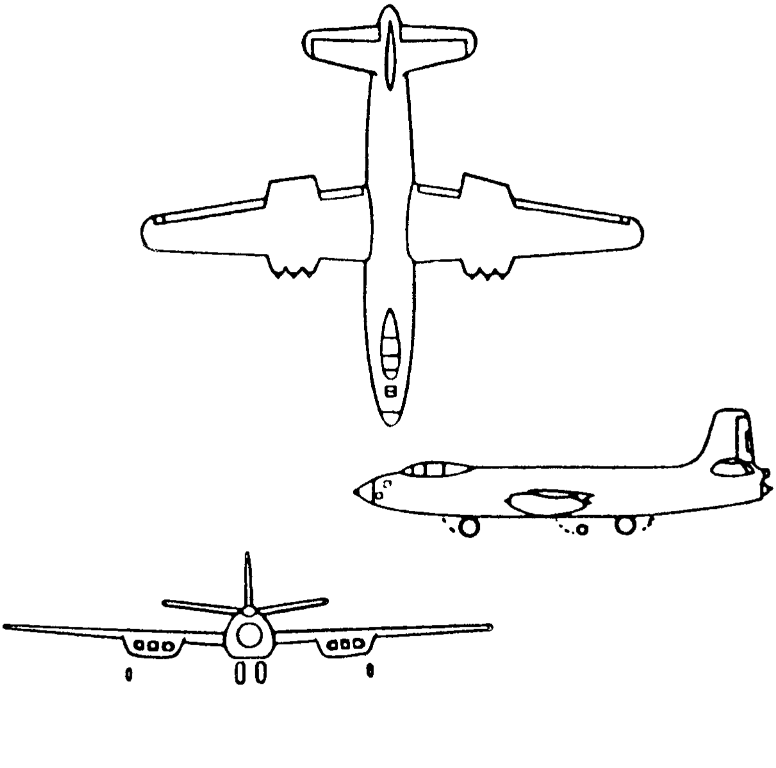
[26] Only some $500,000, covered by the initial letter contract, were unaffected.

[27] Martin had experimented with a 4-wheel bicycle landing gear on an XB-26H and concluded that such an arrrangement was feasible. Bicycle-type landing gears were later used by other jet bombers, including the B-47.



The XB-48, developed by Glenn L. Martin Company.



capable of carrying the so-called "Grand Slam" bombs, as well as the cumbersome atomic bombs of the period.

First Flight 22 June 1947

The XB-48, the first U.S. 6-jet bomber to fly, made its initial flight on 22 June 1947. The experimental plane took off from Martin's airfield at Baltimore and landed some 80 miles away at the Patuxent Naval Air Station, also in Maryland. The 38-minute flight was not a great success. At 10,000 feet, the Martin pilot discovered that the right spoiler aileron snapped up too rapidly. On landing, the XB-48 drifted across the runway. Rudder steering was attempted, but the rudder was ineffective with the full use of brakes. In addition, the brakes overheated and stopped working. The aircraft finally came to a halt off the runway with no damage, even though both tires were worn through.

The second XB-48 did not fly until 16 October 1948, some 3 months behind schedule. The 30-minute flight was satisfactory, but of relative unimportance since the future of the experimental program had already been decided.[28]

Testing 1947-1949

Martin pilots tested the first XB-48 52 times, for a total of 41 hours; the Air Force, 50 times for a total of 64 hours. The second XB-48 was also thoroughly tested. The contractor put in 14 hours, accumulated in 15 flights; the Air Force, 49 hours, reached in 25 flights. Results of the first XB-48's flight test program revealed that the aircraft did not meet the Martin guarantees. The XB-48 was 14,000 pounds overweight; the nose wheel was too sensitive; turbulence occurred in the bomb bay when the doors were open; and metal chips, deposited by disintegrated test stand hydraulic pumps, shattered the hydraulic system.[29]

Program Cancellation 1948

The experimental B-48 program agreed upon in December 1946 was not

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[28] See B-45, pp 64-65, and B-47A, p 107.

[29] The Air Force gave the contractor the option to eliminate all flaws or to pay a lump-sum penalty of $25,000. In January 1950, Martin agreed to pay the penalty.

curtailed. Yet, in spite of the contractor's efforts, no production program followed. Although no firm commitment would be made before many months, planning for the procurement of B-47 production models began in December 1947, right after the XB-47's first flight—a poor omen for the B-48, initially flown in June of the same year.

In the spring of 1948, after early experimental flight information had been obtained for both the XB-47 and the XB-48, the Air Force conducted an evaluation to determine which of the 2 planes could best satisfy the urgent need for a high-speed, high-altitude medium bomber. The evaluation confirmed that the performance of the XB-47 was appreciably better than that of the XB-48. It was also apparent that the XB-47 design provided possibilities for growth which surpassed those of the XB-48. The XB-47's swept-back wing would enable it to attain higher speeds, and its simpler pod-nacelle arrangement minimized the problem of incorporating newer and more efficient jet engines as they became available.[30]

Early in 1949 Martin attempted to rescue the B-48 production program and proposed to modify the second XB-48 by removing the J35 engines and nacelles and installing 4 XT-40A propeller turbines in new and repositioned nacelles, at an estimated cost of $1.5 million. Actually, the reconfigured XB-48 would become a prototype of the Martin Model 247-1, an airplane, the contractor insisted, capable of competing with the B-47, B-50, and B-54. On paper, Model 247-1's performance looked good, but the Air Force did not believe the proposed reconfiguration could be accomplished for the amount of money estimated by the contractor. In addition, since the XT-40A turboprop was a Navy-developed engine, it was doubtful that Martin could obtain enough engines to complete the reconfiguration on schedule. Finally, and of overriding importance, senior Air Force officials believed that turbojet aircraft "currently offered greater promise than turboprop installations." Thus, on 31 March 1949, Martin was formally told that the Model 247-1, like the original XB-48, was a dead issue.

Total XB-48s Accepted 2

The Air Force accepted the first XB-48 on 26 October 1948, but only conditionally. The acceptance became final in 1950, when Martin paid the $25,000 penalty assessed by the Air Force because of the aircraft's several defects. The second XB-48, also conditionally accepted on 26 October 1948,

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[30] The end of the B-48 production program became official in September 1948, when the Air Force ordered the first lot of 10 B-47s.

was finally accepted on 23 February 1949, after the contractor completed various modifications.

Total Development Costs — $11.5 million

The total cost of the XB-48 development program reached $11.5 million. Of this amount, less than $500,000 pertained to the letter contract of December 1944. The rest covered the final contract of December 1946 and represented an increase of about $100,000, justified by various changes ordered by the Air Force.

Final Disposition — 1949-1951

In the fall of 1949, the first XB-48 was cannibalized to provide parts for the second XB-48. The latter aircraft was scheduled for many tests, including tests on the F-1 autopilot, jet engine cooling system, and a hydraulic system for jet engines. The proposed tests, however, were canceled. The Air Force decided to use the second XB-48 as a test-bed for "bad-weather" flight items, including a badly needed deicing system. Completion of the thermal anti-icing survey test program in mid-1951 paved the way for the second XB-48's end. In September, the aircraft was flown to Phillips Field, Aberdeen Proving Ground, Maryland, where the strength of the XB-48 structure was tested until the aircraft was totally destroyed.

TECHNICAL AND BASIC MISSION PERFORMANCE DATA

XB-48 AIRCRAFT

Manufacturer (Airframe)	The Glenn L. Martin Co., Baltimore, Md.
Manufacturer (Engines)	Developed by General Electric; built by the Allison Div. of General Motors Corp., Kansas City, Mo.
Nomenclature	Medium Bomber
Popular Name	None

Length/Span (ft)	85.8/108.3
Wing Area (sq ft)	1,330
Weights (lb) Empty Combat	58,500 92,600 (max) 102,600 (4,968 gal of fuel, included)
Engine: Number, Rated Power per Engine, & Designation	(6) 3,820-lb st J35-B-1 (1st XB-48)[a] (6) 3,820-lb st J35-D-1 (2d XB-48)[a]
Takeoff Ground Run (ft) At Sea Level Over 50-ft Obstacle	 7,900 (at 102,600-lb takeoff)[b] 5,200 (at 102,600-lb takeoff)[b]
Rate of Climb (fpm) at Sea Level	3,250 at design takeoff of 102,000 lb)[b]
Combat Rate of Climb (fpm) at Sea Level	4,200 (at combat takeoff of 86,000 lb)[b]
Service Ceiling (ft) (100 fpm Rate of Climb to Altitude)	39,400[b]
Combat Ceiling (ft) (500 fpm Rate of Climb to Altitude)	43,000[b]
Average Cruise Speed (kn)	360[b]
Max Speed at Optimum Altitude (kn/ft)	454/35,000[b]
Combat Radius (nm)	433 (with max bombload)[b]
Cruising Radius (nm)	783[b]
Total Mission Time	Not Available
Crew	3 (pilot, co-pilot, & bombardier-navigator)
Armament	None (provided for 2 .50-cal machine guns to be controlled by AN/APG-27 Radar)
Maximum Bombload (lb)	22,000 (in various loads)
Maximum Bombload (lb)	22,000

Abbreviations

cal	= caliber	max	= maximum
fpm	= feet per minute	nm	= nautical miles
kn	= knots	st	= static thrust

[a]First known as Allison TG-180s, the initial J35s were axial flow gas-turbine engines, grouped in threes under each wing. The J35-B-1s were later replaced by J35-GE-7s; the J35-D-1s, by J35-GE-9s.

[b]Contractor's estimates only.

YB-49 and YRB-49A Northrop Aircraft, Incorporated

Basic Development — 1944

The YB-49 evolved from the unconventional XB-35 "flying wing,"[31] its development being prompted by a 1944 study of the possibilities of converting the propeller-driven XB-35 to turbojet engines. Actually, the YB-49 project and its reconnaissance counterpart represented the continuing effort of the Army Air Forces (AAF) and Northrop to establish a tactical use for the original "flying wing," yet to be flown but already plagued by virtually insurmountable problems.

Initial Procurement — 1 June 1945

On 1 June 1945, Change Order 11 to Contract W535 ac-33920, a December 1942 document calling for 13 B-35 prototypes, confirmed earlier verbal decisions and authorized Northrop to convert 2 future YB-35s to the YB-49 configuration.

Conversion Slippage — 1947

Conversion of the YB-35 to the YB-49 configuration, due to be completed by June 1946, slipped more than a year. The delay was caused by unforeseen problems, encountered in adding fins to the wings to provide the stabilizing effect that the propellers and propeller shaft housings gave to the basic XB-35.

Special Features — 1947

The YB-49 featured eight 4,000-pound-thrust J35 engines, 2 more than

[31] See this appendix, pp 497–516.

planned; 4 small trailing edge fins, to replace the XB-35's yaw dampening prop shaft housings; 4 large wing fences; and a reconfigured leading edge ahead of and between each pair of fences that provided a low drag intake slot for each of the 2 sets of jet engines. In most other respects, since the all-metal XB-35 airframe was used for the conversion, the YB-49 was identical to the YB-35.

First Flight — 21 October 1947

The initial flight of the first YB-49 occurred on 21 October 1947, from the contractor's plant in Hawthorne to Muroc Army Airfield, both in California. The new prototype's first flight lasted 34 minutes without incident. The second YB-49 was first flown on 13 January 1948, from and to the same places and also without special difficulties.

Testing — 1947-1950

Testing of the first YB-49 was extensive. Northrop test-flew it for almost 200 hours, accumulated in some 120 flights; the Air Force completed about 70 hours, totaled in some 20 flights.[32] Early in 1948, Northrop began test-flying the second YB-49. Some 24 flights were made by the contractor's pilots for a near-total of 50 hours. The Air Force test-flew the second YB-49 5 times, for perhaps 13 hours. In the YB-49's case, early test results acquired special significance. Tragically, just after being officially accepted by the Air Force, the second YB-49 crashed, killing its entire 5-man crew.[33]

Investigations of the second YB-49's crash could assign no specific cause for the accident, but determined that a major structural failure had taken place in flight. An eyewitness described the plane as tumbling uncontrollably about its lateral axis just before hitting the ground. Project officers later verified that under certain conditions a "flying wing" would indeed "somersault" through the air. The loss of the aircraft and further wind tunnel work perpetuated doubts concerning the flying wing's aerodynamic stability and revealed the need for additional flight testing.

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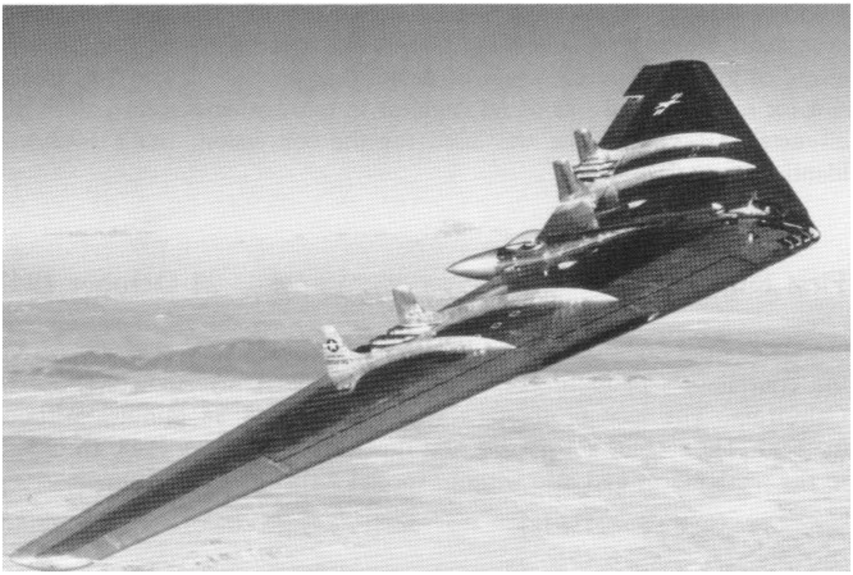
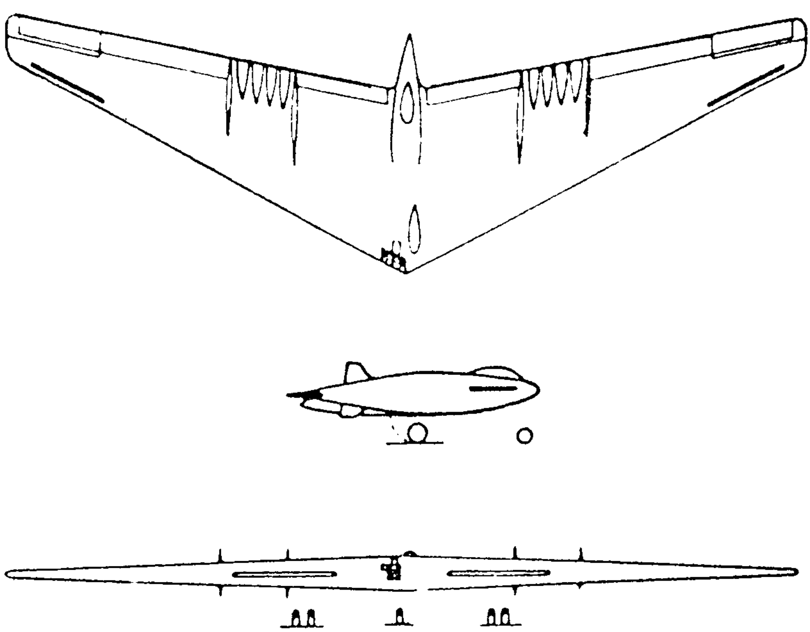
32 Conflicting information did not allow the computation of absolute figures. However, extensive research by various Air Force historians confirmed the stated estimates.

33 Capt. Glen Edwards, from the Air Materiel Command Flight Test Division, was co-pilot on this fatal trip. Muroc Army Air Base, after becoming Muroc AFB on 12 February 1948, was renamed Edwards AFB on 5 December 1949, in honor of Captain Edwards.



The Northrop YB-49 was a converted YB-35, with jet engines instead of propellers.



Program Re-Appraisal 1948–1949

By 1948, progress in range-extension had relegated the YB-49 to the status of a medium bomber. Actually, the YB-49 was the largest of the medium bombers under consideration, but it faced stiff competition from the B-45 (already in production), and from the XB-46, XB-47, and XB-48 (all in flight test). Soon afterward, and although the project would not be firmed up for another year or so, the Aircraft and Weapons Board decided to use flight test results to evaluate the B-47 and B-49 as possible "special piloted atomic" carriers.[34] The YB-49 program also profited from the Air Materiel Command's decision to de-emphasize turboprop propulsion and push turbojet development. Yet, other aspects of the program were not so favorable.

The first YB-49 made a significant flight on 26 April 1948, a test of the aircraft's range which proved quite successful. The aircraft was aloft 9 hours, of which 6 hours were flown at an altitude of 40,000 feet. Both accomplishments were believed to set records for that period. Only 1 engine and 1 auxiliary power unit failure marred the otherwise excellent performance. But the second YB-49's fatal crash in June prompted the contractor and the Air Force to decide that the remaining prototype would be flight tested an extra 125 hours, and the testing that ensued gave mixed results.

Meanwhile, Lt. Gen. Benjamin W. Chidlaw, Deputy Commander of the Air Materiel Command, had ordered that determination of the YB-49's stability as a bombing platform be given first priority. Evaluated against a B-29 on comparable mission tests, the YB-49 (without an autopilot) performed poorly. Pilots concluded that the jet-equipped "flying wing" was "extremely unstable" and found it "impossible to hold a steady course or a constant airspeed and altitude." The YB-49's circular average error and range error were twice those of the B-29. Finally, the B-29 invariably acquired bomb-run stability in under 45 seconds, while the YB-49's best time was over 4 minutes. Clearly, the B-49 program was doomed unless sweeping improvements were made to correct the performance defects demonstrated by the prototype.

Total YB-49s Accepted 2

The first YB-49 was not accepted by the Air Force until 15 March 1950

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[34] See B-47, pp 125-126.

(after being extensively tested by the contractor). The second, ill-fated B–49 prototype was transferred to the Air Force on 28 May 1948. Northrop considered the airplane officially accepted on 5 June, when it crashed.

Subsequent Model Series — YRB–49

Program Cancellation — 15 March 1950

The October 1948 conclusion of the primary evaluation tests comparing the YB–49 and the B–29, and the YB–49's poor showing most likely determined the outcome of the B–49 program. Just the same, the YB–49 testing was extended, and even though remote, the possibility remained that the program might survive its initial calamities. This did not prove to be the case. Between May 1948 and the spring of 1949, the B–49 prototype was involved in 5 incidents, most of them due or related to engine problems. On 26 April 1949, a fire occurred in 1 of the aircraft's engine bays, necessitating $19,000 worth of repairs. Cancellation of the B–49 program became official on 15 March 1950—the day the sole XB–49 crashed and testing came to an abrupt end. There were no fatalities, but crewmen were injured and the airplane was completely destroyed. Failure of the nose gear was the accident's basic cause. Contributing factors were excessive shimmy of the nose wheel and final collapse of the gear, resulting from the unsatisfactory center of gravity.

Total Development Costs

After 1948, the additions and withdrawals of funds made a separate appraisal of any one aircraft's cost impractical, especially since the Air Force found it difficult to secure anything but an overall "flying wing" program cost estimate from Northrop.[35]

Final Disposition — 1948–1950

The second YB–49 was totally destroyed on 5 June 1948; the first, on 15 March 1950.

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[35] See XB–35, this appendix, p 506.

YRB-49A

Basic Development — March 1948

Like the canceled B-49, the RB-49 grew out of the unconventional XB-35, under development by Northrop since 1941. However, the aircraft's basic development did not take shape until March 1948 when the contractor, after canvassing possible uses for the "flying wing," submitted to the Air Force proposals for a photographic reconnaissance version of the aircraft. Referred to as the RB-49A and the FB-49A, the proposed aircraft would be essentially a YB-49, stripped of items required only for bombardment missions and incorporating necessary photographic apparatus. The formal nomenclature of the prototype became YRB-49A.

Early Planning — April 1948

In April 1948, the Air Staff and high-ranking officers of the Air Materiel Command, after comparing reconnaissance versions of the F-12,[36] B-35, B-47, and B-50, concluded that perhaps the eventual RB-49A could "realistically" perform a portion of the strategic reconnaissance mission. Undoubtedly, this optimistic appraisal stemmed from the testing already accomplished on the Northrop aircraft, as well as from the aircraft's range, speed, altitude, and growth potential with combinations of turbojet and turboprop engines. Therefore, 3 versions of an ever-improving RB-49A were planned—an initial aircraft with 8 TB-190A (General Electric J47) turbojets, an interim model powered by 6 Westinghouse J40 engines (when they became available), and an ultimate configuration, which would achieve greater range and economy with 2 Turbodyne T-37 turboprops and 2 TG-190A engines. The ultimate model was not an immediate possibility, since the T-37 engines would not be available until October 1951 or later.

Initial Procurement — 12 June 1948

Believing that the planned RB-49A configuration truly had merits, and

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[36] The F-12 was developed by the Republic Aviation Corporation. Only 2 prototypes came into being.

still eager to salvage its costly investment in the unfortunate XB-35 program, the Air Force promptly decided to endorse the YRB-49A development. Following notice of the decision in May 1948, Northrop received a letter contract on 12 June for preliminary engineering work looking toward an eventual production contract for 30 reconnaissance aircraft, at a cost of $86,800,420,—this total to include aircraft, engineering data, and flight testing.

Production Contract 12 August 1948

Signed on 12 August 1948, Contract W33-038-ac-21721 covered the production of 30 RB-49As and a static test shell. One of the aircraft was to be built by Northrop, the remaining 29 by Consolidated Vultee, at the latter's government-leased plant in Fort Worth, Texas. The agreement had been preceded by difficult negotiations, the 2 contractors being unwilling from the start to accept the Air Force's contention that the nation would benefit from a pooling of Northrop's engineering skill and Consolidated's experience in quantity production of large aircraft.

Program Re-Appraisal Fall 1948

Support of the RB-49A production program was short lived. Less than 2 months after the contract's signature, several Air Materiel Command officials concluded that the program's initial 8-jet version would only be "satisfactory as an interim installation." In late September, the Air Force also began to encounter difficulties in pinning down the 2 contractors' future delivery dates for the 30 RB-49As. Just as disturbing was the continuing indecision over which prototype Northrop would use to develop the YRB-49A. At first, the remaining YB-49 was chosen. Then, various versions of the 13 YB-35s ordered in 1942 were reviewed, before settling on modification of the third B-35 prototype—a YB-35A featuring specific reconfiguration changes dictated early in 1945.

Against this clouded background, a board representing numerous Air Staff offices met in November to review the requirements for reconnaissance aircraft. All 3 versions of the future RB-49As came under fire. The 8-jet RB-49A, it appeared, would not be available until January 1950 and would have an inadequate operating radius; the 6-jet model, planned for 1951, would be much slower than the B-47; finally, Northrop could not promise the ultimate turboprop-turbojet version until 1953, at which time that particular RB-49A would be in competition with (and outclassed by) the

B-52. The Air Staff Board, therefore, recommended elimination of the RB-49A.

Program Cancellation 1948-1949

The RB-49A production program was irrevocably canceled in late December 1948, as the new USAF Board of Senior Officers[37] supported the Air Staff Board's recommendation, deciding also soon afterward to substitute the procurement of additional B-36s for the deleted RB-49As.[38] The RB-49 cancellation became official in mid-January 1949, when the Air Materiel Command directed Northrop to stop work on all phases of the reconnaissance version except for completion and test of the 1 YRB-49A.

First Flight 4 May 1950

Conversion of the third YB-35A was "shop completed" by February 1950, shortly after the Northrop project was totally cut back to the level of a low-budget, state-of-the-art research and development endeavor. Yet, despite the contractor's continuing attempts to revive its program, the April delivery deadline set by the Air Force was not met. The YRB-49A's first flight occurred on 4 May, a 1-month slippage due to the time consumed in installing additional instrumentation. Like the YB-49, the reconnaissance prototype's first flight was from Hawthorne to Edwards AFB, California.

Special Features 1950

The YRB-49A differed significantly from the third YB-35A by featuring 6 engines instead of 8. Four of the YRB-49's 6 J35s were internally-mounted; 2 were outside of the airframe. The removal of 2 engines and the relocation of an additional 2, allowed the YRB-49A to carry much more fuel, a configuration change designed to extend the aircraft's range.

Testing 1950-1952

The YRB-49A's test program was quickly marred by a potentially fatal

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[37] See B-52, p 216.

[38] See B-36, p 26.

accident. On 10 August 1950, during its tenth test flight, the reconnaissance prototype was in a climb at approximately 35,000 feet, at a speed of about 225 miles per hour, when the canopy failed and blew off, tearing away the pilot's oxygen mask and injuring him slightly. Only because the alert flight engineer supplied emergency oxygen was the pilot able to land the aircraft without further incident. The test program was resumed after a replacement canopy was provided and various aircraft modifications were made. No test flights were recorded after 10 September 1950, even though the aircraft was probably still test-flown on and off. In any case, on 6 May 1952, the Air Materiel Command indicated that there was "no future flying time scheduled" for the YRB-49A.

Final Disposition 1953

The YRB-49A, the last of the "flying wings," was flown to Northrop's Ontario International Airport facility, and it most likely remained in storage for 18 months. The Air Force reclaimed and scrapped the aircraft in November 1953.

TECHNICAL AND BASIC MISSION PERFORMANCE DATA

YB-49 AIRCRAFT[a]

Manufacturer (Airframe)	Northrop Aircraft, Inc., Hawthorne, Calif.
Manufacturer (Engines)	Designed by the General Electric Co.; built by the Allison Div. of the General Motors Corp.
Nomenclature	High-Altitude, Long-Range Bomber
Popular Name	Flying Wing

Length/Span (ft)	53.1/172
Wing Area (sq ft)	4,000
Weights (lb)	
Empty	88,442
Combat	133,569
Takeoff	193,938
Engine: Number, Rated Power per Engine, & Designation	(8) 3,750-lb st J35-A-15
Takeoff Ground Run (ft)	
at Sea Level	4,850
over 50-ft Obstacle	5,850
Rate of Climb (fpm) at Sea Level	1,780
Combat Rate of Climb (fpm) at Sea Level	3,785
Service Ceiling (ft) (100 fpm Rate of Climb to Altitude)	35,400
Combat Ceiling (ft) (500 fpm Rate of Climb to Altitude)	40,700
Max Speed with max power at Altitudes (kn/ft)	403/35,000—428/20,800
Combat Radius (nm)	1,403 with 10,000-lb payload at 365 knots in 8:27 hours
Armament	None
Crew	6
Max Bombload (lb)	16,000

Abbreviations

fpm = feet per minute
kn = knots
nm = nautical miles

[a]Based on manufacturer's flight test and wind tunnel data.

XB-51
Glenn L. Martin Company

Manufacturer's Model 234

Basic Development 1945

Development of the XB-51 was initiated in 1945, when the Army Air Forces (AAF) issued military characteristics for a light bomber aircraft. The AAF's requirements led to a design competition, held in February 1946. The Glenn L. Martin Company won the competition with a design for an airplane containing a composite power plant and promising a maximum speed of 505 miles per hour (438 knots), a cruise speed of 325 miles per hour (282 knots), and an 800-mile combat radius. The Martin design, then labeled the XA-45, also provided for a 6-man crew, all-around armament, and high-altitude bombing equipment.

Revised Characteristics Spring 1946

The AAF military characteristics of 1945 were revised in the spring of 1946. The new requirements called for an aircraft with better performance for all-weather, close support bombing. In line with Gen. H. H. Arnold's deletion of the requirement for "attack" aircraft,[39] the revised characteristics also called for a redesignation of the Martin design, subsequently known as the XB-51.

Initial Procurement 23 May 1946

Procurement of the experimental B-51 was initiated by a fixed-price letter contract, issued on 23 May 1946. This agreement gave Martin $9.5

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[39] See this appendix, p 509.

million to produce 2 XB-51s, to be preceded by the usual wind-tunnel models and mockups. Special tools, spare parts, drawings, technical data, armament reports, and the like were also required.

Additional Revisions 1947

The military characteristics of 1945 and 1946 were revised again in 1947 to satisfy officials of AAF Headquarters, who doubted that the XB-51, as then envisioned, would become a satisfactory light bomber. The possibility of seeking 1 or 2 new production sources was considered but given up after the Air Materiel Command pointed out that to stay with the XB-51 and use funds already obligated for this purpose was probably the surest way to acquire a light bomber that would not be obsolete before reaching the inventory.

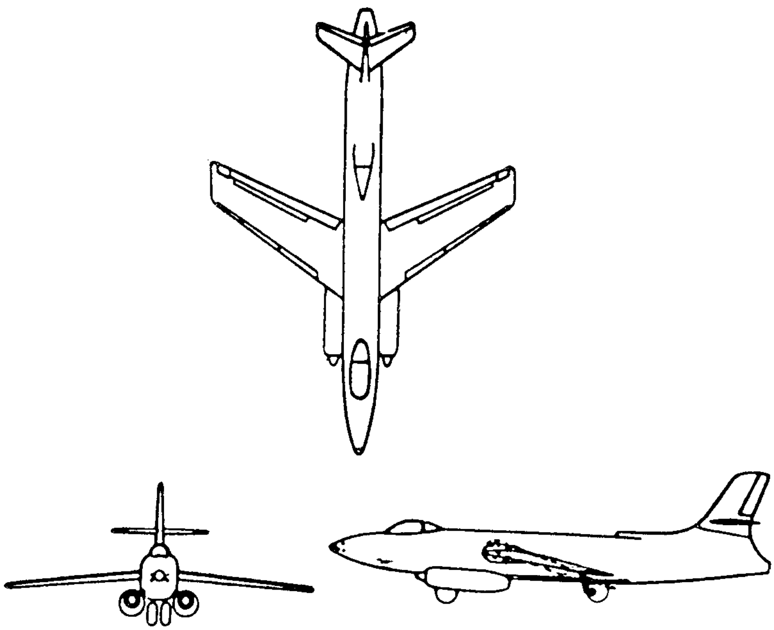
Concurrent studies by Martin resulted in the design of an XB-51 aircraft with a top speed of 620 knots, a cruise speed of 463 knots, and a 378-mile radius of action. The revamped XB-51 was to be equipped with eight 20-millimeter cannon, be capable of carrying a 4,000-pound bomb load, and would require a 2-man crew, 4 men less than originally planned. Further design studies, conducted by Martin at the request of the Air Materiel Command, brought additional changes. More realistically, the revised XB-51's top speed was set at 521 knots and its cruising speed at 434. Since the XB-51 was intended essentially as a low-altitude weapon, the radius requirement was decreased, bearing in mind that the Shoran (*sho*rt-*ra*nge *n*avigation) system earmarked for the plane was limited to less than 200 nautical miles. These final characteristics were approved by AAF Headquarters in early 1947. Shortly thereafter, the aircraft's development, in limbo for over a year, was re-instated.

Special Features 1949

Martin decided that a turbojet version of the basic XB-51 was the best configuration to satisfy the military characteristics that had been finally approved. Hence, the all-metal, mid-wing monoplane was fitted with 3 J47 engines. Two of the engines were in nacelles mounted on pylons on the lower forward sides of the fuselage, while the third engine was carried internally in the rear fuselage, with a top air inlet and a jet exit in the aircraft's tail.

First Flight 28 October 1949

The experimental XB-51 made its first flight on 28 October 1949. It was



Two of the XB-51's turbojets were mounted on the fuselage. The third was inside the rear fuselage.

the Air Force's first high-speed, jet-propelled, ground support bomber, and was one of the first post-war airplanes designed to destroy surface targets in close cooperation with Army ground forces.

Definitive Development Contract 1 November 1949

Martin's letter contract of May 1946 was superseded on 1 November 1949 by a formal contract of the cost-plus-fixed-fee type. This contract (W33-038 ac-14806), carrying the same number as the 3-year-old letter contract, increased the amount initially obligated by $500,000 to cover the contractor's fixed fee.

Subsequently, change orders were to raise the cost of the ill-fated, $10.2 million development contract. Meanwhile, the procurement requirements of 1946 remained unaltered. Martin was required to provide mockups, spare parts, technical data, and 2 XB-51s.

Testing 1949-1952

Testing of the first XB-51 was extensive. The Phase I tests, which lasted until the end of March 1951, indicated that relatively few modifications were needed and attested to the serviceability and excellent functional design of the experimental aircraft. Results of the Phase II tests, that had been conducted from 4 April to 10 November 1950, corroborated these findings. Martin pilots flew the first XB-51 (Serial No. 46-685) for 211 hours, accumulated in 233 flights. Air Force pilots totaled 221 hours on the same aircraft. The number of Air Force test flights was not accurately recorded, but did exceed 200. Flight testing of the second XB-51 (Serial No. 46-686), first flown on 17 April 1950, although thorough, was relatively brief. Martin test pilots flew the aircraft 125 hours, accumulated in 168 flights; the Air Force put in 26 hours, presumably reached in 25 flights. The second XB-51 was destroyed on 9 May 1952, during low-level aerobatics over Edwards AFB, California. The pilot was killed as the aircraft exploded and burned upon striking the ground.

Total XB-51s Accepted 2

The Air Force accepted the 2 XB-51s built by Martin. The first one was accepted and delivered on 22 January 1952;[40] the other during the previous month, on 8 December 1951.

Program Cancellation — November 1951

The Air Force canceled production of the B-51 before the 2 experimental aircraft were formally accepted. Air Force records offered various reasons for the decision. For example, the XB-51 had received a second-best rating in comparison with other aircraft designed to fulfill similar mission roles. Yet, these records failed to identify the aircraft which were compared and the factors that established the XB-51's disappointing rating. Considering the time invested in the XB-51's development (about 5 years), the Air Research and Development Command offered a more specific explanation. The command stated that termination of the XB-51 contract in November 1951 was due to the fact that the plane, in its existing configuration, did not meet the requirements, particularly the range requirement, of the Tactical Air Command.

Total Development Costs — $12.6 million

Although Martin was informed in November 1951 that the XB-51 program was ended, the light-bomber contract was not closed out until 7 October 1953, when a last change order was issued. This document had several important purposes. It instructed the contractor to repair the first of the 2 experimental aircraft which, though significantly damaged in February 1952, was the only remaining XB-51. The Air Force also instructed Martin to prepare the plane for bomb-dropping tests and to send 2 field service representatives to participate in a 3-month bomb-dropping program to be conducted at Edwards AFB. The final change order, in addition, determined the last sums owed to Martin. Included were $381,439 for the aircraft's repair, some $90,000 for the required special work and the field representatives' services, plus 2 fixed-fees. Added to the expenses previously incurred for minor repairs and unexpected modifications, this brought the total cost of the experimental program to $12.6 million, a $2.4 million increase in about 4 years.

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[40] Delivery of the first XB-51 was delayed because of the extensive testing conducted by the contractor—a routine procedure.

Final Disposition 24 March 1956

The Air Force did not determine the final disposition of the repaired and much improved XB-51. The aircraft was totally destroyed on 25 March 1956 in a crash at Biggs Field, Texas. In the meantime, however, a great deal was learned from the experimental program. The work performed by the 2 XB-51s in the high-speed bomb-release program contributed much to advancing the state-of-the-art in that field. Also, the tail configuration, variable incidence wing, and bicycle-type landing gear of the XB-51 provided useful design data.

TECHNICAL AND BASIC MISSION PERFORMANCE DATA

XB-51 AIRCRAFT

Manufacturer (Airframe)	The Glenn L. Martin Co., Baltimore, Md.
Manufacturer (Engines)	The General Electric Co.; Schenectady, N.Y.
Nomenclature	Light Bomber
Popular Name	None

Length/Span (ft)	85.1/53.1
Wing Area (sq ft)	548
Weights (lb)	
Empty	29,584
Combat	41,547
Takeoff	55,923[a]
Engine: Number, Rated Power per Engine, & Designation	(3) 5,200-lb st J47-GE-13
Takeoff Ground Run (ft)	
At Sea Level	4,340[a] (no assist)
Over 50-ft Obstacle	5,590[a]
Rate of Climb (fpm) at Sea Level	3,720 (normal power)
Combat Rate of Climb (fpm) at Sea Level	6,980 (max power)
Service Ceiling (ft) (500 fpm Rate of Climb to Altitude)	32,400 (takeoff weight/normal power)
Combat Ceiling (ft) (500 fpm Rate of Climb to Altitude)	38,900 (combat weight/max power)
Average Cruise Speed (kn)	434
Max Speed at Optimum Altitude (kn/ft)	500/35,000 (combat/max power)
Combat Radius (nm)	378 with 4,000-lb payload at 463 kn average in 1.82 hr
Total Mission Time (hr)	2.07
Crew	2 (pilot and Shoran operator)
Armament	8 20-mm guns with total ammunition of 1280 rounds
Maximum Bombload (lb)	4 internal bombs (1,600 lb ea) or 2 external bombs (2,000 lb ea)
Maximum Bomb Size (lb)	4,000
Rockets	Provisions only for (8) 6-in HVAR[b]

Abbreviations

cal	= caliber	max	= maximum
fpm	= feet per minute	nm	= nautical miles
kn	= knots	st	= static thrust

[a]Including 1,275 lb water/alcohol.
[b]High-Velocity Aircraft Rockets.

YB-60

Consolidated Vultee Aircraft (Convair) Corporation

Basic Development — 25 August 1950

The YB-60 originated in August 1950, when the Consolidated Vultee Aircraft (Convair) Corporation offered to develop the B-36G, a swept-wing, all-jet version of the B-36F—fourth model of the basic B-36, initiated in 1941. The design, covered by the contractor's formal proposal, could eventually be converted into a turboprop bomber. Moreover, existing B-36s could later be brought up to the new configuration's standards.

Military Characteristics — November 1945

The first in a series of post-World War II military characteristics for heavy bombardment aircraft was issued on 23 November 1945. These characteristics were revised many times, but by 1950 the experimental aircraft thus far favored still fell short of satisfying the overall performance and long-range requirements expected of an atomic-capable, strategic bomber, due to be operational around 1955.[41]

Initial Procurement — 15 March 1951

A letter, rather than a formal agreement, supplemented the basic B-36 contract and authorized Convair to convert 2 B-36Fs into prototype B-36Gs, entirely equipped with turbojets but capable of accepting turboprop engines. The first YB-36G was to be ready for flight testing in December 1951; the second, in February 1952.

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[41] See B-52, pp 207-218.

Redesignation — Mid-1951

The proposed B-36G had little in common with the B-36F. The Air Force therefore determined that the B-60 designation would be assigned to the plane, because of the striking change in physical appearance and improvement in performance over that of the conventional B-36 airplane.

Program Change — August 1951

A misunderstanding concerning the configuration of the B-60 prototypes compelled Convair to recommend in August 1951 that at first only 2 stripped aircraft be developed. Accepting responsibility for the error, the contractor also proposed that the second YB-60 later be completed as a full tactical model. The Convair solution meant that separate specifications would have to be developed for each prototype. The Air Force agreed, after a 2-day conference during which the basic tactical configuration was set.

Special Features — 1951–1952

The B-60 prototype differed significantly from the B-36 by featuring swept-back wings and swept-back tail surfaces, a new needle-nose radome, a new type of auxiliary power system, and 8 Pratt & Whitney J57-P-3 jet engines, installed in pairs inside "pods" suspended below and forward of the leading edge of the wings. Another special feature of the YB-60 was its extended tail, which enabled the aircraft to remain in a level position for a considerable period of time during takeoff and to become airborne, with a gross weight of 280,000 pounds, after only 4,000 feet of ground roll.

Engine Shortages — 1951–1952

The J57-P-3, earmarked for the YB-60, was primarily scheduled for the B-52. Thus, while Convair would be able to use the Boeing-designed nacelles and engine pods, which seemed to be a distinct advantage, engine shortages were to be expected. This was particularly true, since the J57 engine was itself the product of an intensive effort to develop a high-thrust turbojet with a low fuel consumption. By the beginning of 1951, engine prototypes had accrued only 550 hours of full-scale testing. In 1952, even though production was already started, the engines were likely to remain in very short supply for quite a while.

First Flight 18 April 1952

The YB-60 flew for the first time on 18 April 1952—only 12 days after the prototype's eighth J57-P-3 engine finally arrived at the Convair's Fort Worth plant. The 66-minute flight was hampered by bad weather, but 2 subsequent flights in the same month were entirely successful, the YB-60 actually displaying excellent handling charateristics. This encouraging trend, however, did not prevail.

Flight Testing 1952-1953

Flight testing of the YB-60 officially ended on 20 January 1953, when the Air Force canceled the second phase of the test program. Convair test-flew the first YB-60 for 66 hours, accumulated in 20 flights; the Air Force, some 15 hours, in 4 flights. The second YB-60, although 93 percent complete, was not flown at all. By and large, test results were worrisome, because the stripped YB-60 displayed a number of deficiencies. Among them were engine surge, control system buffet, rudder flutter, and problems with the electrical engine-control system.

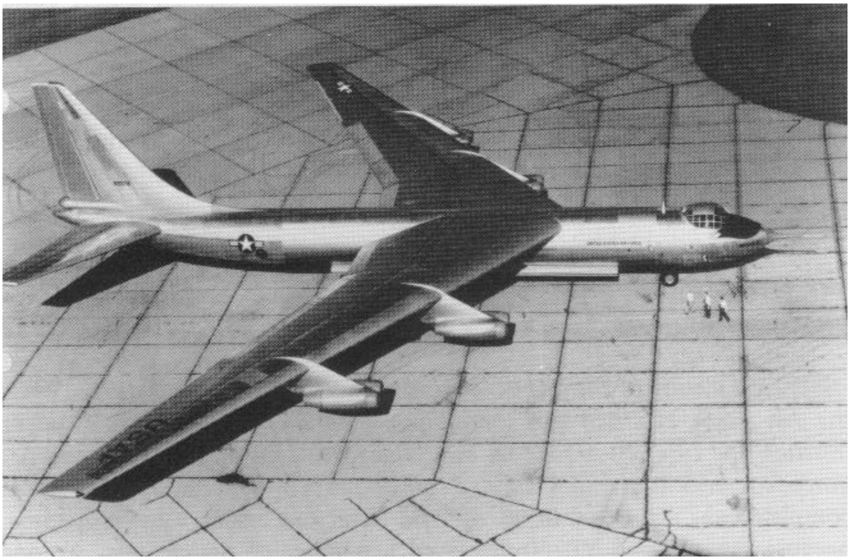
Program Cancellation 14 August 1952

The Air Force canceled the B-60 program several months before the prototype testing was officially terminated. The decision was inevitable. From the start, the project's sole purpose had been to help the Air Force in its quest for a B-36 successor. In this capacity, the B-60 competed all along with the B-52. There was no official competition, but test results were irrefutable. The YB-52 demonstrated better performance and greater improvement potential than the YB-60.[42] The latter was handicapped by the speed limitation imposed by structural considerations at low altitude and buffet at high altitudes. Also, the Convair prototype's stability was unsatisfactory because of the high aerodynamic forces acting upon the control surfaces and the low aileron effectiveness of the plane.

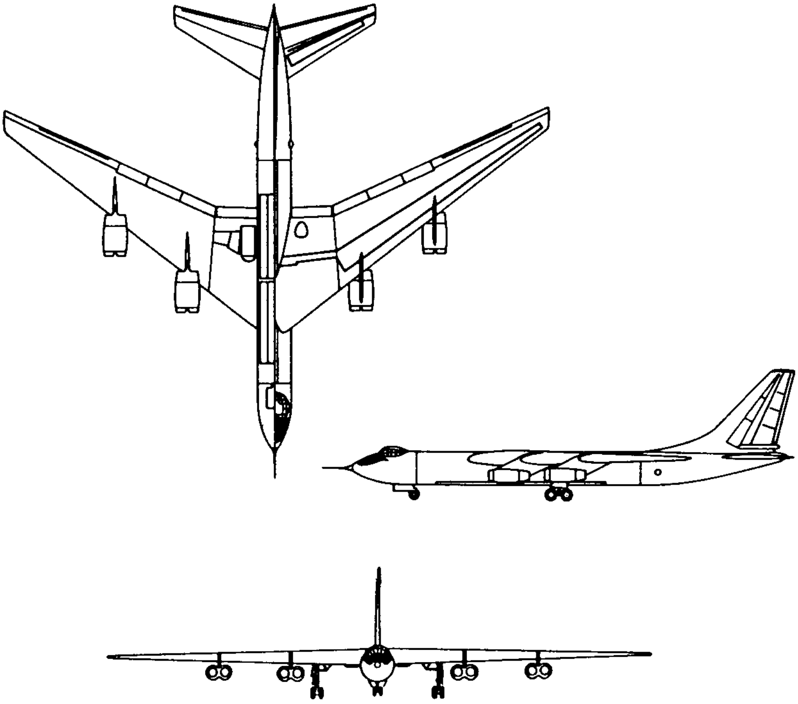
Total YB-60s Accepted 2

The B-60 program was canceled in the summer of 1952, and testing of

[42] The YB-52's first flight on 15 April 1952—3 days ahead of the YB-60's—was an impressive success and generated great enthusiasm for the Boeing airplane.



The prototype YB-60, a reconfigured B-36 with jet engines and swept-back wings.



the stripped prototype ended in January 1953. Even so, the Air Force did not accept the 2 YB-60s before 24 June 1954. There were valid reasons for the delay. Convair truly believed, and tried to convince the Air Force, that the YB-60s should be used as experimental test-beds for turbopropeller engines. Shortage of money and the YB-60's several unsafe characteristics accounted for the Air Force's decision to turn down Convair's tempting proposal.

Total Development Costs $14.3 million

The final cost of the 2 B-60 prototypes was set at $14,366,022. This figure, agreed upon by both the Air Force and the contractor on 13 October 1954, included Convair's fee, the contract termination cost, and the amount spent on the necessary minimum of spare parts.

Final Disposition June 1954

The Air Force scrapped the 2 YB-60s before the end of June 1954.

TECHNICAL AND BASIC MISSION PERFORMANCE DATA

YB-60 AIRCRAFT[a]

Manufacturer (Airframe)	Consolidated Vultee Aircraft (Convair) Corporation, Fort Worth, Tex.
Manufacturer (Engines)	The Pratt & Whitney Aircraft Division of United Aircraft Corporation
Nomenclature	Strategic Heavy Bomber
Popular Name	None

Length/Span[b] (ft)	171/206
Wing Area (sq ft)	Not Available
Weights (lb)	
Empty	150,000
Takeoff	410,000 (contractor design)
Engine: Number, Rated Power per Engine, & Designation	(8) 9,000-lb st J57-P-3
Service Ceiling (ft)	45,000
Maximum Speed (kn)	451
Combat Speed (kn)	440
Range (nm)	8,000
Combat Radius (nm)	2,910 with 10,000-lb payload at average speed of 400 kn
Crew	10

Abbreviations		
kn	=	knots
nm	=	nautical miles
st	=	static thrust

[a]Based on contractor's estimates and flight-test results.

[b]The new swept wing reduced the overall span to 206 ft as compared with 230 ft for the B-36.

XB-70A
North American Aviation, Incorporated

Manufacturer's Model NA-278

Weapon System 110A

Basic Development 1954

The XB-70A had its genesis in Boeing Aircraft Corporation's Project MX-2145, in which the contractor conducted studies relating to the type of weapon system required to deliver high-yield special weapons. The contractor, along with the Rand Corporation, considered various types of weapon system carriers. Among them were manned intercontinental bombers, delivering both gravity bombs and pilotless parasite bombers; manned bombers, air-refueled by tankers to extend their ranges and cover round-trip intercontinental distances; manned aircraft and drone bomber combinations; and unmanned bombers. During these studies Air Force Headquarters requested enlargement of the study program to include possible trade-off information; for example, the potential results of trading weight for speed, weight for range, or speed for range.

Boeing presented the requested information on 22 January 1954, pointing out the possibilities of a bomber aircraft powered by chemically augmented nuclear powerplants. For the first time, it appeared feasible to develop a weapon system of a reasonable size possessing the unlimited range characteristics of nuclear propulsion,[43] plus a high-altitude, supersonic dash capability. In March 1954, Boeing presented promising data on a chemically augmented, nuclear-powered aircraft. At the same time, both the Convair

[43] The development of nuclear propulsion for aircraft or missiles originated in 1945. In May 1946, the Army Air Forces signed a "letter of intent" with the Fairchild Engine and Airplane Corporation, thereby conferring on the highly classified NEPA (Nuclear Energy for the Propulsion of Aircraft) program a legal right to exist. While favoring the program, General LeMay, then Deputy Chief of Air Staff for Research and Development, said the work to be performed under NEPA would be somewhat speculative.

Corporation and Lockheed Aircraft Corporation, under contracts with the Office of Aircraft Nuclear Propulsion, submitted similar data.

Developmental Changes — Fall of 1954

In the fall of 1954, the Air Force Council endorsed 2 independent but simultaneous development programs, one for a nuclear bomber capable of short bursts of supersonic speed;[44] the other, for a subsonic, chemically powered, conventional bomber. The Air Force Council's announcement closely followed the October publication of General Operational Requirement No. 38. The document was brief. It simply called for an intercontinental bombardment weapon (a piloted bomber) that would replace the B-52 and stay in service during the decade beginning in 1965.

General Operational Requirement — 1955

The Air Force, on 22 March 1955, put out a second general operational requirement, No. 82, which superseded No. 38. Like its predecessor, the new general operational requirement was short. It called for a piloted strategic intercontinental bombardment weapon system that would be capable of carrying a 20,000-pound load of high-yield nuclear weapons, a requirement increased to 25,000 pounds by a September amendment. But the task of defining the Air Force's new project fell to the Air Research and Development Command. The command, therefore, had issued a study requirement, designated No. 22, which identified the Air Force's future new bomber as "Weapon System 110A" and established 1963 as the target date for the first wing of 30 operational vehicles.

Study Requirement 22's performance objectives were mach .9 for cruise speed and "maximum possible" speed during a 1,000-nautical mile penetration. Still, high speed was of less importance than the penetration altitude and radius. A revision of Study Requirement 22 on 15 April stipulated that the new weapon system's cruise speed should not be less than mach .9, unless a lower speed would result in a significant range increase. There were other important changes. Instead of the subsonic requirement covered by General Operational Requirement 38, maximum possible "supersonic"

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[44] General Operational Requirement No. 81, issued in March 1955, specifically called for the development of a nuclear-powered weapon system that would be capable of performing a strategic mission of 11,000 nautical miles in radius, of which 1,000 miles were to be traveled at speeds in excess of mach 2, at an altitude of more than 60,000 feet.

speed within the combat zone was desired. On 11 October, Air Research and Development Command amended the revised Study Requirement 22. The amendment set July 1964 as the target date for the first operational wing of B-70s—so designated in February 1958. The purpose of the delay was to avoid financial and overall weapon system risks, if at all possible.[45]

Other Requirements 1955–1956

In early 1955, the Air Force released another general operational requirement (No. 96) for an intercontinental reconnaissance system having similar objectives as the previously established bombardment system, known as Weapon System 110A. In July, the Air Research and Development Command issued a study requirement of General Operational Requirement 96 that validated a reconnaissance version of the B-70. The reconnaissance system was identified as Weapon System 110L. The 2 systems were combined soon afterward, becoming in the process Weapon System 110A/L.

Program Implementation June 1955

In June 1955, the Air Staff directed that development of Weapon System 110A/L be initiated as soon as possible with a multiple, competitive "Phase I" program.[46] Although 6 eligible contractors were contacted, only the Boeing Airplane Company and North American Aviation, Incorporated chose to submit proposals.

Contractual Arrangements 1955–1956

On 8 November 1955, the Air Force awarded letter contracts to both Boeing and North American for the Phase I development of Weapon System 110A/L. Boeing's letter contract amounted to $2.6 million; that of North

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[45] In 1955, the Air Research and Development Command estimated the weapon system's costs through fiscal year 1962 at $2.5 billion. The estimate covered development, test aircraft, and 30 operational bombers, but assumed that a nuclear bomber would also be developed, that a new engine for the chemically powered bomber would be created, and that the price of certain subsystems, earmarked for the B-70, would be borne by the nuclear aircraft program.

[46] The use of "phase" contracts was not new, having been approved as early as 1944 by the Army Air Forces to facilitate the termination of contracts dealing with highly experimental and, therefore, very uncertain programs.

American, to $1.8 million. Each contractor had to furnish a design for the required weapon system; provide models, drawings, specifications, reports, and other data; conduct studies and wind tunnel tests, and construct a mockup. The mockup was to be completed and ready for Air Force inspection within 2 years of the date on which the contractor accepted the contract. Contractor fees could not exceed $450,000.

The 2 letter contracts became definitive in 1956. The Boeing contract, AF33(600)-31802, signed on 15 March, specified a total estimated cost of $19.9 million; the North American contract, AF33(600)-31801, signed on 16 April, $9.9 million, subject to renegotiation. The Air Force, in its definitive contracts, allotted originally $4.5 million to Boeing and $1.8 million to North American.

Military Characteristics 1956

Concurrent with the letter contracts of 1955, the Air Force established specific requirements that were included in the final documents signed in 1956. To begin with, each contract emphasized that the purpose of the entire program was to develop, test, and produce for wing strength by 1963 (much sooner than decided in October 1955) a chemically powered weapon system which, in conjunction with the nuclear-powered bomber, would replace the B/RB-52 as a "first line operational weapon."

With regard to operational characteristics, the new weapon system was to rely primarily on nuclear weapons to accomplish its mission, and the origin and termination of its operations were to be within the limits of the North American continent. The Air Force specified that weapon system 110A/L would have to be capable of performing during the day, at night, and in any kind of weather. A minimum unrefueled radius of 4,000 nautical miles, and a desirable extended radius of 5,500 nautical miles were required, with aerial refueling allowed in the latter case. Finally, the minimum target altitude was to be 60,000 feet, and the contracts reiterated that cruise speed could not be less than mach .9, with maximum supersonic dash speed in the combat zone.

These were exacting characteristics. Studies of conventional aircraft had shown that no such performance could be obtained with proven design techniques. The Air Force acknowledged that the ability to satisfy its demands, particularly the radius-of-action and speed requirements, would depend on the use of high-energy fuels, new engines, new design techniques, and some other break-through in the state-of-the-art by the operational date of 1963. The Air Force also made sure that the contractors knew that while range and speed trade-offs would be acceptable in order to assure maximum supersonic dash at a "practical" gross weight, every reduction would have to be minimal. Finally, the new weapon system's configuration would have to allow for the easy addition of state-of-the-art improved subsystems and components, not initially incorporated.

Design Proposals — Mid-1956

Naturally enough, the preliminary design proposals submitted in mid-1956 by Boeing and North American were quite different. Boeing utilized a conventional swept-wing configuration; North American, a canard-type, resembling a scaled-up Navaho missile.[47] Still, in order to attempt meeting the payload requirements and ranges stipulated in the spring of the year, the contractors had incorporated similar features in their respective designs. The aircraft envisioned by both would weigh some 750,000 pounds and require the use of cumbersome floating wing panels. These panels would carry fuel for the outgoing trip and be jettisoned when empty. Maximum speed might then exceed mach 2 by a significant margin.

The Boeing and North American preliminary designs had another common factor: both were unsatisfactory. The gross weights were excessive. The proposed fuel devices, whether fuel panels or straight floating wing tips, while promising to extend the aircraft's subsonic range, seemed impractical. To begin with, the enormous expendable panels (or non-folding floating wing tips) would create logistical problems and runway difficulties because of the total width of any airplane so equipped. In September, a disappointed Air Staff recommended that both contractors "return to the drawing board." And money being short, a more drastic decision followed that nearly spelled the program's cancellation. On 18 October, the Air Force discontinued the weapon system's Phase I development. Boeing and North American were allowed to resume their studies, but solely on a reduced research and development basis.

Concerned that the contractors might construe their contract's reorientation as resulting from lack of funds—an interpretation not far from the truth—and would merely mark time while refining their current designs, the Air Force promptly minimized the impact of its October decision. First, new work statements were issued, underscoring the necessity of achieving acceptable, but less exacting, performance characteristics. Then on 20 December, the Air Force sent identical letters to the presidents of Boeing and

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[47] The North American SM-64A Navaho (System 104A) was a vertically launched, air-breathing, intercontinental surface-to-surface, delta-wing missile, with a length of 87 feet and a diameter of 6½ feet. Production was canceled in July 1957 because of budgetary and technical problems. The Navaho development cost over $600 million, but the work expended on the canceled program was not a loss and benefited other projects significantly.

North American, asking that every possible means be explored to improve the aircraft's range "through complete redesign if necessary."

Contractor Selection — 23 December 1957

After the delay induced by the rejected proposals, events moved swiftly. By March 1957, it seemed almost certain that the new weapon system could be an all-supersonic cruise air vehicle as opposed to a "split-mission" (subsonic cruise-supersonic dash) aircraft.[48] In other words, aircraft designers had discovered that, if the entire design (especially engines, air induction system, and airframe) was geared for a single flight condition such as mach 3, the range of the supersonic system would compare favorably with that of a subsonic vehicle. Both contractors, independently, had also concluded that, as suggested by the Air Force, high-energy fuel would be needed and that its use should be extended to the engine afterburner.

In mid-1957, believing their re-oriented contractual commitments had been fulfilled, Boeing and North American asked for an early competitive selection of 1 contractor over the other. Dual contracting and dual funding made extra work and was costly. Moreover, the Air Research and Development Command was convinced that state-of-the-art advances had been fully exploited by both contractors. Further study of the project would mean more delay and be self-defeating. Hence, the tempo of activities quickened. On 30 August, the Air Force directed a 45-day competitive design period, ending with the onsite inspection of each contractor's facilities. On 18 September, the Air Force gave Boeing and North American the new system characteristics established for the competition. These characteristics called for a speed of mach 3 to mach 3.2, a target altitude of 70,000 to 75,000 feet, a range of 6,100 to 10,500 miles, and a gross weight between 475,000 and 490,000 pounds.

Meanwhile, a source selection evaluation group had been organized. It comprised 3 teams: representatives from the Air Research and Development Command, the Air Materiel Command, and, for the first time, a using command—the Strategic Air Command, in this case. The evaluation group, numbering about 60 members, reviewed the North American proposal during the last week of October; that of Boeing, during the first week of November.[49] The 3-team evaluations were presented to the Air Force Council

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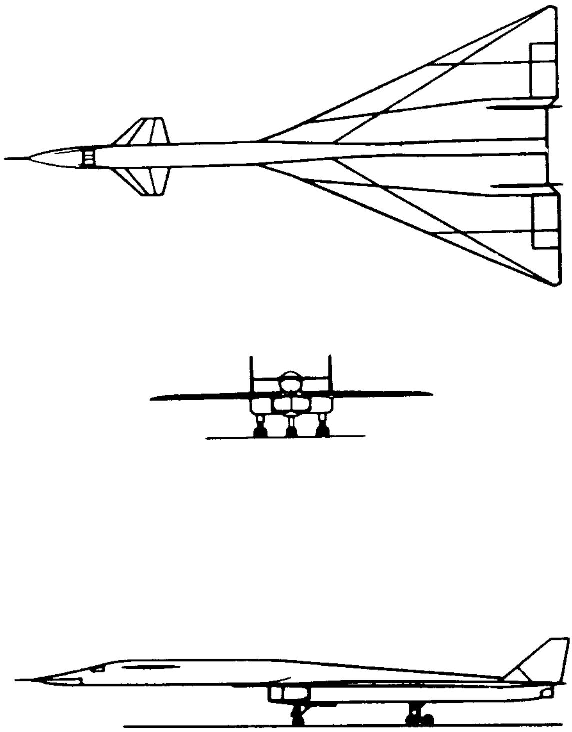
[48] Theoretical research on the "supersonic wedge principle," conducted by the National Advisory Committee for Aerononautics in 1956, actually had much to do with the "graduation" to an all-supersonic flight pattern.

[49] Due to the success of the 3-team evaluation group, the Air Force changed its source selection procedures, the using command becoming an integral part of the selecting process.



The striking XB–70A was "rolled out" at the contractor's plant.

on 15 December. The North American proposal was found unaminously to be substantially superior to that of Boeing. The Air Force formally announced North American's selection on 23 December.

New Planning 1958

As winner of the 1957 competition, North American on 24 January 1958 signed contract AF33(600)-36599. Strictly speaking, this document again covered only the new weapon system's Phase I development. Just the same, availability of the first operational wing (30 planes and 15 test vehicles) was already planned for late 1965. In February 1958, believing that by late 1965 or thereabouts, when the RB-70 would become operational, other systems could better satisfy the reconnaissance requirements, the Air Force canceled the development of Weapon System 110L (part of WS 110A since 1956).

While the reconnaissance requirement was being deleted, an 18-month acceleration of the B-70 program was planned. This change, endorsed by the Air Research and Development Command and Air Materiel Command, scheduled the aircraft's first flight for December 1961 and formation of the first operational wing for August 1964. No performance decrease would result, and the increase in costs would not exceed $165 million. The Air Staff approved the accelerated plan in principle on 19 March 1958. In the same month, a revised general operational requirement was issued, updating such matters as the speed specification. In April, a preliminary operational concept was published.

In the fall of 1958, the Air Force's apparent optimism had a severe jolt. Gen. Thomas D. White, Air Force Chief of Staff since August 1957, announced that the B-70 program's planned acceleration was no longer viable because of funding limitations. A first flight, therefore, should not be expected before January 1962; an operational wing, in August 1965, at the earliest. This reversal damaged the program, particularly the weapon system's components. General White wanted more judicious use of currently available equipment and flight test inventory. He further wished to reduce the overall complexity of the bombing-navigation and missile guidance subsystems. Of greater import, and a harbinger that worse might yet come, General White also told his staff that the Eisenhower Administration believed that no large sums of money should be committed to the program before the B-70 prototype had proven itself. General White's words reflected the Administration's determination to hold military expenditures for radically new or unproven weapon systems to a minimum, while taking advantage of technological advances. Deployment of the free world's first long-range ballistic missiles, and accelerating the operational readiness of additional weapons systems of this type, which appeared more cost-effective and less speculative, fell under the purview of such a philosophy.

Mockup Inspection 30 March 1959

A development engineering inspection and mockup review were conducted at North American's Inglewood plant on 2 and 30 March 1959, respectively. The mockup review differed from the inspection in that it was styled to present the operational characteristics and suitability of the weapon system's configuration, rather than to introduce detailed system analysis and theory. On both occasions, the Air Force requested a great many changes, some of which were considered of primary importance. Nevertheless, almost 95 percent of the work generated by the requested alterations was accomplished before the end of the year.

New Setbacks 1959

Decisions made in the second half of 1959 hampered Air Force aircraft development efforts, placing additional pressure on the B-70 program.[50] On 11 August, the Department of Defense canceled the high-energy fuel program. The use of this fuel had been counted on to extend the B-70's range substantially over its required radius. As it turned out, the high-energy fuel program cancellation had a lesser impact than anticipated because other jet fuels, JP-6 especially, were greatly improved. Just the same, as planning stood in mid-1959, elimination of the high-energy fuel program required additional configuration changes and, more specifically, a new engine for the B-70.

Termination on 24 September of the North American F-108 Rapier, a never-flown long-range interceptor under letter contract since 1957, was another blow. The B-70 program was directly affected. It would now be compelled to finance, at least partially, such development items as engines, escape capsules, and fuel systems that had been common to both aircraft systems and previously covered by F-108 funds. The loss was expected to boost B-70 program costs by at least $180 million.

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[50] The nuclear-powered bomber, after overshadowing the chemically powered aircraft for years, began to suffer from financial malnutrition in 1956. By mid-1959, decisions at the highest executive level had put the program into almost total eclipse. The project's downfall was bound to impede the B-70 program since the cost of several B-70 subsystems were to be borne by the nuclear-powered bomber—officially canceled by the Kennedy Administration in March 1961.

Near-Cancellation 1959

General White's words of caution notwithstanding, more than 15 major subcontracts were let during the early part of 1959. In the ensuing months, after the high-energy fuel program and F-108 project were given up, money became increasingly scarce, and most B-70 activities were slowed down. But the program's new predicament was only a beginning.

In November 1959, during a meeting concerning the military programs of the coming year, President Eisenhower told the Air Force Chief of Staff that the "B-70 left him cold in terms of making military sense." General White conceded there were important questions involved and that the aircraft was very different from anything previously developed. He said the B-70 must overcome the terrific heat generated by high speed and high altitude and that the shape of the aircraft's wings and fuselage must be studied. However, to eliminate such unconventional aircraft would be going too fast and too far. Hardly impressed with the many pro-B-70 arguments put forth, the President stressed that the B-70, if allowed to reach production, would not be available for 8 or 10 years, when the major strategic retaliatory weapon would be the missile. The President finally agreed to take another look at the B-70 proposition, but in the same breath pointed out that speaking of bombers in the missile age was like talking about bows and arrows in the era of gunpowder.

The Air Force announced on 29 December that the B-70 program was reoriented to produce a prototype vehicle only and that the development of most sub-systems was canceled. The program's near demise was generally attributed to the Administration's budget.

Program Reendorsement 1960

The politics of the 1960 presidential campaign kindled the interest of both parties in the B-70. Thus, with the approval of the Defense Department, the Air Force in August 1960 directed that the XB-70 prototype program once again be changed to a development and test program. Twelve B-70 prototypes were added, and the program was designed to demonstrate the bomber's combat capability. This directive, coupled with a congressional appropriation of $265 million for fiscal year 1961, restored the B-70 to the status of a weapon system headed for production.

In September, North American was instructed to proceed with the design, development, fabrication, and testing of a number of YB-70s. Also, development of the major systems for an operational mach 3 bomber had to be ensured, which meant that many of the recently canceled subcontracts (let by the prime contractors early in 1959) had to be reopened. This exercise might be time-consuming as well as difficult, since some of the subcontractors might now be involved in other work. Even so, by mid-October the defensive subsystem contract with Westinghouse Electric Corporation had been reinstated. In November, North American reactivated the contract with Motorola, Incorporated for the mission and traffic control system of the B-70. In the same month, development of the B-70's bombing and navigation system, under the auspices of the International Business Machines Corporation and significantly reduced since the summer of 1959, regained the impetus normally afforded a system intended for production. Still, the B-70 program's recaptured importance was to be short lived.

Definite Cancellation 1961-1962

Once in office, it did not take long for President John F. Kennedy to take a critical look at the B-70 program. Like his predecessor, President Kennedy obviously doubted the aircraft's reason for being from the standpoint of future operations. On 28 March 1961, he recommended that the program be continued in order to explore the problems of flying at 3 times the speed of sound with an aircraft "potentially" useful as a bomber.[51] This, President Kennedy underscored, should only require the development of a small number of YB-70s and bombing and navigation systems. No more than $220 million should be needed in fiscal year 1963, and the program's total cost should not exceed $1.3 billion.

President Kennedy's words gave the Air Force no choice but to redirect the B-70 program from full weapon system status to that of a mere prototype aircraft development. Since the aircraft's eventual production appeared now most unlikely, the Air Force immediately began to consider various alternatives to the defunct B-70. In May 1961, there was talk of an improved B-58, armed with both bombs and air-launched missiles; of a specially designed, long-endurance, missile-launching aircraft; of transport planes modified to launch ballistic missiles; of the nuclear-powered aircraft, and again of a reconnaissance B-70, which would also be capable of striking the enemy.[52] In August, the U.S. Senate attempted once more to rescue the

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[51] President Kennedy's recommendations were part of his special message on the Defense budget, as submitted to the Congress on 28 March. The President emphasized the importance of accelerating long-range missile programs and of increasing the armed forces' capability to handle limited wars.

[52] The Air Force's persistent search for a new manned bomber seemed unrealistic. On 25 May 1961, in an address to a joint session of the Congress, the President proposed to reinforce further the military establishment's capabilities in limited warfare and to expand substantially the Defense programs related to the newly accelerated national space effort. These specific

B-70 and asked that a production program be outlined for the purpose of introducing the aircraft into the operational inventory at the earliest possible date. Undaunted, Secretary of Defense Robert S. McNamara expressed his thorough dissatisfaction with North American Aviation's handling of the B-70 development.

The year 1962 did not resolve the B-70 predicament. The President insisted that only $171 million of FY 63 funds ($49 million less than proposed in 1961) be spent on the prototype program, instead of the $491 million requested by the Air Force and previously approved by Congress. In March, Congress indicated that the Air Force should use the $491 million for planning and procurement of a reconnaissance and strike B-70 (RSB-70), but later in the month reduced the amount to $362.6 million. In April, a group headed by Gen. Bernard A. Schriever, Commander of the Air Force Systems Command, developed several approaches to the proposed RSB-70 system. The development plan preferred by the group would cost $1.6 billion and it programmed the RSB-70's first flight within little more than 2 years. In June, this plan and others were disapproved by the Department of Defense. Nevertheless, on 23 November the President authorized the addition of $50 million to the currently approved $1.3 billion B-70 development program. The extra money was intended for the development of highly experimental sensor components, a requirement if the RSB-70 (as unlikely as it was) or any similar new weapons system should be considered later.

Technical Problems 1962

As explained to members of the Congress in January 1960 by Thomas S. Gates, Secretary of Defense during the last 2 years of the Eisenhower Administration, the B-70 program was hampered from the start by technical problems stemming from the "use of metal and components . . . still in the research stage." By 1962, although much progress had been made, severe problems remained. North American was still working on an automatic air induction control system for regulating the flow of air to the J93-3 jet engines, originally designed to power the canceled F-108 and, following the end of the high-energy fuel program, immediately earmarked for the B-70.

The secondary power generating subsystem, due to provide current to the pump that maintained hydraulic pressure, also was unsatisfactory.

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goals clearly indicated that production of a costly new aircraft was excluded from President Kennedy's foreseeable planning.

Excessive vibration caused failures in the generator gear boxes, and the hydraulic pumps frequently broke down. Braces were added to steady the gear boxes, but the pumps had to be rebuilt with metals capable of withstanding the intense heat of supersonic operations as well as the extreme pressure generated within the hydraulic lines.

At the close of 1962, other serious problems still prevented completion of the first air vehicle, accounting for North American's continual revision of the XB–70's delivery schedule. Defective stainless steel honeycomb panels necessitated an unanticipated number of repairs. The panels of the air ducting system bay and the fuel tank areas had numerous examples of such defects. A nickel-plating process was sufficient to eliminate most imperfections, but repairs on the fuel tank areas had to be air-tight to prevent the escape of nitrogen gas. In December, North American was considering giving up the use of polyimide varnish in favor of vitron sealant. Another significant problem was that the wings did not fit properly to the wing stubs. Special adapters had been developed and were being manufactured, but again this took time and money.

Other Difficulties 1963–1964

In 1963 and 1964 frustrations with the B–70 increased. Almost 40 of the $50 million approved for the development of sensor components was diverted to the experimental bomber to allow continuation of the 3-plane program. In June 1963, the Air Force converted the XB–70 contract from the cost-plus-fixed-fee to the cost-plus-incentive-fee type. But no spectacular progress ensued. In September, North American suggested further delivery revisions. The first aircraft, North American said, would be completed in April 1964—4 months past the latest deadline assigned by the Air Force. In October, continued technical problems and rising expenses prompted the Air Force to request that the cost of a 2-vehicle program be defined. On 7 January 1964, Gen. Curtis E. LeMay, Air Force Chief of Staff since 30 June 1961, although a strong supporter of the B–70, endorsed the Air Force Council's recommendation favoring the 1-vehicle reduction. The decision was dictated by the compelling need to avoid exceeding the program's approved total cost of $1.5 billion. The decision also practically closed the case of the two-XB–70 program and definitely prevented the start of RSB–70 development.

First Flight — 21 September 1964

The first flight of the XB-70A Valkyrie[53] occurred on 21 September 1964, nearly 4 years later than the date scheduled in 1958 (right after North American had won the contract). The experimental bomber flew for approximately 1 hour in the northeast-southwest corridor between Palmdale, California, and the Rogers Dry Lake at Edwards AFB, also in California. The 2-member crew—Alvin White, North American Chief Test Pilot, and Col. Joseph F. Cotton, USAF B-70 Chief Test Pilot—landed successfully at Edwards AFB. Nevertheless, the plane had to undergo additional ground tests before entering an extensive flight testing program at Edwards.

Special Features — 1964

The striking features of the experimental B-70 centered on the configuration and composition of its airframe, with its semi-monocoque fuselage of steel and titanium. Also, the bomber's external skin was composed of brazed stainless steel honeycomb sandwich, wide use having been made of titanium alloys. The XB-70's flying controls comprised elevons on the trailing edges of the cantilever delta wings and twin vertical fins and rudders. The large canard foreplane was adjustable to achieve "trim" (balance in flight or landing, etc.). Its trailing edge flaps enabled it to droop the elevons to act as flaps, making it possible for the XB-70 to take off from and land on existing B-52 airstrips.

Unrelenting Problems — 1965–1966

Continued technical difficulties delayed the XB-70's testing program. For the same reasons, completion of the second experimental B-70 took longer than expected, and the bomber did not fly before July 1965. Less than a year later, on 19 May 1966, the second XB-70A flew for 32 minutes at the sustained speed of mach 3. Unfortunately, tragedy closely followed this remarkable achievement. On 8 June, the plane was lost in a mid-air collision with a Lockheed F-104 fighter. The loss, occurring at approximately 25,000 feet, near Barstow, California, 43 miles east of Edwards AFB, reduced the XB-70A program to a single vehicle.

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[53] The name Valkyrie resulted from a "name the B-70" contest, sponsored by the Strategic Air Command in the spring of 1958.

Total XB-70As Accepted **2**

Total Development Costs **$1.5 billion**

Final Disposition **1967**

In March 1967, the Air Force transferred the remaining XB-70A to the National Aeronautics and Space Administration, where the plane took part in an expanded flight research program. The program's main objective was to verify data applicable to a supersonic transport. The space agency's retention of the XB-70 was of short duration. Before the end of the year, the Valkyrie reached its final destination and was put on display at the Air Force Museum, Wright-Patterson AFB, Ohio.

TECHNICAL AND BASIC MISSION PERFORMANCE DATA

XB-70A AIRCRAFT[a]

Manufacturer (Airframe)	North American Aviation, Inc., Los Angeles, Calif.
Manufacturer (Engines)	General Electric Co., Flight Propulsion Division, Evendale, Ohio
Nomenclature	Supersonic Bomber
Popular Name	Valkyrie

Length/Span (ft)	185.8/105
Wing Area (sq ft)	6,297
Weights (lb)	
Empty	231,215
Combat	341,096
Takeoff	521,056 (273,063 lb of fuel, included[b])
Engine: Number, Rated Power per Engine, & Designation	(6) 28,000-lb st (max) YJ93-3 (axial turbojet)
Takeoff Ground Run (ft)	
At Sea Level	7,400 (with max power)
Over 50-ft Obstacle	10,550 (with max power)
Rate of Climb (fpm) at Sea Level	7,170 (with military power)
Combat Max Rate of Climb (fpm) at Sea Level	27,450 (with max power)
Service Ceiling (100 fpm Rate of Climb to Altitude)	28,100 ft (with military power)
Combat Service Ceiling (100 fpm Rate of Climb to Altitude)	75,500 ft (with max power)
Combat Ceiling (500 fpm Rate of Climb to Altitude)	75,250 ft (with max power)
Basic Speed at 35,000 ft (kn)	1,089 (with max power)
Average Cruise Speed (kn)	1,721
Max Speed at Optimum Altitude (kn/ft)	1,721/75,550 (with max power)
Combat Range (nm)	2,969
Total Mission Time (hr)	1.87
Crew	2 (pilot and co-pilot)
Armament	None
Maximum Bombload (lb)	65,000 (space provisions, only)
Maximum Bomb Size (lb)	25,000

Abbreviations

fpm	= feet per minute
kn	= knots
max	= maximum
nm	= nautical miles
st	= static thrust

[a]Derived from flight-test results.
[b]Specifically, 43,646 gal of JP-6 fuel.

B-1A
Rockwell International Corporation

Manufacturer's Model W/S 139A

Basic Development 1963

Known as the Advanced Manned Strategic Aircraft (AMSA) until April 1969, the B-1 had its beginning in July 1963, when a USAF program change proposal called for an extra $25 million in fiscal year 1965. The Air Force wanted to use this money to develop 1 or more of the various advanced strategic manned systems then under study in mid-1963. Unofficially, the B-1 dated back to 1961, when the Air Force began considering alternatives to the canceled B-70.

Developmental Planning 1961-1963

Budgetary restrictions and the Eisenhower and Kennedy Administrations' clear belief that missile systems[54] like the Minuteman[55] were the strategic weapons of the future generally explained why the XB-70 did not go to production. Gen. Thomas S. Power, Commander-in-Chief of the Strategic Air Command since 1 July 1957, offered another reason: the B-70 was really "killed" because it was designed for flight at very high altitudes —an advantage when the aircraft was first conceived, which lost most of its attraction when the Soviets developed effective, high-altitude antiaircraft missiles. Whatever the cause, several studies were undertaken to circumvent the B-70's deficiencies, while enhancing the manned bomber concept. The Air Force insisted that bombers would continue as a necessary dimension to the United States' strategic deterrent capability.

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[54] See this appendix, p 569.

[55] The first Minuteman squadron was activated in late 1961, but the new intercontinental ballistic missile did not become operational until 11 December 1962.

The first of the bomber studies accomplished in the early sixties was finished in 1961. Known as SLAB (for *S*ubsonic *L*ow *A*ltitiude *B*omber), the study demonstrated that a fixed-wing aircraft of 500,000 pounds, with a payload of 12,000 pounds and an 11,000-nautical mile range, including 4,300 nautical miles at low altitude, was needed to replace the B-52. Next came ERSA (for *E*xtended *R*ange *S*trike *A*ircraft), a study which maintained that a 600,000-pound plane of variable swept wing with a payload of 10,000 pounds and a total range of 8,750 nautical miles (with 2,500 nautical miles at 500 feet) would suffice. Then in August 1963, a third study, LAMP (for *L*ow *A*ltitude *M*anned *P*enetrator), was completed. It recommended a 350,000-pound aircraft with a 6,200-nautical mile range (and 2,000 nautical miles at low altitude), carrying a 20,000-pound payload. As anticipated by the Air Force, these studies were not conclusive, and other planning was already in motion.

By mid-1963, a Manned Aircraft Studies Steering Group, headed by Lt. Gen. James Ferguson, Deputy Chief of Staff, Research and Development, examined various possibilities. Included were a long-endurance aircraft, a supersonic reconnaissance craft and, eventually, LAMP, which the steering group later recognized as most promising. In the meantime, another major Air Force effort to calculate its future needs had been making progress. Initiated in 1963 and known as "Forecast," the project was directed by Gen. Bernard A. Schriever, Commander of the Air Force Systems Command and an advocate of acquiring an advanced manned system.

In October 1963, Generals Schriever and Ferguson, accompanied by Lt. Gen. William H. Blanchard, Deputy Chief of Staff, Programs and Requirements since August 1963, met with other members of Project Forecast and the Manned Aircraft Studies Steering Group. The 2 organizations, after arguing over such factors as size and payload, eventually reached conclusions that were to provide the foundation for a new bomber, now termed the Advanced Manned Precision Strike System (AMPSS).

Requests for Proposals — November 1963

In November 1963, the Air Force gave 3 contractors—the Boeing Company, General Dynamics Corporation, and North American Rockwell Corporation[56]—requests for proposals for the AMPSS. However, as in the B-70's case, Secretary of Defense Robert S. McNamara had a tight hold on

[56] The North American Rockwell Corporation was formed on 22 September 1967, when North American Aviation, Incorporated, and Rockwell Standard Corporation merged, the 1967 designation being applied ahead of time for clarity's sake.

any money earmarked for a sophisticated new bomber. In addition, Mr. McNamara questioned the validity of the assumptions used by the Air Force to justify the AMPSS. Because of the Secretary's doubts, only $5 million became available, and the released requests for proposals were limited to the mere study of the bomber concept. Moreover, some of the tentative requirements outlined by the Air Force were promptly discredited by all contractors. One of the suggested USAF designs would have involved prohibitive costs; another, including a vertical and short takeoff and landing capability, was not feasible when dealing with the heavy gross weights envisioned by the Air Force. In any case, the industry's negative comments proved academic. By mid-1964, when the results of every study had been received, the requirements outlined in the requests for proposals of November 1963 had been substantially altered.

New Requirements — Mid-1964

By mid-1964 the bomber concept, illustrated by the proposed AMPSS, remained basically unchanged, but some of the tentative requirements previously identified had been redefined and the aircraft, expected to satisfy the new criteria, had been retitled as the Advanced Manned Strategic Aircraft (AMSA). Briefly stated, the AMSA system, while retaining the required takeoff and low altitude characteristics of the AMPSS, would also be capable of maintaining supersonic speeds at high altitudes. As a basis for further study, the Air Force in July 1964 gave the renamed, and now supersonic system, a projected gross weight of 375,000 pounds, and a range of 6,300 nautical miles, 2,000 of which would be flown at very low altitudes.

Project Slippage — 1964–1968

Against odds which at first appeared highly favorable, the AMSA project was to remain unsettled for years to come. Gen. Curtis E. LeMay, Air Force Chief of Staff, after briefing President Lyndon B. Johnson in December 1963 on the program's importance, secured in 1964 the Joint Chiefs of Staff's approval of the USAF plans. In that year, as well as others, Congress approved all the AMSA money the Air Force wanted, be it for project definition,[57] or for the advanced development of engines and of an

[57] Project definition would produce data on probable costs, time needed for development, and technical risks. If the results were satisfactory, the Air Force would be in a position to contract for further work.

avionics system. Yet, Secretary McNamara again refused to commit any Department of Defense funds unless he was given a better justification for developing the new manned system and a clearer picture of what the projected AMSA could do.

Attempts to change Secretary McNamara's opinion of AMSA were futile. The Secretary thought surface-launched ballistic missiles could perform the "assured destruction" strategic mission better than manned bombers, and insisted that development of an expensive new system of the AMPSS/AMSA class was most unlikely. On the other hand, he believed the technological effort of avionics and propulsion research and development should go on to produce advances in the state-of-the-art applicable to future or existing manned systems. Thus, while only small sums would be released for preliminary AMSA studies, significant amounts would be allocated for research work on subsystems and components.

In late 1964, Boeing, General Dynamics, and North American Rockwell submitted initial reports on their study of AMSA. Concurrently, propulsion reports were received from Curtiss-Wright, General Electric, and Pratt & Whitney, while International Business Machines (IBM) and Hughes Aircraft sent in their avionics recommendations. In 1965, as the airframe contractors continued to study the AMSA system, General Electric and Pratt & Whitney were selected to construct 2 demonstrator engines that would meet the requirements of the AMSA mission. While this seemed encouraging, the uncertainty of the AMSA project would soon increase.

In December 1965, the Defense Department selected an elongated version of the General Dynamics F-111, known as the FB-111,[58] to replace the Strategic Air Command's B-58s, B-52Cs, and B-52Fs by fiscal year 1972. The Air Force had not requested the development of a bomber version of the controversial F-111, and opinion varied widely on its likely value. Still, the acquisition of a low-cost, interim bomber had merits. The Air Force endorsed production of the plane so long as it did not jeopardize AMSA development. As General Ferguson stated in 1966, the FB-111 was and would remain a "stopgap airplane," an assessment shared by the Strategic Air Command and the entire Air Staff even though Secretary McNamara continued to think otherwise.

By 1968, an advanced development program for avionics had been assigned to 2 contractors, IBM and the Autonetics Division of North American Rockwell. They were to determine if advanced avionics concepts were achievable and compatible to operational development. Ten sub-

[58] Development and production of the FB-111 proved to be closely interlaced with the whole F-111 program. The bomber's coverage was therefore included in the F-111 chapter of *Post-World War II Fighters*, Vol. 1 of the *Encyclopedia of U.S. Air Force Aircraft and Missile Systems*.

contractors, selected by the 2 firms, worked on various components, studied a wide range of components, including forward-looking radar, doppler radar, and infrared surveillance. Early in that same year, the Joint Chiefs of Staff recommended the immediate development of AMSA, and Secretary McNamara once more vetoed the proposal. He preferred instead to develop several subsystems and components for upgrading the performance of the FB-111s and the remaining B-52s with new technology that might be applied to AMSA.

Planning Changes — March 1969

The election of Richard M. Nixon in 1968 brought about a fundamental transition in strategic thinking, particularly with regard to the continued usefulness of the strategic bomber. In March 1969, Melvin R. Laird, the new Secretary of Defense, announced that the Defense Department's bomber plans were being changed. To begin with, the programmed acquisition of 253 FB-111s would be reduced to 76, because the FB-111 lacked the range and payload for strategic operations. Secretary Laird also directed the acceleration of the AMSA design studies, noting that despite the numerous and costly improvements earmarked for the last B-52 models (B-52Gs and B-52Hs), a new strategic bomber was "a more appropriate solution for a longer term bomber program."

New Designation — April 1969

In April 1969, Secretary of the Air Force Robert C. Seamans, Jr.,[59] redesignated the AMSA as the B-1A.[60]

New Requests for Proposals — 3 November 1969

New requests for proposals were not issued before November 1969, even

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[59] Secretary Seamans succeeded Harold Brown on 14 February 1969. Dr. Brown had replaced Eugene M. Zuckert as Secretary of the Air Force on 1 October 1965—a position held by Secretary Zuckert since 23 January 1961. Mr. Zuckert began serving the Air Force in 1947, when he was Assistant Secretary for Management and worked closely with W. Stuart Symington, the Air Force's first Secretary. Mr. Zuckert proved to be an earnest supporter of the AMPSS/AMSA bomber. Dr. Brown for a while became an advocate of the manned strategic aircraft, although not necessarily of AMSA.

[60] The B-1A designation was temporarily changed to B-1. Still, most of the time, the system continued to be referred to as B-1A.

though a competitive aircraft system design, coupled with an initial engine development program, had been approved in November 1968. The delay, oddly enough, was intended to speed up matters, which it did.

From the start, it had been clear that the design characteristics of the manned strategic bomber system would change as full-scale development proceeded. Because of the system's complexity, trade-offs that would affect performance were not only expected—they were considered as a future integral part of development. The Air Force was convinced that a continuation of the design competition would be fruitless and that, as agreed by Secretary Seamans, further studies would only add to the vast amount of paperwork already produced. Defense Secretary Laird's decision in March 1969 to revise the program in order to begin the B-1A's engineering development sooner confirmed the Air Force's conclusions that additional competitive designs would be time consuming and raise the program's cost without a commensurate return that could be measured by any tangible improvement of the system.

Thus, requests for proposals were issued in November 1969 that reflected an unequivocal departure from the temporizing motions of the past. The new requests were based on Defense Department approval of the USAF engineering plan and were meant to promote the prompt award of major contracts. The same airframe manufacturers, plus the Lockheed Aircraft Corporation, were in fact asked how they proposed to fabricate the B-1A airframe and to satisfy the integration requirements of the total system. In the same month, engine proposals were requested from the General Electric Company, and the Pratt & Whitney Corporation. Proposals for avionics design were again solicited, this time from 15 avionics companies. Only 5 of them chose to submit proposals to the B-1A program office.[61]

Contractor Selection 1969-1970

The avionics proposals received in December 1969 were swiftly disposed of, those of the Autonetics Division of North American Rockwell and the Federal Systems Division of IBM being selected on the 19th. In another positive departure from past procedures, the contracts awarded to the 2 companies no longer centered on feasibility but on advanced development studies. Yet, the overall avionics program was soon to experience serious setbacks.

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[61] Established within the Aeronautical Systems Division as the AMSA program office on 13 March 1964 and redesignated in the spring of 1969.

Selection of the airframe and engine contractors started poorly, as Congress cut back on B-1A money for fiscal years 1970 and 1971. Such a decision was bound to increase development time which, in turn, would raise costs. Still, the Air Force had no recourse. Contractors had to revise airframe and engine proposals (received in January and February 1970) to fit under the program's immediate funding ceiling. The revision delay was short, but no effort could completely eradicate the impact of present and future financial restraints.

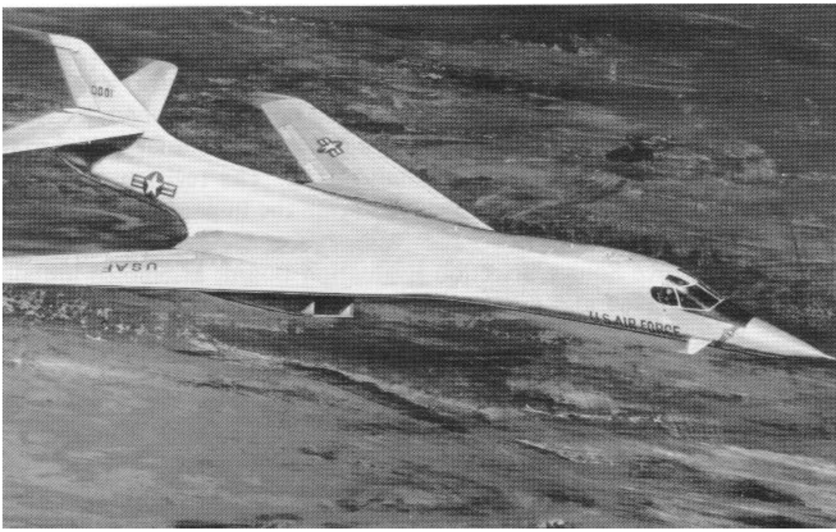
The Air Force Source Selection Evaluation Board, assembled initially on 8 December 1969 and numbering about 600 personnel at one time or another, began evaluating and scoring the revised proposals in the spring of 1970. On 5 June, following a presentation to the Defense Systems Acquisition Review Council, Deputy Secretary of Defense David Packard endorsed the Air Force's contractor selection. On the same date, Air Force Secretary Seamans announced that North American Rockwell and General Electric had been selected as the respective B-1A airframe and propulsion contractors. Secretary Seamans's announcement, wholly supported by the Air Force Chief of Staff and all the general officers in charge of the various Air Force commands concerned with the program, rested on 2 basic factors: superior technical proposals, as well as lower cost estimates.

Contractual Arrangements — 5 June 1970

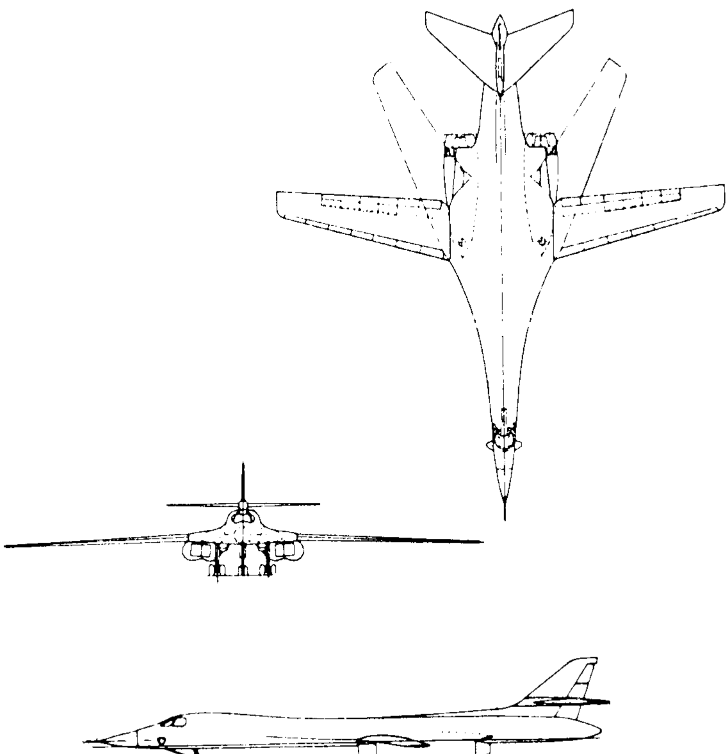
The Air Force negotiated 2 cost-plus-incentive-fee contracts for the B-1A development—a type of contract providing great incentive for technical innovations. Both contracts were awarded on 5 June 1970. The North American Rockwell contract (F33657-70-C-0800), with its 90/10 sharing basis,[62] had a target price of $1.3508 billion. If performance, cost, and time estimates were met, the contractor's incentive fee would amount to $115.75 million. The contract called for the development and delivery of 5 test aircraft, plus 2 structural test articles. It also covered system integration, which encompassed Total System Performance Responsibility, meaning that North American Rockwell would not be simply responsible for the B-1A airframe, but for the full-fledged weapon system.

The General Electric Company cost-plus-incentive contract (F33657-70-C-0801) had a sharing basis of 80/20 and a target price of

[62] The contract's sharing arrangement meant that 10 percent of any amount over the target ceiling of $1,350.8 million would be deducted from the contractor's incentive fee. But if the contractor fulfilled his commitments for less than targeted, 10 percent of the difference would be added to the incentive fee.



An artist's conception of the B-1 in flight.



$406.7 million.[63] It covered the design, fabrication, and qualification testing of 40 engines, as well as a potential incentive fee of $30.2 million.

Immediate Setback 1970

As already noted, the Air Force knew that unexpected funding restrictions would cloud the beginning of the B-1 development. A possible palliative was to minimize management costs and to promote economy in the acquisition of the aircraft without affecting its future performance. To this aim, a special study—Project Focus—came into being. Sponsored by the B-1 project office and actively supported by the 2 major contractors, Focus did satisfy some of the Air Force's money-saving requirements. However, the Focus managerial achievements were not enough to prevent the entire project, as well as related studies, from infringing on other facets of the B-1A development program.

Most Focus recommendations were approved by Secretary Seamans before the end of 1970. One of them dealt with the assignment of a minimum of program office personnel in close proximity to the plants of principal contractors and subcontractors. The arrangement, not new but significantly extended, would reduce the voluminous, periodic paper reports that routinely plagued important development programs. It would also foster the detection and solution of many problems before they could affect cost, schedule, or performance. The Air Force believed a savings of about $60 million might ensue. Many other Focus recommendations were endorsed. Some of them, particularly those with long-range impact, were open to question.

The B-1A program was not an experimental or a prototype venture. Yet, without definitive financial support from the Congress, the Air Force did not know how many aircraft the ultimate B-1 force would include. A figure of 241 production aircraft was used for planning purposes, but this planning was doubly tentative in view of Deputy Secretary of Defense Packard's new concept of systems acquisition. "Fly-before-buy," as the concept was known, emphasized hardware demonstrations, at predetermined dates, prior to making such major program decisions as full-scale development and production. In addition, approval of the Department of Defense Systems Acquisition Review Council would be needed before the B-1A development program could enter a new phase.

All Project Focus decisions had been reached under the purview of

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[63] The cost-sharing basis of the General Electric contract followed the formula used for North American Rockwell, except that percentages and amounts were different.

Deputy Secretary Packard's new acquisition concept. Among the most salient ones was the determination that efforts not directly contributing to a logical production decision would be deleted or deferred until such a decision had been made. Also, B-1A flight test hours would be reduced by combining the development, test, and evaluation phase (DT&E) with the initial operational test and evaluation phase (IOT&E). This was a fairly drastic departure from the established USAF testing cycle, in which the contractor took care of all initial tests (Category I) and the Air Force's participation began with the so-called Category II.[64] But the new procedure of having Air Force and contractor personnel fly together in test aircraft was expected to eliminate duplication that usually occurred during the categories I and II flights of the regular test program. In any case, the program's thoroughness was not to be undermined. The initial development flight test program was scheduled for 1,060 hours, 100 of which (later increased to 200) were to be completed prior to a production decision.

Project Focus did not overlook wind tunnel testing. Such testing would not be diminished, but the USAF facilities at the Arnold Engineering Development Center in Tennessee would be used to the maximum extent possible. Air Force program officials, after meeting with Arnold personnel, had estimated that the air vehicle would require over 18,000 hours of wind-tunnel testing; the engine, some 12,000. Other noteworthy recommendations, due to decrease costs by almost $180 million, were to be reflected in a forthcoming program reduction.

Program Reduction — 18 January 1971

The B-1A development program, initiated under the procurement arrangement of June 1970, did not last long. As anticipated, Congress in the summer of 1970 had further restricted the B-1 funding to levels below $500 million for several fiscal years to come. And while Focus and additional B-1 innovation studies helped to save money, they could not totally prevent some undesirable changes. On 18 January 1971, Secretary Seamans approved a reduced program which cut the number of flight test aircraft from 5 to 3, decreased the airframe's amount of costly titanium, and slightly lowered some performance requirements. In addition, the procurement of engines was slashed from 40 to 27; selected major structural items would be tested to design-limit load levels to eliminate, if at all possible, the purchase of a static test aircraft; and the development program's pace would be slowed down.

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[64] Until the late fifties, phases—instead of categories—delineated specific facets of the testing program. However, the program's streamlining and new terminology barely affected the test cycles and objectives. For details, see B-52, p 225.

In effect, as rescheduled, the B–1A's first flight would slide from March to April 1974, and a production go-ahead would not be considered before April 1975—a 1-year lapse between first flight and production decision, instead of the 6 months originally agreed upon. Finally, the initial operational capability (IOC) date was moved to December 1979, when the Strategic Air Command would receive its 65th B–1A. This was a long delay. Back in 1970, the Air Force had planned that the command would receive the 68th production aircraft by December 1977 and would reach IOC by that date.

Other Changes — Mid-1971

Early in 1970, IBM and North American Rockwell had participated in avionics studies, referred to as Junior Crown. This project analyzed the pros and cons of various avionics packages, taking into consideration size, performance, and cost. Junior Crown, in addition, identified equipment and development phases associated with the progression from the initial avionics subsystems to the standardized ones. But the period's budgetary limitations had also induced B–1 program officials to single out alternate design configurations. Five of those alternate combinations were based on the initial subsystems; 4, on the avionics equipment featured by several F–111 models.

In mid-1971, Secretary Seamans informed Gen. John D. Ryan, Air Force Chief of Staff since 1 August 1969, that because the B–1A production go-ahead had been postponed and only limited avionics would be needed for quite a while, earlier avionics plans could be shelved. All told, selection of an avionics subcontractor was no longer urgent; as required to accomplish the Category I tests, research and development, test and evaluation (RDT&E) B–1As would be fitted with FB–111A components and other off-the-shelf avionics; such equipment would be installed by North American Rockwell; and industry was being notified that the choosing of an avionics integrating contractor was deferred.

Secretary Seamans's decision did not negate the built-in growth factor approach that had been part of the Air Force's B–1A requirements from the start. This approach meant that technological advances could be incorporated into the aircraft design throughout the development period. In fact, while early B–1As would be equipped with available avionics, space would be provided to allow for the later installation of a more advanced network.

Unexpected Shift — September 1971

After stating in mid-1971 that selection of an avionics integrating contractor could wait, the Air Force changed its mind. On 29 September, requests for proposals that separated the avionics subsystems into offensive and defensive functions, were issued to 27 companies. Only 5 companies chose to submit proposals, but all were received before the end of November. Still, the evaluation of proposals was a time-consuming task, a factor that probably explained the Air Force's unexpected about-face. In any case, it would take until 13 April 1972 for the Boeing Company to receive the $62.4 million contract that was involved. This agreement, covering the development of offensive avionics and integration of avionics subsystems, like those of the 2 main contractors, was of the cost-plus-incentive-fee type. The contract's terms were different, however. It had a 90/10 sharing percentage arrangement, and a zero to 14 percent profit range, with a $1 million award fee provision.

In November 1971, requests for proposals for the B-1A's future defensive avionics also were issued to 23 companies. Only 2, Airborne Instrument Laboratory, a division of the Cutler-Hammer Corporation, and the Raytheon Company, responded. Evaluation of the 2 proposals was completed in February 1972, but no contract resulted because the Air Force decided that new requests for proposals were needed. The decision was prompted by the system's complexity. The Air Force believed that development of the advanced defensive avionics wanted for the B-1A could very well involve great technological risks. Therefore, it would be more sensible to divide the project into 2 phases. The first would be a 10-month attempt by 2 competing contractors, working under fixed-price contracts for a maximum combined price of $5 million. The second phase would cover engineering development, but only 1 cost-plus-fixed-fee contract would be finally awarded.

The revised requests for proposals were received by 23 firms on 17 May 1972. One year later, the same 2 contractors (Airborne Instrument Laboratory and Raytheon Company) were nearing completion of their Phase I contract—the 10-month risk reduction demonstration. Phase II, due to begin in mid-1973, was scheduled to run through December 1976. It would commence with proposal instructions for development of the radio frequency surveillance and electronic countermeasures subsystem. In the event that contractor proposals proved unacceptable, the Air Force planned to evaluate one of its own conventional subsystems.

Mockup Review — October 1971

The B-1A mockup review occurred at the North American Rockwell's Los Angeles Division in late October 1971, 2 months after the arrival of a full-scale mockup of the General Electric F101 engine. The review's primary objective was to determine if the USAF specifications were being met by the prime contractors, but some 200 Air Force representatives also examined the location of equipment in the mockup, ease of maintenance and operation being of great importance. The mockup review board and the contractors ended developing and processing 297 requests for alteration. Over 90 of those concerned the maintenance of the future aircraft; nearly 60 dealt chiefly with safety; and 10 with the aircraft's logistical support. The rest fell in the operational category. In addition, there were 21 requests for alterations to the engine, the most noteworthy one involving a change in the piping to make the engine handling mount more accessible.

Special Features 1971-1973

The future B-1A's most notable features were its variable swept wings, which could be fully retracted or totally extended in flight. The aircraft's body shape also was most unusual in that it tended to blend smoothly into the wing to enhance lift and reduce drag.[65] Finally, particularly in view of their length, the location of the 4 F101 supersonic turbofan engines, each in the 30,000-pound thrust class, was another very special feature. The engines (2 per pod) were mounted beneath the inboard wing, close to the aircraft's center of gravity, in order to improve stability when flying through the heavy turbulence often experienced at low altitudes.

The B-1A's special features promised to pay high dividends and put the new weapon system in a unique category. It differed radically from existing bombers,[66] particularly the B-52, the Air Force's highly praised but aging mainstay. Specifically, the B-1A's variable-geometry (swing) wing and high thrust-to-weight ratio would enable it to use short runways, a characteristic due to provide additional opportunities for aircraft dispersal throughout the United States. The new bomber would have a low turn-around and maintenance repair rate because of new methods for rapidly checking out and verifying subsystems. Although only two-thirds the size of the B-52, with aerial refueling the B-1A would be able to carry twice the weapons load over the same intercontinental distances. The future aircraft's supersonic fly-out speed would get it airborne faster, a vital asset in case of an alert warning. And with regard to a nuclear attack, hardening techniques would

[65] In accordance with the so-called blended-wing body concept.

[66] The relatively small FB-111A, the production of which ended in July 1971, basically was little more than a modified fighter. Its take-off weight was under 110,000 pounds and this interim bomber, as the Air Force regarded it, could not even be remotely compared to the future aircraft.

enable the B-1 bomber to withstand greater over-pressures and thermal radiation from nuclear weapons.

An automatic terrain-following radar and a near-sonic speed capability at low altitudes would permit the new weapon system to penetrate the sophisticated defenses expected to be used into the 21st century. The B-1A's low-altitude performance also would be a defensive advantage against enemy interceptor aircraft since the high aerodynamic stresses of low altitudes would nullify the interceptors' effectiveness. Moreover, the new bomber's small radar cross section would minimize its detection by enemy radars.

Development Problems 1971-1972

Development of any weapon system routinely entailed problems, and the Air Force did not expect the B-1A to deviate from this pattern. Yet, by the end of 1971, except for some weight increase, not an unusual occurrence, and difficulties with the crew escape system, problems were minor. For example, the aircraft's windshield, which included a thin polycarbon inner layer, had poor optical qualities and tended to shatter upon impact. However, 2 new windshields, incorporating different inner layers of stretched acrylic, were soon to be tested, and 1 of the 2 most likely would be satisfactory. The integrated semi-conductor of the Central Integrated Test System AP-2 computer also was deficient, but the technical problems of this major component were solvable.

The crew escape system was a different story. As developed (and eventually installed on the first 3 RDT&E B-1As), it resembled the F-111's crew module which ranked as a major advancement in aircraft design.[67] But when it came to the 4-crew B-1A, the new module's research and development costs could reach about $125 million; nearly half of that amount had already been spent, and test results thus far had been disappointing. Another alternative might be the development of standard, but greatly improved ejection seats—not the Air Force's preferred solution, but an option of last resort. Consequently, the B-1A program office in early 1972 planned to study once again the various options to the basic module system, knowing full well, however, that no clear answer was in sight. The B-1A's

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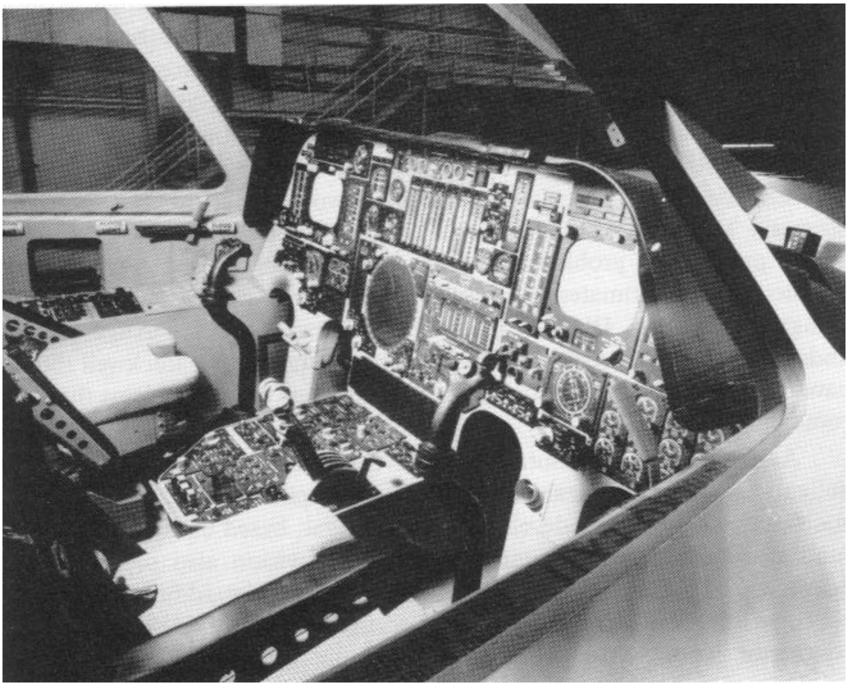
[67] Developed by the McDonnell Aircraft Corporation and initially tested in 1966, the crew module of the General Dynamics F-111 was fully automated. When forced to abandon his aircraft, the pilot only had to press, squeeze, or pull 1 lever. This caused an explosive cutting cord to shear the module from the fuselage; a rocket motor ejected the module upward and it parachuted to the ground or sea. There, like the Mercury and Gemini capsules of the U.S. early space programs, the capsule could serve as a survival shelter for the F-111's 2 crewmen.

prototype F101 engines also were experiencing some of the problems common to all development programs in their early stages. Such difficulties centered on turbine blade failures, high speed compressor stalls, excessive oil consumption, and related deficiencies. But all problems were being taken care of or soon would be. And the propulsion outlook seemed even more rewarding, when USAF engineers commented in mid-1972 that the General Electric F101 had the potential to be the most durable high-performance engine the Air Force had yet procured.

Second Slippage 1973

An April 1972 review of the B-1A program at the Los Angeles Division of the Rockwell International Corporation[68] yielded encouraging results, leading the Air Force to conclude that the B-1A's first flight would occur,

[68] So designated on 16 February 1973, following merger of the North American Rockwell Corporation with the Rockwell Manufacturing Company.



Interior view of the cockpit in a B-1 full-scale mockup.

as scheduled, in April 1974. But the optimism of the spring of 1972 did not necessarily prevail 1 year later.

In July 1973, Secretary of the Air Force John L. McLucas, who had replaced Secretary Seamans in May, notified Senator John C. Stennis, Chairman of the Senate Armed Services Committee, that fabrication of the first RDT&E B-1A had fallen behind schedule. The start of the second one also had been delayed, because the effort involved in manufacturing and assembling the aircraft had been underestimated. The Air Force had become aware of such problems in early 1973 and had turned down the contractor's request for overtime work, since this expedient might increase the program's technical risks and would definitely raise costs. Slowing down the development program seemed to be safer. As now planned, the initial flight of the first B-1A would take place in mid-1974; fabrication, assembly, and flight testing of the second and third B-1As would be slightly delayed, and the production decision would be postponed from July 1975 to May 1976. The new schedule would increase the estimated total development cost from $2.71 billion to $2.79 billion—an $80 million solution, cheaper than attempting to adhere to the original timetable through the expensive use of overtime.

As a direct response to Secretary McLucas' news, the Senate Armed Services Committee's Research and Development Subcommittee held on 27 July a special hearing concerning the B-1A program. Senator Thomas J. McIntyre, Chairman of the subcommittee, expressed his concern about the state of the program. Senator Barry Goldwater commented on the Air Force's inability to adhere to schedule and cost estimates for the program and requested assurance that the Air Force would meet the new schedule. Secretary McLucas pointed out that the Air Force did not anticipate any major production problems. Except for increases caused by inflation, production cost estimates were not expected to rise excessively. Maj. Gen. Douglas T. Nelson, Director of the B-1 program since 13 August 1970, underlined the Air Force's own dissatisfaction, stating that Rockwell should have been better prepared either to prevent or to solve the problems that had come up.

Asked about the contractual provision which limited government obligation each fiscal year, General Nelson explained that this provision enabled the Air Force to develop a stable budget, based on the contractor's funding request for the coming year. The provision also precluded the possibility of a subsequent request by the contractor for additional funds to continue working. The obligation for fiscal year 1974 was $312 million. The contractor would have exceeded this amount by $134.8 million if the development program had not been restructured and if the original schedule had been allowed to continue.

Another Reduction — Mid-1973

Restructure of the B–1A development required the amendment of the program's 2 major contracts, since both included very specific provisions. By supplemental agreement, signed before 15 July 1973, the first flight of the Rockwell International B–1A was moved from April to June 1974, and the initial flights of the second and third articles were scheduled for January 1976 and September 1975, respectively.[69] Selected static tests were to be completed by February 1976, while procurement of a full-scaled fatigue test B–1A was definitely deleted.

The General Electric contract, modified in the summer of 1973 like that of Rockwell International, involved more drastic changes. To save money, the number of experimental F101 engines was reduced from 3 to 2, the quantity of prototype F101s was cut from 27 to 23, and the option for 6 F101 qualification test engines was canceled. The modified contract provided for 4 F101 qualification test engines, and for an extended YF101 flight test program of 1,105 hours, due to end in September 1978. As in the airframe's case, engine deliveries were paced down.

The development program's entire funding also was spelled out in no uncertain terms. The total allotment for fiscal year 1970 through fiscal year 1974 was limited to $1.0238 billion, and the allotment for fiscal year 1975 was not to exceed $200 million. The allotment for subsequent years was established at $153.2 million per year, without restriction. Funds for the offensive avionics were included in such figures. The multi-year total for both offensive and defensive avionics was set at $71.8 million, but the money could be disbursed in a more flexible fashion. In other words, not more than $30 million could be spent in any given year through fiscal year 1974, but if only $11.8 million had been paid out by then, the remaining $60 million could be later disbursed in one lump sum.

The avionics funding flexibility was important in view of the fact that amendment of the B–1A weapon system's 2 major contracts dictated another significant change. Specifically, the Boeing offensive avionics integration contract, a $62.4 million deal, had to be revised to match Rockwell's new delivery schedules. Simply put, Boeing would have to postpone for 8 months the installation, check-out, and flight testing of the offensive avionics which, from the start, had been earmarked to be first integrated in the second B–1A.

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[69] This apparently odd sequence made sense; since the second B–1A was to be fitted with the first set of offensive avionics, a trying as well as time-consuming task.

Total B–1A's Accepted None

Total Development Costs $1.1338 billion

As of mid-1973, cumulative development costs reached over $1.13 billion. This total included the amount spent since 1963 on AMPSS/AMSA studies and other related projects. In 1970, when the program's first reduction occurred, Air Force budget analysts estimated that total development costs would reach $2.6283 billion; production costs (for the planned 241 B–1s), $8.4943 billion. Hence, the Air Force anticipated the entire program's cost would top $11 billion.

Program Status 1973

As 1973 came to a close, the future of the Air Force's new bomber, be it known as the AMSA or the B–1A, remained uncertain. In August, the Air Force Secretary asked Dr. Raymond L. Bisplinghoff, Deputy Director of the National Science Foundation, to conduct an independent review of the B–1A's status. Secretary McLucas' concern centered primarily on the restructured program's management and the adequacy of efforts to develop and produce the aircraft. The Secretary's request led to the formation of a review committee of 25, staffed with people from industry, the Air Force Scientific Advisory Board, other government agencies, and retired military and civilian federal employees. Members of the Bisplinghoff Committee, as it became known, worked quickly. On 4 October, Dr. Bisplinghoff and 3 committee members gave Secretary McLucas their findings.

Briefly stated, the committee did not foresee any technical problems that would prevent successful development or production, although the B–1 weapon system's complexity could not be overlooked. In this regard, except for wind tunnel testing and engine development,[70] the development program's new schedule was still unrealistic, and the program was insufficiently funded. There was no money to cope with possible problems. Moreover, 3 test aircraft were not enough in view of the redesign work that probably would be necessary prior to production. This was particularly crucial, since each test aircraft had a specific purpose. Should 1 of the 3 aircraft be destroyed during testing, the program's risks would be greatly increased.

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[70] The propulsion system, the committee members confirmed, was the program's brightest spot; chances were good that cost, schedule, and most technical goals would be realized.

Dr. Bisplinghoff in his conclusion described the B–1A's structure as airworthy, but heavy and costly. The Bisplinghoff Committee questioned the accuracy of the USAF estimates of the aircraft's empty weight, range, take-off distance, and refueling altitude. Therefore, the program's cancellation should be seriously considered, in the event of a further funding reduction for an already "marginal" program. As time would show, lack of funds, technical difficulties, and other problems were to plague the B–1A program. Governmental policy changes obviously had the greatest impact. But while the B–1A was to become a dead issue under one administration, a subsequent one would champion an improved version of the aircraft, later known as the B–1B.

TECHNICAL AND BASIC MISSION PERFORMANCE DATA

B-1A AIRCRAFT[a]

Manufacturer (Airframe)	Rockwell International Corp., Los Angeles Div., Los Angeles, Calif.
Manufacturer (Engines)	General Electric Co., Evendale Plant, Evendale, Ohio
Nomenclature	Strategic Bomber
Popular Name	None

Length/Span (ft)	145.3/136.7
Wing Area (sq ft)	1,946
Weights (lb)	
Empty	143,000 (est)
Combat	200,102 (est)
Takeoff	360,000 (est)—limited by landing gear strength
Engine: Number, Rated Power per Engine, & Designation	(4) 29,850-lb st F101-GE-100 (max with afterburners) (axial turbofan)
Takeoff Ground Run (ft)	
At Sea Level	4,440 (with max afterburner thrust)
Over 50-ft Obstacle	6,135 (with max afterburner thrust)
Rate of Climb (fpm) at Sea Level	2,820 (intermediate thrust)
Combat Max Rate of Climb (fpm) at Sea Level	30,930 (with max afterburner thrust)
Service Ceiling (100 fpm Rate of Climb to Altitude)	27,000 (intermediate thrust)
Combat Service Ceiling (100 fpm Rate of Climb to Altitude)	39,300 (intermediate thrust)
Combat Ceiling (500 fpm Rate of Climb to Altitude)	58,800 (with max afterburner thrust)
Basic Speed at 35,000 ft (kn)	1,092 (with max afterburner thrust)
Average Cruise Speed (kn) Outside Penetration Zone	420
Max Speed at Optimum Altitude (kn/ft)	1,262/59,000 (with max afterburner thrust)
Combat Range (nm)	6,103
Total Mission Time (hr)	14.0
Crew	4 (pilot, co-pilot, & 2 sub-systems operators)
Armament	
Internal	24 AGM-69A SRAMs[b]
External	8 AGM-69A SRAMs
Maximum Bombload (lb)	75,000

Abbreviations

cal	= caliber	max	= maximum
fpm	= feet per minute	nm	= nautical miles
kn	= knots	st	= static thrust

[a]January 1972 estimates.

[b]Short Range Attack Missile (SRAM), produced by the Boeing Airplane Company.

Glossary

AAF	Army Air Forces
AFB	Air Force Base
AMC	Air Materiel Command
AMPSS	Advanced Manned Precision Strike System
AMSA	Advanced Manned Strategic Aircraft
ARDC	Air Research and Development Command
Convair	Consolidated Vultee Aircraft Corporation
DT&E	development, test, and evaluation
ECM	electronic countermeasures
ECP	engineering change proposal
ELINT	electronic intelligence
ERSA	Extended Range Strike Aircraft
FEAF	Far East Air Forces
FPF	fixed-price-firm (contract)
FPI	fixed-price-incentive (contract)
FPIR	fixed-price-incentive renegotiable
FY	fiscal year
GAM	guided air missile
GEBO	generalized bomber study
GOR	general operational requirement
IBM	International Business Machines, Inc.
IFF	identification friend or foe
IOC	initial operational capability
IOT&E	initial operational test and evaluation phase
IRAN	inspect and repair as necessary
LAMP	Low Altitude Manned Penetrator
LAMS	Load Alleviation and Mode Stabilization
MADREC	Malfunction Detection and Recording
NASA	National Aeronautics and Space Administration
PACAF	Pacific Air Forces
QRC	quick reaction capability
RAF	Royal Air Force
Rand	The Rand Corporation, Santa Monica, Calif.
RDT&E	research and development, test and evaluation phase

GLOSSARY

SAB	Supersonic Aircraft Bomber
SAC	Strategic Air Command
SHORAN	short-range navigation technology
SLAB	Subsonic Low Altitude Bomber
SRAM	short-range attack missile
TAC	Tactical Air Command
TARC	Tactical Air Reconnaissance Center
TRW	tactical reconnaissance wing
USAF	United States Air Force
USAFE	United States Air Forces in Europe
VDT	variable discharge turbine
WIBAC	Wichita Boeing Aircraft Company (Project)

Selected Bibliography

This volume, covering over 30 years of aviation technology in bomber aircraft, is a compilation of Air Force data from countless official documents. Secondary sources (commercial publications, newspapers, etc.) were used only to confirm data of minor importance. The most important source materials were the major command histories and the special studies of the Air Force Logistics Command, the Aerospace Defense Command, and the Strategic Air Command. Air Staff semiannual reports, technical summaries, and records of wing and squadron histories also provided valuable information. These documents are in the archives of the USAF Historical Research Center, Maxwell AFB, Alabama. Those of special interest are listed below.

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