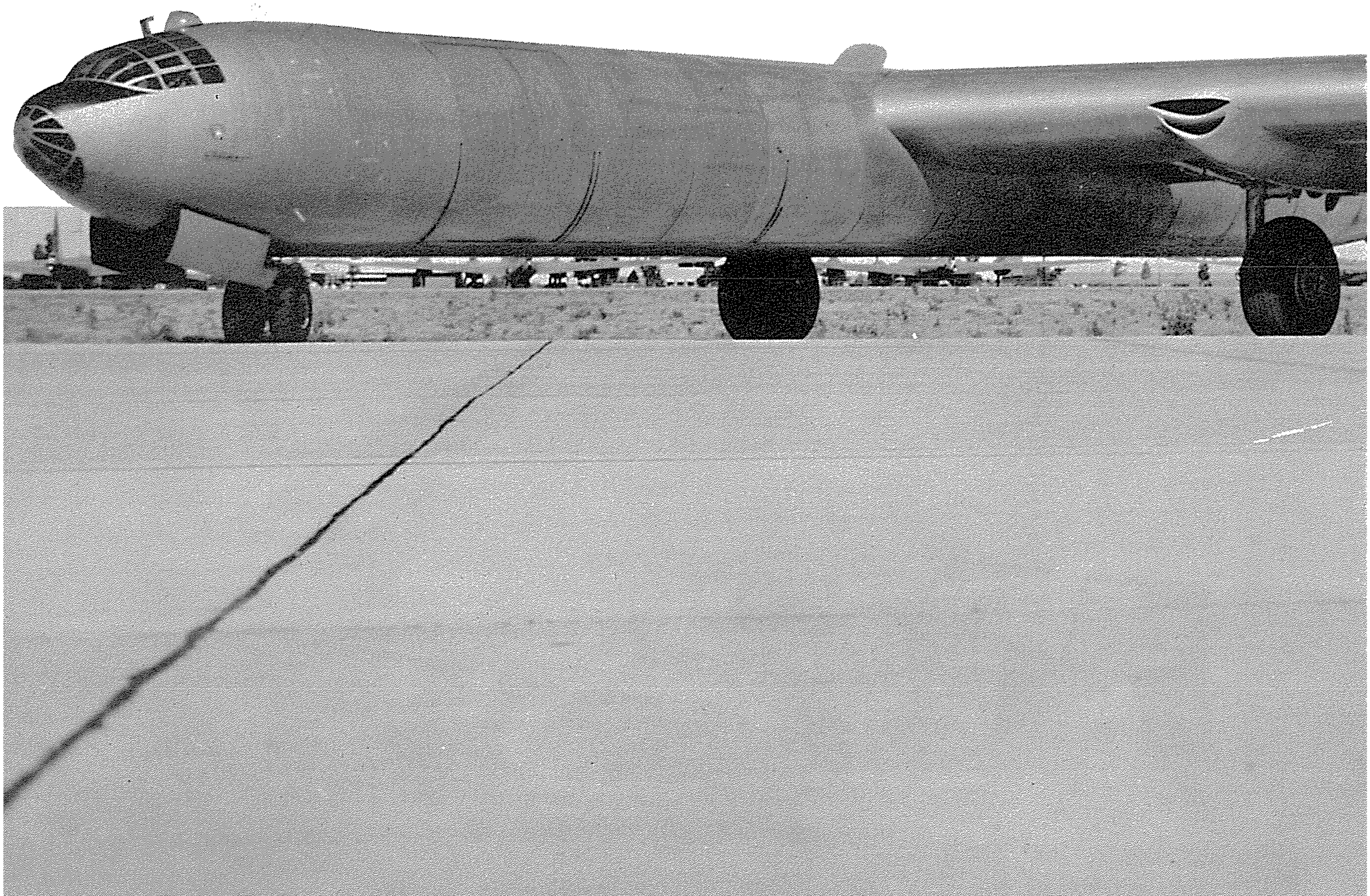
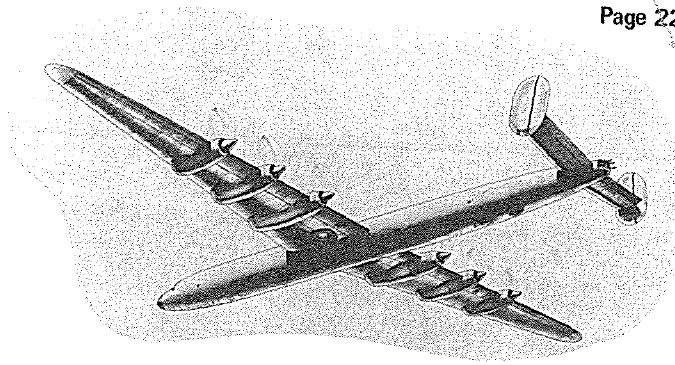
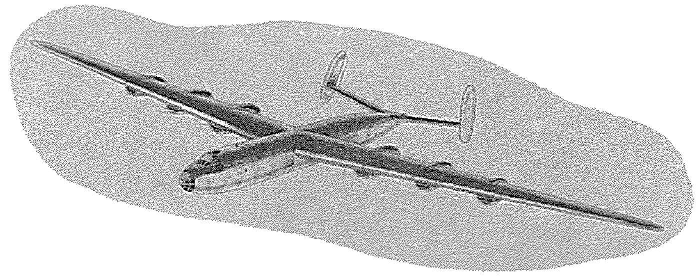
DESIGN DEVELOPMENT OF THE

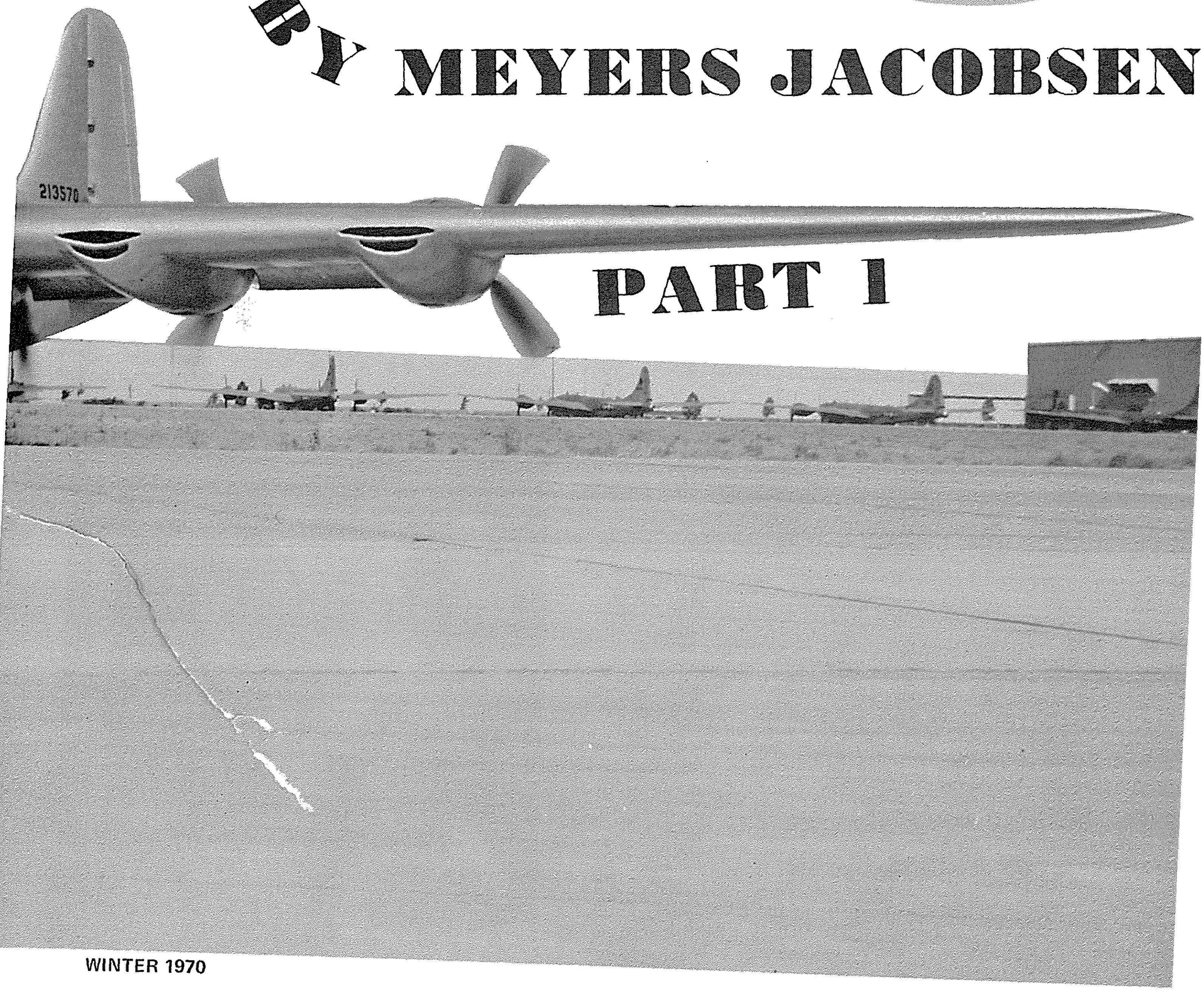


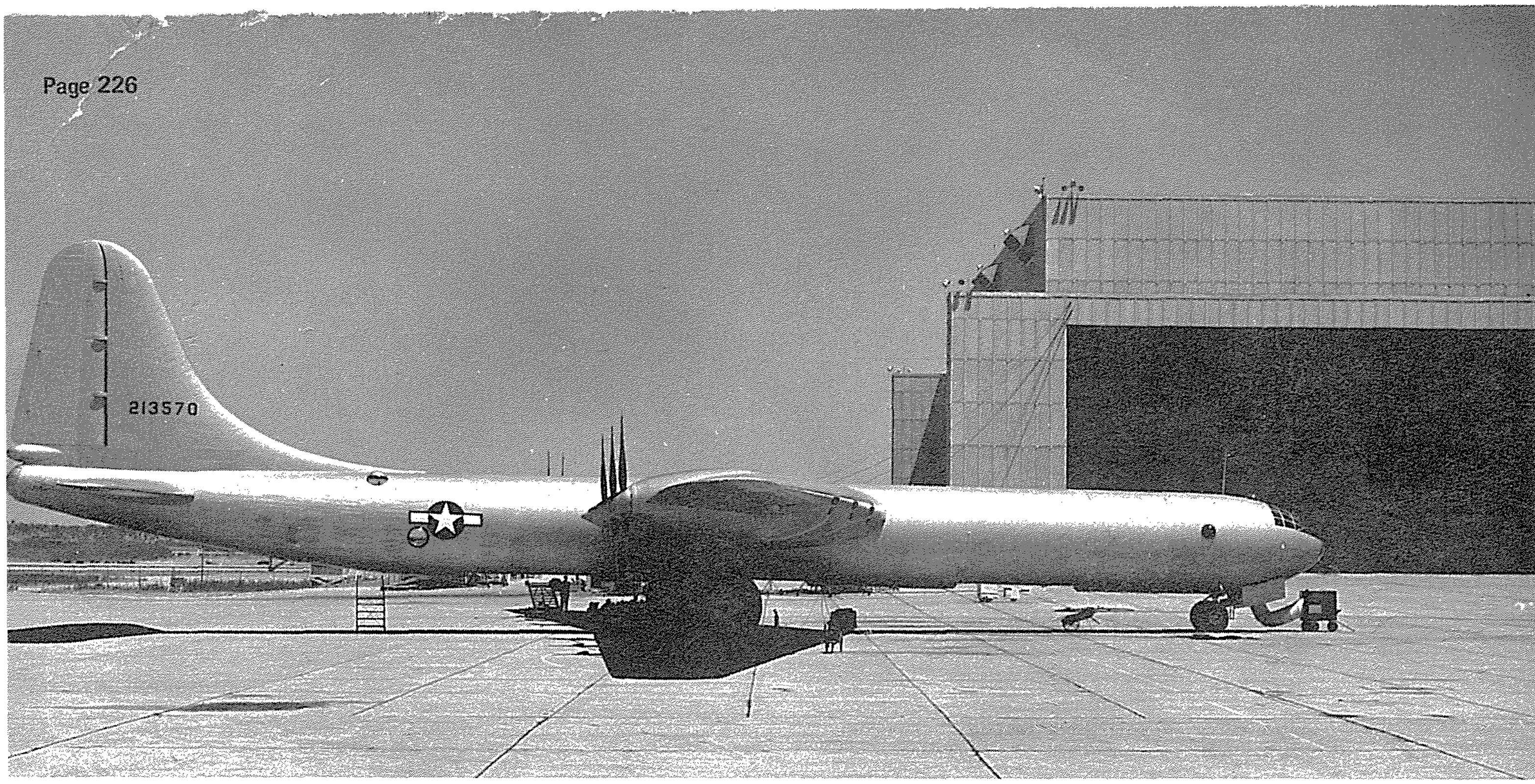




XB-36 BY MEYERS JACOBSEN

PART 1





Nearing the date of the first taxi tests, the XB-36 was being readied in the August sun, with the ground air conditioning unit connected at the forward inlet. The longest development program to date culminated in the first flight of the XB-36 on August 8, 1946. (Photo–Convair)

THE XB-36 PROTOTYPE STORY

The concept of the XB-36 intercontinental bomber had its origin in the year 1940, in some heavy bomber advance design studies conducted by Consolidated Aircraft Corp. Its actuation into a reality began in the Spring of 1941, some eight months prior to the entry of the United States into the Second World War. By early 1941 Nazi Germany dominated almost the whole of Europe – Britain stood alone – and the U-boats were slowly starving the British population and industry. The defeat of Britain, which appeared quite possible, could leave the U.S. without European allies or bases, while in the western Pacific, war clouds were impending, manifested in the invasion of China.

Faced with the overwhelming prospect of war, advance planning demanded realization of the need for a bomber capable of striking European targets from the North American continent. Accordingly, President Franklin D. Roosevelt, in conference with Gen. George C. Marshall and Air Corps leaders, directed that an intercontinental heavy bomber be developed.[1]

The competition for the design was initiated by the Army Air Force on 11 April 1941, asking for a bomber that could: 1)–carry a 10,000 pound load to a target 5,000 miles away and return; 2)–haul 72,000 pounds of bombs over a reduced range; 3)–travel at 300 to 400 miles per hour, and 4)–take off and land on a 5,000 foot runway. The requirements seemed quite unrealistic. The Boeing B-17, then the pride of the AAF, with an effective combat radius of 1,000 miles, could certainly not perform this mission. Two of the country's major aircraft manufacturers were solicited, Boeing and Consolidated. Preliminary design studies were drawn up, struggling with the 10,000 mile range requirement, and although Douglas and Northrop both entered the competition on an unsolicited basis, neither were able to come in with a proposal meeting AAF's requirements. They expressed doubt that such an airplane could be developed in the foreseeable future. Northrop, however, submitted its design for the XB-35 Flying Wing, a concept which seemed to hold some promise and it was developed simultaneously with the XB-36.

Anticipating the future need for a long range airplane, Consolidated had begun its design work in September 1940, as Model 35, and submittal of its proposal to "develop and construct two long-range, high-altitude, bombardment airplanes," of six-engine, pusher-type design, which the company felt would meet all of the AAF specifications, was made in October 1941. Interestingly, Wright Field engineering personnel, working independently of CAC, had also designed a six-engine, pusher-type bomber for the inter-continental mission, not differing greatly from Consolidated's Model 35.

B/Gen. George C. Kenney, then head of the Air Corps Experimental Division at Wright Field (later the first commander of the postwar Strategic Air Command), presented the drawings and his recommendations to M/Gen. Arnold, recently designated chief of the Army Air Forces.

I. M. LADDON

He felt that the CAC proposal, evaluated by the Air Material Division, might have the best potential. With the information before him, Gen. Arnold directed that arrangements be completed to purchase two experimental airplanes, as XB-36. The contract, W535-AC-2232, was awarded on 15 Nov. 1941, less than one month before Pearl Harbor. Basically it said that the cost of the two airplanes, including engineering, mockup, fabrication and testing of wind tunnel models, was to be $15 million, and that Consolidated would receive a fixed fee of $800,000. The total cost of the design competition had come to $435,623, of which $135,455 was paid to the winner, CAC, and the balance, over $300,000, went to Boeing, the loser. Also, the airplanes were to be built in San Diego, the first to be delivered in thirty months and the second to be delivered within six months after the first. Thus the first XB-36 should make its initial flight in May 1944.

In the closing days of 1941, with war now a reality, the most extensive research program ever associated with an Air Force airplane was launched. Consolidated was faced with problems never before encountered, most of which stemmed from the very large size of the airplane. There was then little experience with the structure/gross weight ratios dictated by the airplane's huge dimensions. In order to cruise the 10,000 mile mission, of almost two days' duration, the airplane must have low aerodynamic drag, low fuel consumption, and high engine durability. The fundamental factor influencing the selection of the pusher-type design was the need for smooth air flow over the wing, and location of the nacelles in the rear portion of the wing minimized external drag, and directional stability was improved.

In implementing its design, CAC would have to pay particular attention to aerodynamic smoothness and weight, and an enormous amount of new development work would have to be undertaken.

The development of manufacturing processes to produce smooth-skin, bonded structures was begun since unnecessary protuberances and joints between skins would all affect the speed and range, and absorb horsepower. Weight control was exercised by everyone on the project, as the design of details, assemblies and equipment had to be kept strictly within the weight allotments for each portion of the structure. The lessons emphasized were that, for each pound of weight over the allowance, two pounds of fuel would have to be added to achieve the maximum range of 10,000 miles.

New system equipment was required which, in many cases, was beyond the state of the art of that period. For ...mple, a 3,000 psi hydraulic system was deemed ...y. Consequently new pumps, valves, and actuating ...sm had to be developed from scratch, and the ...t weight of the sytem equipment was considerably ...an that of the standard 1,500 psi systems then in ... At the same time, Wright Field developmental ...oratories had been considering a new 400 cycle, 208 ...lt, 3-phase alternating current system. This would permit the use of new light-weight actuating motors. In a typical application, a 16-hp geared motor of 3,500 rpm would weigh only 23 pounds compared to 100 pounds for a similar motor of the direct current system. Greater reliability with higher rotation speeds could be obtained, and since no commutator or brushes were required the troublesome problem of arcing at the brushed in high-altitudes was overcome.

A methyl-bromide fire extinguisher system was developed to replace the usual carbon-dioxide system for powerplants. Methyl-bromide, having a much lower boiling point than carbon dioxide, allowed it to be stored as a liquid at lower pressure, thus permitting lighter weight storage tanks and conducting lines. (In actuality, it was not used on the first XB-36 but was installed on the second airplane which became the YB-36 and on the production airplanes.

The design genesis for the XB-36 prototype began with CAC's Model 35, a circular-fuselage, high-wing, twin-tail bomber which was to be powered with four pusher engines. It was smaller, (but larger than the B-29); wingspan was 164 feet, length 128 feet and wing area was 2700 square feet compared to the XB-36's respective figures of 230, 163 and 4,772. Very shortly after the award of the contract to Consolidated all of the existing Model 35 drawings were changed to Model 36 to coincide with the AAF's designation and avoid confusion. Most of the main characteristics of Model 35 were retained in the XB-36 design, including the twin tail, at least for a while.

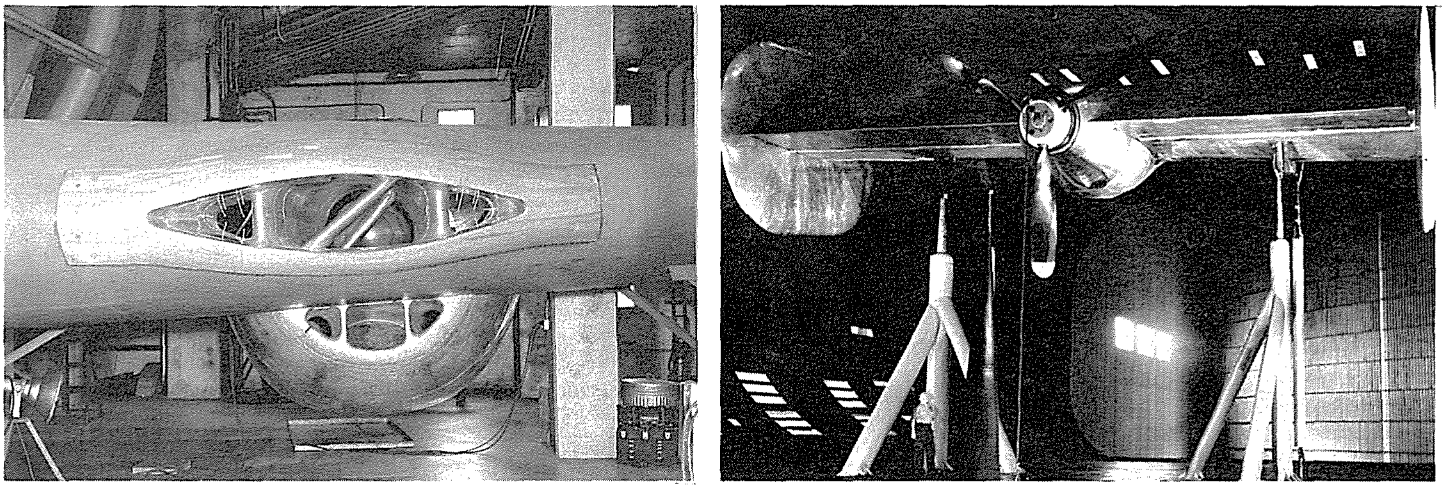
The Consolidated engineering team began work on the XB-36 almost immediately after the award of contract. Within a few days the Japanese attack at Pearl Harbor would change the course of everyone's life, but the excitement of a new project was on their minds at the moment, relaizing the magnitude of the task.

I.M. Laddon, Executive Vice President, had been the management's guide and had brought the project through its preliminary design and proposal stage. He was confident in CAC's ability to produce the airplane, and since he was an engineer at heart, and had been Chief Engineer for several years over projects that included the Catalina flying boat, he closely supervised the progress all through the program. As events later turned, the dynamic, cigar-smoking, intense "Mac" Laddon had to direct the program through some difficult periods and, in the postwar period, personally defend the B-36 from severe critics.

Harry A. Sutton, head of the Engineering Department, and Ted P. Hall, head of Preliminary Design group, set the division to work. Ralph L. Bayless was heading up Aerodynamics Group, with Ken Ward in charge of finalizing the external shape, and with Robert H. Widmer who began preparations for the long wind tunnel program.

The War struck, and reordered priorities at every level of effort, but in the early days of 1942 the wind tunnel model, of 1/26 scale, was carefully worked out and Widmer conducted and evaluated the tests in tunnels at both Massachusetts and California Institutes of Technology, attempting to achieve thy highest possible aerodynamic efficiency. Great effort was put into laminar flow wing design. The first airfoil selected, the NACA 65, had some unsatisfactory drags characteristics, which was found out in the tunnel tests of June 1942. Although a new tunnel model was constructed in the next several months it was delayed until almost a year later by higher priorities of other programs in getting back into the wind tunnel. These tests of 1943 determined that the NACA 63 series of airfoils should be used. Further analysis resulted in redesign of the wing's trailing edge to a 3-degree sweepback for weight and balance reasons. Widmer's engineers made exhaustive tests for flap and aileron effectiveness and surface control deflections, in addition to the usual tests to derive basic data on lift, drag, pitch, roll and yaw moments, and side forces. Ultimately, wind tunnel tests were scheduled into the large tunnels at Langley Field and Ames Laboratory at Moffett Field.

With the wind tunnel program under way, and preliminary drawings of outline and equipment spacing beginning to come from the drafting boards, a full-scale mockup was built in the Spring of 1942. It represented the complete fuselage, half the wing, and the twin-tail. This was constructed of wood in the long building adjacent to the



Flow of air through and around the power plant was a major part of XB-36 development. At left, the inlet, with pressure instrumentation tubes installed. Right, a section of the wing with power plant, in the Ames Lab wind tunnel. (Photos—courtesy of Dalton Suggs)

engineering department in CAC's San Diego plant. It was moderately detailed, including the landing gear and armament turrets, both of which portions of the airplane were to undergo considerable change in the months ahead. Size and vulnerability of the single-wheel landing gear caused much concern, and the placement of the defensive gun turrets, their relationship to the bomb bays, and the number and types of guns to be used stayed in a continual "state of flux" during the entire design program. The mockup was finally approved by the AMC in September 1942.

At the outset the XB-36 was to be powered by the 28 cylinder Pratt & Whitney "X" engine of 3,000 hp. In early 1941 this was a "paper" engine but P & W proceeded with its design, working closely with the Power Plant Lab at Wright Field and Consolidated's Power Plant Group. This engine, basically two 14-cylinder R-1830 Twin Wasp engines combined, had to put out 3,000 hp at 2,700 rpm for the XB-36's takeoff conditions, and to develop the stamina for a 10,000 mile mission. The 3,500 hp R-4360 Wasp Major, as it became, was a tremendous achievement by itself and in addition to the B-36, came to power the Boeing Stratocruisers and KC-97's of the postwar period.[2] CAC's Power Plant Group was under O.W. "Bud" Moerschel, with Bob Goodyear as assistant. The Senior Power Plant Design Engineer, Dalton B. Suggs, who had been on the Catalina and Liberator power plant programs, was assigned to the XB-36 in early 1942. He stayed throughout the entire program, moving to Ft. Worth with it in 1942, at which time he was promoted to Power Plant Design Group Engineer. But in early 1942, with Paul Lynch and a small cadre of engineers, Suggs made the initial layout and general arrangement studies. After the move to Ft. Worth the fullscale mockups were completed, nacelle test stands were built.

Consolidated Aircraft Corporation had moved before. It was organized by Major Reuben Fleet in 1923 in East Greenwich, R.I., moved to Buffalo, N.Y. in 1925 and to San Diego in 1933 and 1934, then with only 900 employees. By 1939 it had grown to 6,000, and as expansion of the industry took shape, it stepped up to around 40,000 employees by the middle of 1940.

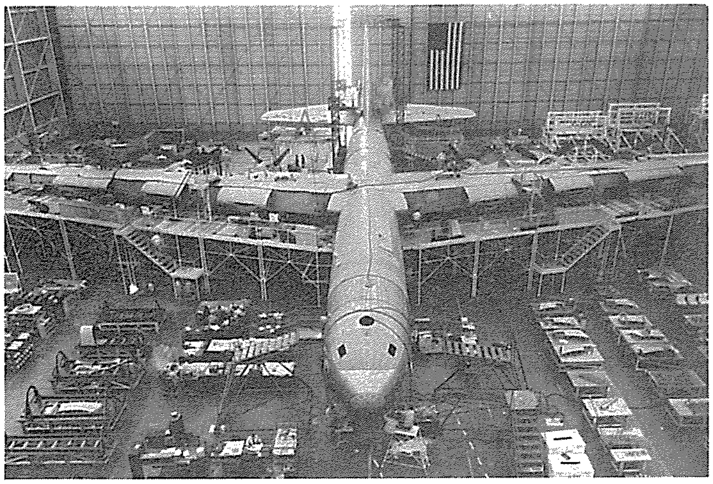
The War Department selected Forth Worth, Texas for heavy bomber production in January 1941 and an immense factory, Goverment Plant No. 4, was built across the field from Ft. Worth Army Air Field, to be operated by Consolidated and to assemble sections of the B-24 being built at Ford Motor Co.'s Willow Run Plant. As the B-24 program accelerated rapidly, manufacturing capacity was added at Ft. Worth. Ground for the plant was broken on 17 April 1941, and the first B-24 from the line was flown one year later, by George J. Newman, the plant manager.

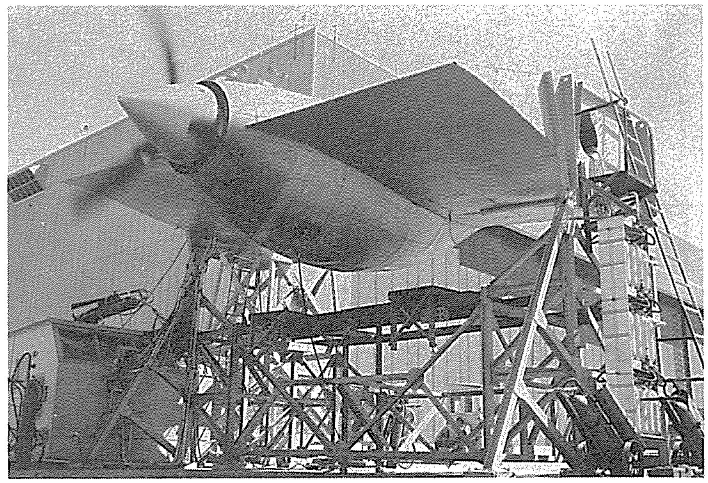
During the War, CAC operated 13 divisions throughout the country. There were manufacturing plants at Downey and San Diego, Ft. Worth, Nashville, Louisville, Wayne (Mich.), Allentown, New Orleans, and Miami. Modification plants were at Tucson, and Elizabeth City, N.J. A research division was at Dearborn, and CAC, later Convair, operated a trans-Pacific airline called Consairway for the Air Transport Command. The plants at Downey and Nashville came as the result of merger with Vultee Aircraft Corp. in March 1943, becoming the Consolidated Vultee Aircraft Corp., and still later Convair Divisions afterwards as the postwar era came and further mergers brought the conglomerate, General Dynamics.

As the war moved into 1942 the San Diego plant became saturated with work, and the decision was made to move the XB-36 project to Ft. Worth. Accordingly the almost 200 engineers, and the wooden mockup secured on a flat railroad car, were moved in August. The engineers were placed in an area of the factory paint shop while new facilities were being prepared; the mockup went into the experimental department. However, it soon became apparent that the experimental area would not be large enough to construct the prototypes and funds were requested for an addition to the building. Actually a new building was constructed, with its main bay 300 feet square. The roof was 90 feet from the floor, and the o[illegible] work height was 60 feet. It was not completed u[illegible] Spring of 1944.

Other factors in the move were the protection affo[illegible] the inland site and possibly planned production [illegible] windowless factory. Responsibilities for the two divis[illegible] were set up by I.M. Laddon and directed through Har[illegible] Sutton, who had charge of engineering at both divisions. Under the plan, San Diego would be responsible for basic design and wind tunnel testing. Stress analysis, weight control, fabrication and construction of the two prototypes and the flight test program were to be implemented by Fort Worth. R.C. Sebold became Chief of Engineering and Herbert W. Hinkley became XB-36 Project Engineer. Sebold had acquired his nickname, "Sparky" from his high school track teammates because of his speed; they dubbed him after the comic-strip character Barney Google's racehorse "Sparkplug."

Jack W. Larson became Assistant Chief Engineer, and Henry K. Growald came in as Hinkley's assistant. The team





By May 1948, the XB-36 was taking final shape in the experimental building. (Photo—Convair). At right, the engine test stand outside the experimental building on which hundreds of test hours were run. (Photo—Convair, courtesy of Dalton Suggs)

of Sebold and Growald were chosen for their expeirence in areas important to the XB-36: Hinkley had been stress analyst at CAC in 1933, and had worked on the B-24. Growald was in Armament. Another member of the team with long experience in stress analysis and structures was Les Moffett, moved into the position of assistant project engineer on structural design.

Until almost the last days of the War the XB-36 program was subject to the ups and downs of priority shifts, always in the position of accomodating some other program. For months the primary emphasis of the CAC effort was on the B-24, but in September 1942 Gen. Arnold ordered the "highest priority" to both XB-35 and XB-36; the U.S. was taking its losses in the Pacific at the hands of the Japanese and it could not be clearly seen that the tide would reverse itself. Possibly North American-based airplanes would be needed sooner than anyone thought. The priority was short-lived when the tide turned at Guadalcanal and the pressure was lifted.

Delays began to be experienced in the development program as wind tunnel tests were downgraded in priority; additional months were lost in the wing trailing edge redesign, and even the move contributed a loss of 3 to 4 months. Still later, in 1943 as the fall of China seemed imminent, the XB-36 was moved to the fore again. The military situation in Europe was shifting in favor of the Allies, but should China fall to the advancing Japanese it was felt that long-range bases might again be needed. Ironically, the island-hopping campaign in the Pacific brought bases within B-29 strike distance, but this could not be foretold with certainty in mid-1943.

Concurrent with the increased priority of the XB-36 in September 1942, the XC-99 was initiated as a troop carrier airplane, resulting from CAC's Model 37 design study. It was intended to utilize XB-36 wing and power plant design, and the fuselage was to be build at San Diego and the wing and power plants at Ft. Worth. It was scheduled for delivery in September 1944, five months after the scheduled first flight of the XB-36.

The most difficult obstacle to progress of the project became the shortage of manpower as the war grew in intensity. The lack of experienced and qualified engineering personnel was especially felt on a project as large and complex as the XB-36. By mid-1943, with the accelerated B-24 program siphoning off personnel, and selective service attrition taking its toll, the average engineering experience fell to only one year and three months.

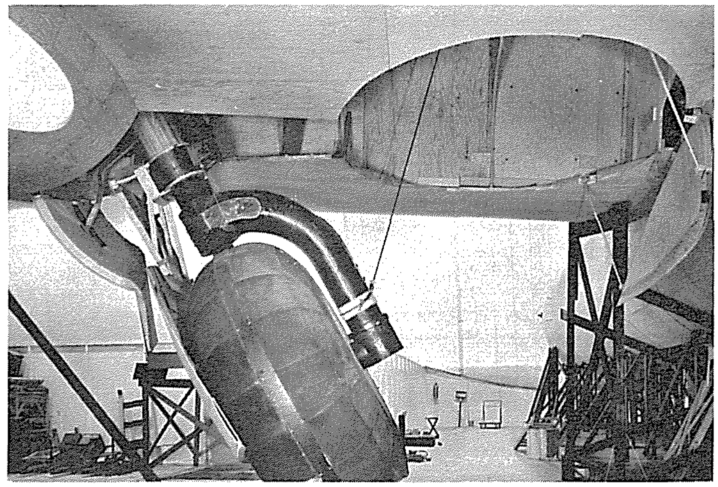
Material suppliers, chiefly concerned with getting out existing orders for urgently needed parts, were reluctant to participate. Thomas P. Girdler, then President of Convair, complained to Secretary of War Robert A. Patterson that it was difficult to get contractors to work on an order for only two airplanes. He suggested that suppliers could be interested if the program held some promise for large scale production.

The result was a "letter of intent." After discussion with Gen. Arnold, Secretary Patterson directed Gen. Oliver P. Echols, the AAF head of procurement, to issue the letter of intent to build 100 B-36 bombers at Ft. Worth.[3] This commitment, in July 1943, plus the increased priority occasioned by the decline in the China mainland campaign, gave new impetus to the lagging XB-36, but again, as the situation in the Pacific improved the program slipped into competition for scarce resources.

The letter of intent was replaced in August 1944 with a firm contract for the 100 B-36 airplanes but no priority was assigned. In the latter days of the war, in the interest of achieving increased progress, it was decided that as much as two years could be cut from the developmental time of the B-36 by beginning production even before the two experimental models were rolled out. This ultimately came to pass.

Finally, following the capture of the Marianas Islands, from which B-29's and B-32's could bomb the Japanese homeland, Convair was ordered to step up the B-32 program. Once again the XB-36 stood down for a lesser airplane. A July 1944 letter to Harry Woodhead from Gen. B.E. Meyers, of the Air Material Command directed that "positive and vigorous action to place the B-32 on a Number One priority from an engineering,tooling and production standpoint, without reference to the effect this action may have on the XB-36 and B-36 programs."[4] By late 1944 the XB-36 experimental factory was eighteen months behind schedule, and this blow further complicated the material delays, armament revisions and minor redesigns of system equipment.

In the Fall of 1943 the AMC was doing the static tests of the twin-tail configuration. After a considerable amount of research, and conferences with Convair, it was decided to abandon the twin tail in favor of a single fin and rudder. Static tests of the twin-tail, with its large vertical fins and rudders and associated control bracketry, showed that these could shear off in a hard landing or severe flight conditions. The design had been successful on Consolidated's large flying boats, and there was some influence felt by Reuben Fleet's preference for it as well as the "trademark"



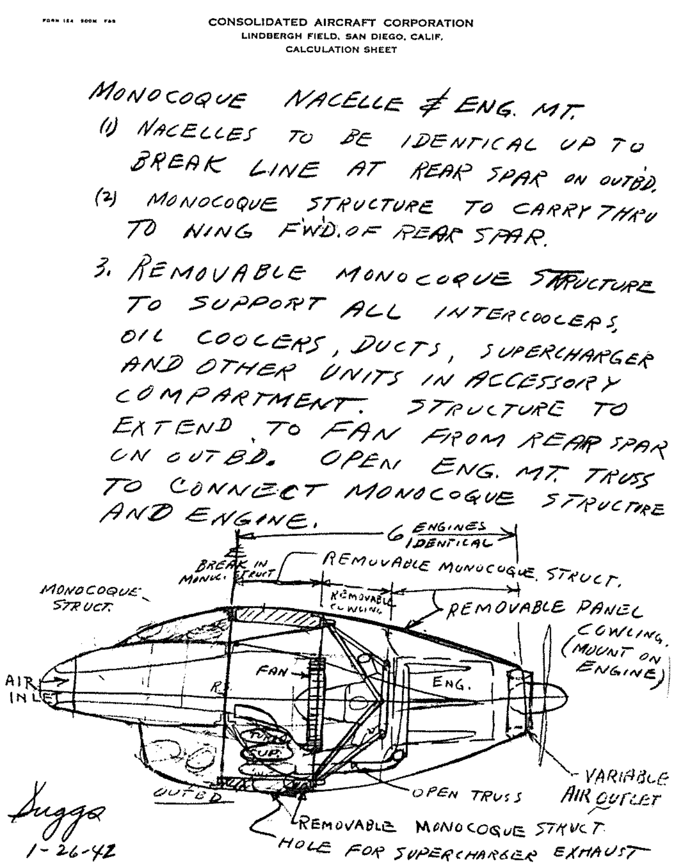
The North-South runway being extended into Lake Worth for the B-36 program in August 1945. B-32 flight line and experimental building at upper right. Right, the 110x46 inch wheel mockup. Landing gear design for the B-36 was subject to much discussion. (Photos—Convair)

appearance of the B-24, but the extreme size of the XB-36 became the overriding factor.

In another part of the airplane, a single-wheel landing gear was incorporated because the state of the art at that time was not sufficiently advanced. There was not the experience available to design multi-wheel gear with adequate braking capacity that could be accomodated in the wing trailing edge as retracted. On the other hand, AAF was concerned that the single-wheel safety factor, and possibility of a blowout on takeoff or landing, would make the entire airplane vulnerable. Also, special runways would have to be constructed with 22 inch thickness of concrete. Later on, when the XB-36 made its initial flight there were still only three airfields capable of accepting it on landing, its "home" field at Ft. Worth, Eglin Field (the Air Force Proving Grounds) and Fairfield-Suisun Army Air Field (later Travis AFB.)

Research into single, dual, triple and quadruple-wheel designs went on during 1944 and into 1945, but existing brake design meant a 65 inch tire tread in a four-wheel arrangement, and this could not be housed in the wing. Consequently work proceeded on the single-wheel design, with Goodyear Tire & Rubber Co. as the subcontractor. The 110 inch diameter by 46 inch wheel was, and still is, the largest airplane tire ever developed, weighing 1,475 pounds by itself.

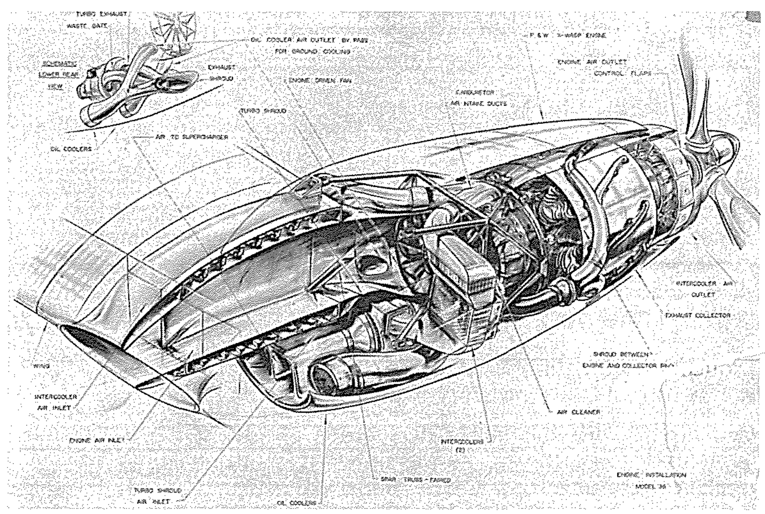
Below left, notes from a design conference on the power plant installation by Dalton Suggs. Right, the artist's rendering two months later. Right below, the "X-Wasp" engine conceived for the design became the R-4360-5 viewed from right side, 28 Sept. 1943. (Courtesy of D. Suggs)

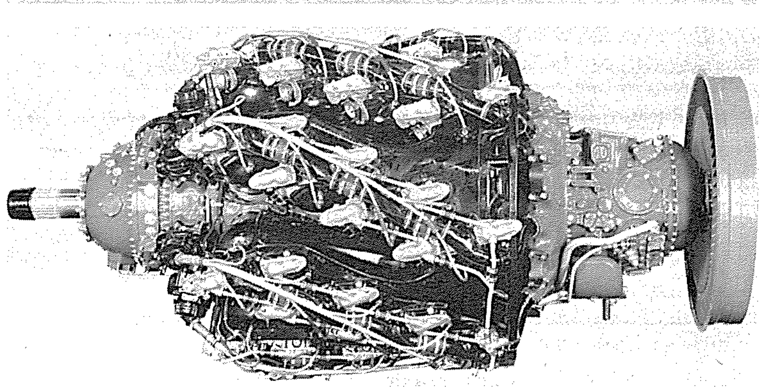


CONSOLIDATED AIRCRAFT CORPORATION
LINDBERGH FIELD, SAN DIEGO, CALIF.
CALCULATION SHEET

MONOCOQUE NACELLE & ENG. MT.
(1) NACELLES TO BE IDENTICAL UP TO BREAK LINE AT REAR SPAR ON OUTBD.
(2) MONOCOQUE STRUCTURE TO CARRY THRU TO WING FWD. OF REAR SPAR.
3. REMOVABLE MONOCOQUE STRUCTURE TO SUPPORT ALL INTERCOOLERS, OIL COOLERS, DUCTS, SUPERCHARGER AND OTHER UNITS IN ACCESSORY COMPARTMENT. STRUCTURE TO EXTEND TO FAN FROM REAR SPAR ON OUTBD. OPEN ENG. MT. TRUSS TO CONNECT MONOCOQUE STRUCTURE AND ENGINE.

Suggs
1-26-42





Eventually the development of an improved braking system and a 56 inch diameter, 16 inch tread, high-pressure tire made the four-wheel gear possible, but in the post war period. For a period of more than a year the XB-36 and YB-36 were each flown with single-wheel gears before the first B-36 flew with multiple wheels.

POWER PLANT DEVELOPMENT

The first hand-made test engine, the R-4360-5P, was to have been delivered in May 1943. Design improvements delayed it until October but within two months thereafter the full-scale wind tunnel tests were begun in Wright Field's 20 foot tunnel. Air inlet configuration, and the intricate interior air duct system were influential on the external configuration of the airplane, thus tests on these features were inaugurated first, along with the engine cooling fan and diffuser system which affected engine performance. These were directed by Dalton Suggs, in close liaison with the AMC Power Plant Lab and Pratt & Whitney engineers.

As it developed, an extensive fan redesign was necessary, along with cooling correlation tests. (The lower forward portion of the nacelle was redesigned for aerodynamic and engine intake efficiency reasons.) The carburetor was especially large, nearly 22 inches wide, and this partially restricted a straight-through flow of air over the top engine cylinders. The actual shape and direction of the intake vanes had to be determined by powered wind tunnel testing, The results, plus revised cylinder head baffling, helped to correct the flow of cooling air over the engine.

As delivered from Pratt and Whitney, the -5P engine was equipped with a type 11-11A cooling fan, designed to be in operation at all times the engine was running. The engine cooling tests were run all through 1944 and well into 1945, during which there were seven different fans tested. The 11-11A type was replaced with a 34-blade fan and the air diffuser tunnel was belled out to increase its cross-sectional area within the nacelle. This slowed down the air and greatly improved cooling. The AMC Power Plant Lab concurrently developed a fan which also improved cooling of the engine during ground operations.

In August 1945 the engine tests moved to the full-scale 40 ft. x 80 ft. wind tunnel at Ames Laboratory, Moffett Field, under the direction of Dalton Suggs. The first engine, the -5P failed in test in September and another was brought from Fort Worth. Testing, for the purpose of determining aerodynamic characteristics of the wing-flap trailing edge in combination with the propeller, was resumed in October.

The propeller was the Curtiss Electric 19 ft. diameter test article. Its hub incorporated an intricate motor mechanism utilizing hydraulic and electric combinations to change the blade angle. In normal flight operation the propeller was to be able to change pitch 4½ degrees per second at 1,000 rpm. For feathering or reversing the change was to be 45 degrees per second. Further, the propellers were to be automatically, and synchronously, controlled to maintain selected rpm speeds within a few revolutions of each other from engine to engine on the airplane.

The same propeller hub was used as had been used in the tests at Wright Field, but with an integral oil pump and high-speed clutch installed. All during the tests difficulties were experienced with oil leaks and excessively high temperatures within the propeller control unit. These were later remedied by Curtiss technicians.

Evaluation of the test results indicated that the high resonance points were in two ranges, 1150 to 1350 rpm, and 1950 to 2175 rpm. The passage of the propeller blades through the wake of the wing caused a high degree of stress in the low pressure area directly behind the moving airfoil. This could be overcome by operating the engines at speed/altitude/rpm ranges that would minimize the effects of buffetting of the propeller blades on the adjacent flap structure. As a result, the recommendation was that continuous operation at certain speeds should be avoided. For 20 degrees of flap, speeds should not exceed 170 mph; for 40 degrees flap, 110 mph.

In the period following the surrender of Germany, and when it appeared that the end of the war might be in sight, warplane procurements were cut back and many contracts were re-examined. However, the requirement for a long range bomber had not changed. It was, in fact, reaffirmed by the tremendous cost in lives and material in the campaign for advance bases. Further, as the war ended in a flash of awesome fury, the advent of the A-bomb provided yet another reason for the development of the intercontinental bomber. Retaliation, to be immediate, could not wait for the conquest of overseas bases. An Air Staff Group conference, within days prior to the surrender of Japan, recommended that four groups of B-36's be included in the mobile task force of the proposed 70-group postwar Air Force, and the continuation of the B-36 program.[5] Japan surrendered on the 14th. On the 15th of August the B-32 production was cancelled, and all of these airplanes were destined for the scrap heap together with tooling. For the first time since the preliminary design days of 1941 the XB-36 program could now have the experienced engineering and production personnel that it needed. The end of the war, and assignment of new administrative personnel to the Fort Worth Division, gave a new feeling of enthusiasm for the program.

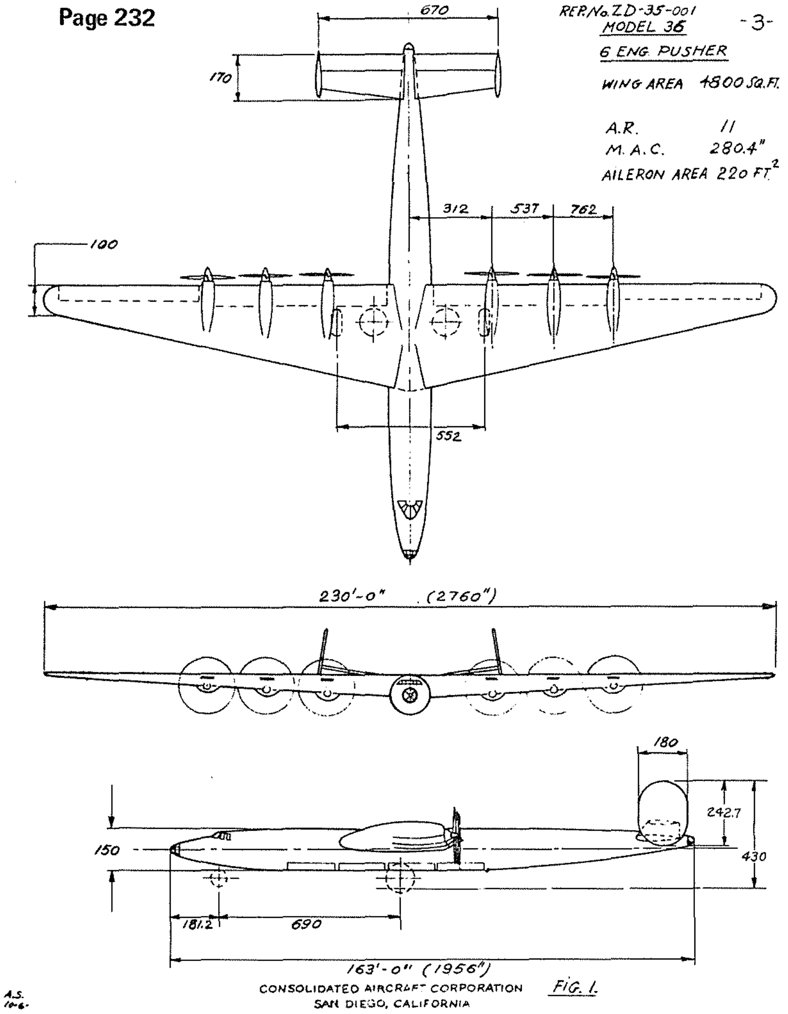
NEW ENTHUSIASM

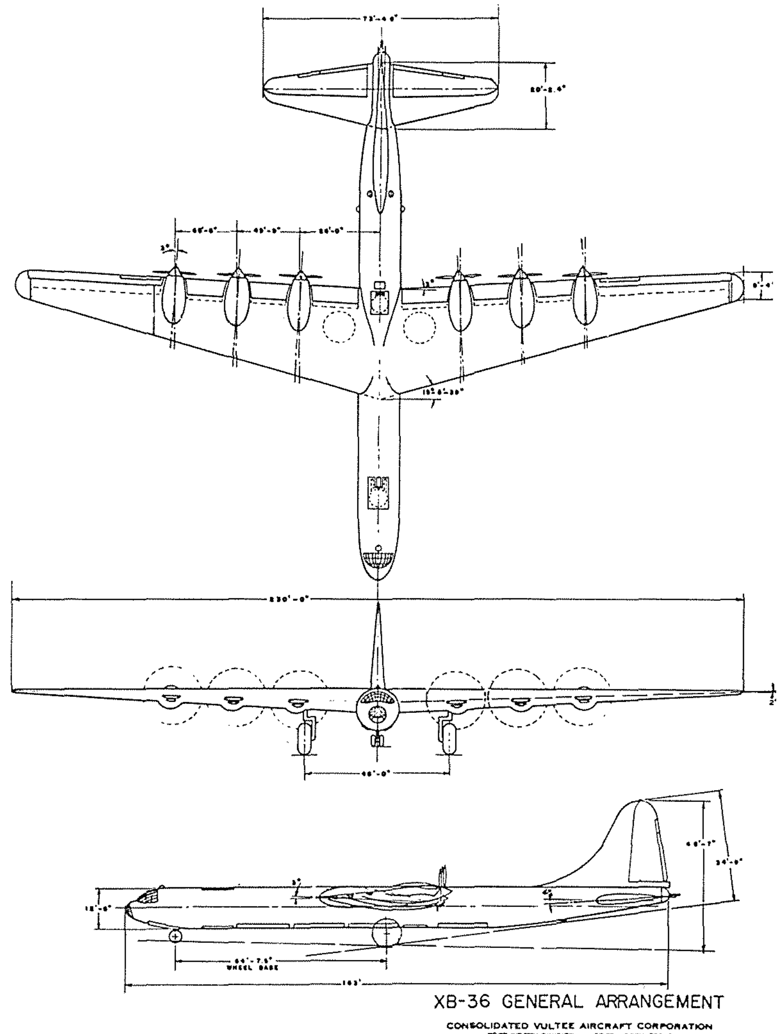
Retired Navy Commander Roland G. Mayer succeeded George Newman as Plant Manager. Mayer had been in the Navy 22 years, was a recognized expert on lighter-than-air aircraft having been aboard the SHENANDOAH (he was one of the survivors of its ill-fated crash), the AKRON, and the MACON.[6]

Ray O. Ryan was brought from the Downey (Vultee) Division in January 1945 by Sebold as assistant manager of the experimental shop, a month after the shop had been placed under engineering control instead of the Division Manager. Ryan was made Experimental Shop Manager in April, succeeding R.C. Maving.

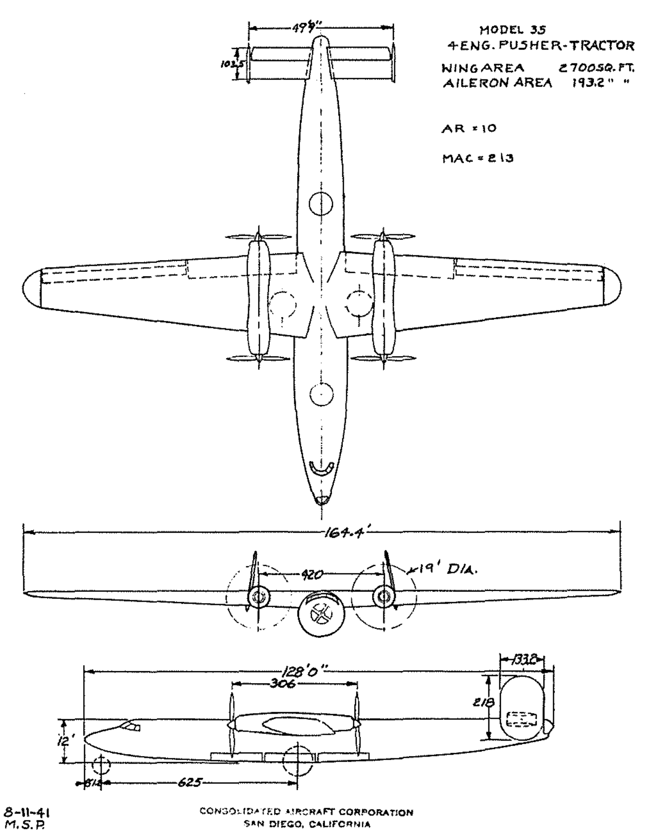
Sebold and Hinkley became involved in the investigation of the workmanship on the XB-36 structure when its fabrication passed into their control. They brought to light facts indicating that quality control had gotten out of hand during the war months. It appeared that there were many parts of the structure not given proper heat treatment or were fabricated from improper materials. There had been many minor "fixes" of poor workmanship, and the integral fuel tanks were noted to require excessive rework to stop leaks. Wing contours were not according to design, although not considered detrimental to the XB-36 performance.

The information was received with dismay at Wright Field, and an inspection team of AMC officials visited the Experimental Shop in July. The team consisted of Maj. W.M. Cade of ATCS Engineering Division, Lt. J.A. Boykin, Jr. of the XB-36 Project Office, L.J. Marts of Inspection, and Lt. Col. R.E. Ludick, the AAF Plant Representative. Inspection of the detail parts, assemblies, tools, manufacturing techniques and examination of structural repairs was made. In a letter to Convair's President Woodhead on 29 August 1945, B/Gen. L.C. Craigie, then commander of the Engineering Division, Wright Field,





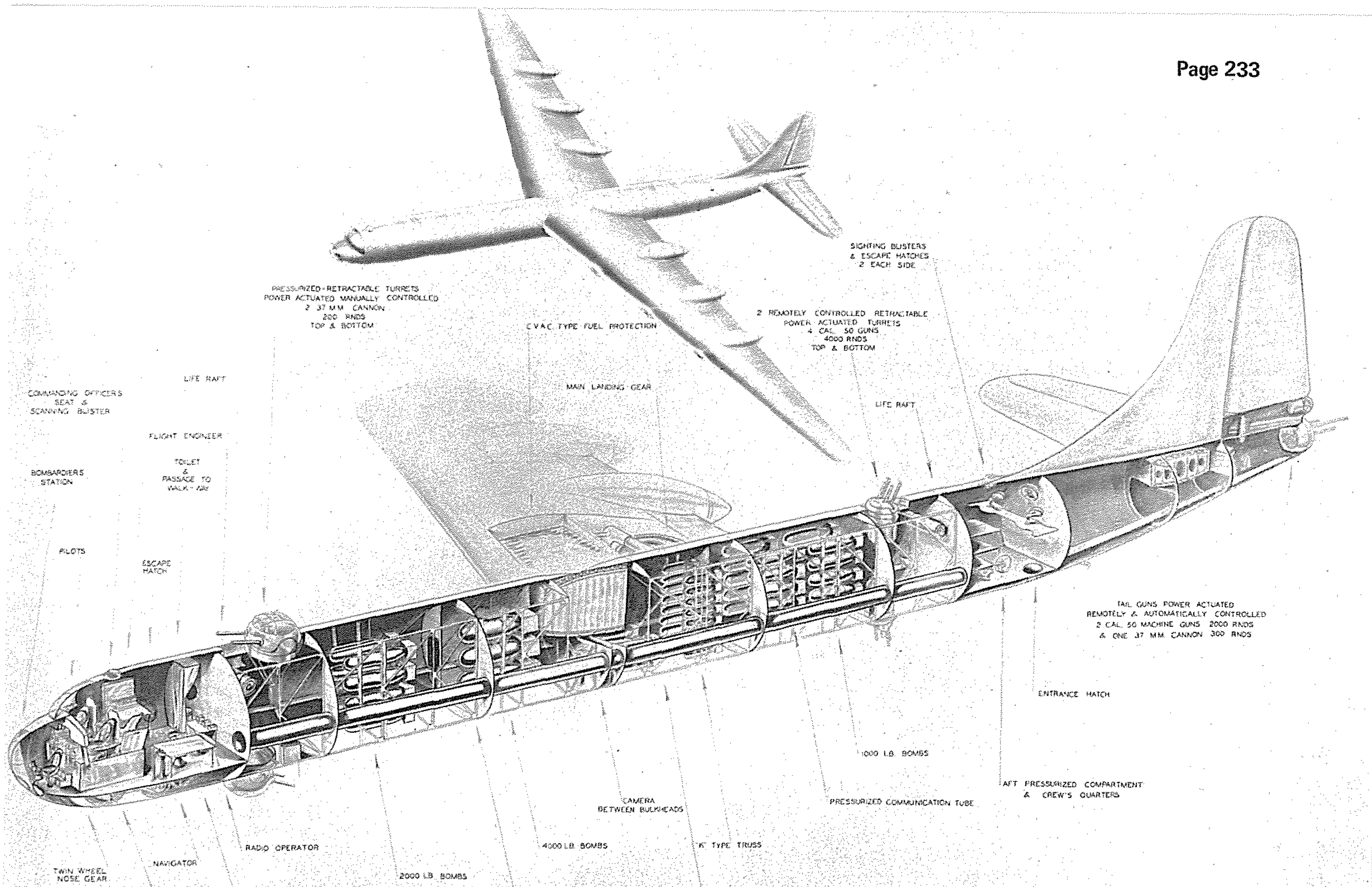
The concept of the Intercontinental Bomber evolved from Consolidated's 4-engine Model 35 of the 1940 studies to the 6-engine B-36 shown in the cutaway drawing of 1946 (opposite page), bridging pre-war and post-war technologies.



expressed concern at the poor workmanship and he asked Convair to take corrective action.

Convair volunteered, and ran, a metallurgical survey of the types of material and heat treatments of all primary structure. Of the more than 15,000 samples tested, some 20 percent were of different materials than specified by drawings and up to 10 percent were under strength. Extensive repairs were undertaken but the basic structural components of the XB-36 were considered safisfactory, and the program proceeded.[7] Action was also taken by the AAF to implement its own surveillance system, and additional inspectors were put to work along with those of Convair to "tighten" the quality control system. It must be noted that a large portion of the work on the XB-36 had been improvised, since tooling and manpower had been in short supply. Higher priorities of other programs had magnified the problems. Reorganization and closer supervision by Ray Ryan brought new efficiency and a new mood; this and other changes helped to reestablish confidence in Convair's development of the airplane. In August Ryan was moved up to Assistant Division Manager and Wesley Magnuson came from the Valiant Trainer production as the now third Experimental Shop Manager. Hinkley went up to Assistant Chief Engineer for Production Design, and Henry Growald, a very competent engineer, took his place as Project Engineer.

Just three weeks after V-J Day the XB-36 was rolled out of the Experimental Shop on its own gear. There was much to be done, but the Convair Model 36, begun before the U.S.



HEAVY BOMBARDMENT AIRPLANE
6 ENG.
MODEL 36

entered WWII, after several design changes and many refinements, was a reality at last. Its obvious change, the tail, now rose nearly 47 feet above the ground. And it was big. The tailplane was nearly the same as the wingspan of the C-47; its wing span greater than anything yet conceived to that date. And it would someday fly, almost one year later.

The end of the war, the assignment of new personnel to the project, and the almost concurrent rollout of the XB-36, permitted some reassessment of the problems yet facing the design team before the airplane could be finished. Chief among them was the ever-present weight of the final configuration.

Concern was expressed by Convair. Redesign of the tail and the engine nacelles, minor revisions, and failure of some of the GFE (Government Furnished Equipment) manufacturers to meet their weight restrictions was gradually adding a few thousand pounds to the total. In early 1945 the AAF had requested armament changes which added nearly five tons. The crew was also increased to fourteen men.

The armament changes in early 1945, from eight .50 cal. machine guns and six 37 mm. cannon to ten .50 cal. and five .37 mm., was again revised in mid-year 1945. AMC decided to use eight General Electric powered, remotely controlled turrets housing two 20 mm. cannon each, and all turrets were to be completely retractible except those at nose and tail. This final arrangement was used on the B-36B's, but was never installed on the XB-36.

It was originally proposed that the propeller drive on the Wasp Major engine incorporate a two-speed, shiftable gear with .29 and .50 ratios. Pratt & Whitney encountered difficulty in design and the two-speed gear was changed to a single ratio gear of .381. This caused a loss of 300 miles from the intended range and took 21 mph from the proposed top speed. Additional loss of 270 miles range was due to higher fuel consumption. However, the decision to use ground powered starters instead of engine self-starters obviated a further weight gain.

The final phase of XB-36 development was entered with the weight and performance comparisons looking about as follows:

	PROPOSED (1941)	PRE-FIRST FLIGHT CONFIGURATION (1945)
Gross Weight	265,000 pounds	278,000 pounds
Top Speed	369 mph at 40,000 ft.	323 mph at 30,000 ft.
Service Ceiling	40,000 feet	38,200 feet
Takeoff over 50 ft. obstacle	5,000 feet	6,100 feet
Maximum range	10,000 miles	9,360 miles

Many means had been taken to keep the weight of this very large structure and its components to a minimum, becoming a general design philosophy. The integral fuel tanks system was determined necessary because of the weight of conventional rubber cells. A rubber covering was attached to the sides and bottoms of middle and outboard tanks but omitted from the inboard tanks; these would be used first anyway on long missions, and therefore would not be vulnerable over the target area.

New materials and processes had been studied as the design progressed and the war-stimulated technology increased. The new 75S aluminum alloy, of greater strength than the 24S alloy then in common use, was investigated and though it came into limited application in the XB-36, the postwar production B-36's were able to take a significant weight advantage. Magnesium, though comparatively little used prior to the War in aircraft structures, was incorporated at every possible location as technicians from Dow Chemical Co. and American Magnesium Corp. worked closely with Convair in the design stages.

Now that there was the framework of a giant airplane to be seen there was a constant stream of visitors to the Ft. Worth plant. Though they were not always enthusiastic about the airplane and the entire program, they could not help being impressed by the size of the XB-36.

Much time was consumed by these "feather merchants" but the top engineering personnel and that of the AAF Plant Rep. office extended themselves to show off the new giant. More seriously though, the delays of material suppliers in furnishing needed components, and strikes by AFL unions affected both engineering and production, first in October 1945 and February 1946.[8]

The first of the production-type R-4360-25 engines was delivered in August 1945, to be used for the ground engine tests. Suggs began testing almost immediately and continued in the nacelle test stand outside the Experimental Building through the next year, performing service life and functional checks on practically every part of the powerplant. Various systems for the airplane were tested on this same setup. The flight engines for the XB-36 arrived one at a time through November 1945, each arrival being the cause for a minor celebration.

Henry Growald, Project Engineer was so anxious to see delivery of the propellers that he asked Curtiss to consign them to him personally, assuming that they would come to Convair and thus be called immediately to his attention. But, in the middle of one night, the propellers, each requiring four crates for various components, were unloaded in front of his house.

As the final year of the XB-36 development program began in January 1946, Major Stephen P. Dillon came to the Ft. Worth plant as Assistant AAF Plant Representative under Col. Fred Henry. Maj. Dillon had flown B-17's in North Africa and because of his combat experience, later assisted Wright Field in developing improved firepower, performance & combat serviceability for the B-17 and P-38. Prior to his assignment at Convair he was at Bell Aircraft's Marietta plant doing flight-acceptance testing of B-29's. The B-36 was a logical progression from B-17's and B-29's he had flown, and he began the closest liason with Convair engineers in learning and understanding every facet of the new bomber.

The man chosen to take the XB-36 into the air on its initial flight was Beryl A. Erickson. A slight, quiet, quick-witted man with a crew haircut, he had been working with XB-36 project for nearly two years. Born in Santa Monica, CAlif. he went to Venice High School with Stephen Dillon, and had learned to fly in his teens. When he and Dillon graduated in 1934, Beryl treated the class to a special event not on the program. The graduation ceremonies were being held in the football stadium because the 1933 Long Beach earthquake had damaged the school auditorium. During the early part of the program, Beryl, flying a 37 hp Curtiss-Wright Jr., passed low over the gathering and dropped a scroll with streamers of the school colors, red & white. Everyone including Stephen Dillon looked up in amazement. The Principal read Beryl's message of congratulations to the class of '34. Twelve years later, Beryl Erickson was to make another memorable flight also witnessed by his friend.

Erickson became an American Airlines pilot and flew DC-3's in the late thirties. He joined Consolidated in early 1941, and did much of the developmental flying for both the B-24 and B-32 bombers. He was one of the few pilots checked out in the Douglas XB-19, largest landbased airplane in the world prior to the XB-36. He became Convair's XB-36 Project Test Pilot.

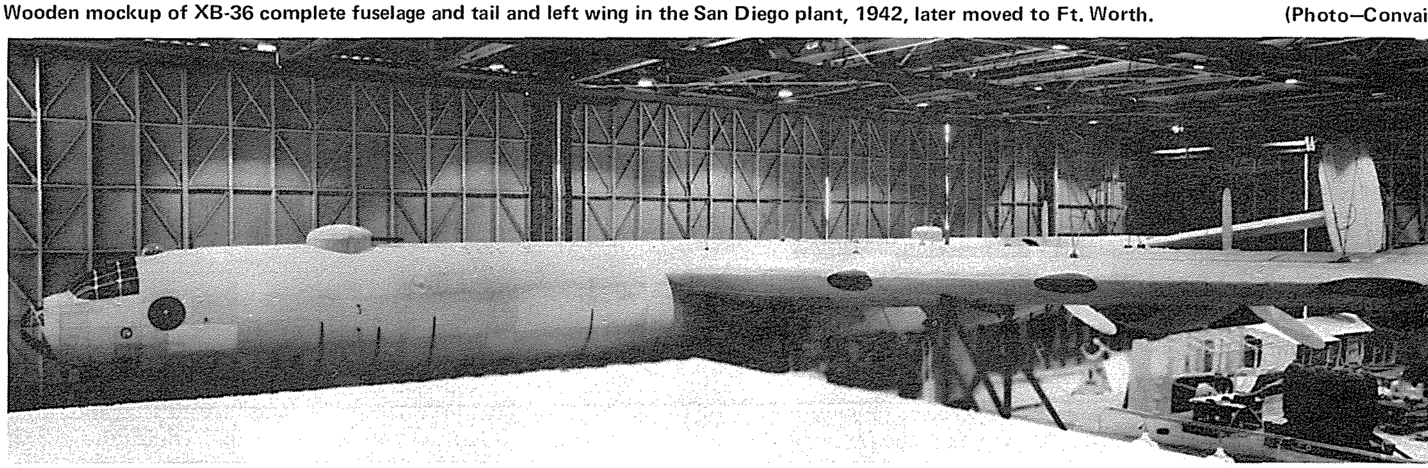
The XB-36 started engine run tests on June 12 and during one of the early run-ups, the wing flaps literally disintegrated!

The magnesium alloy, fabric-covered flaps could not withstand the tremendous punishment caused by propellor turbulence. The structure experienced rib-cracking and fabric ruptures up to the torque box and it was necessary to delay further testing for six weeks while stronger aluminum alloy flaps were fabricated.

A 689 Safety Board of AMC officials arrived to inspect the airplane in July.[9] The AAF was eager to get the XB-36 into the air at the quickest possible date and had met with Convair to determine ways of expediting the initial flight. Among decisions reached was that the 689 Board would make an informal inspection from the safety standpoint only, that No. 1 and No. 4 bomb bays only need be operative, vibration testing of the complete airplane with empty fuel tanks would be performed later and that cabin pressurization testing be also deferred.

Taxi tests began on July 21 to check out and confirm that all flight systems were airworthy. The flight control system of spring servo-tabs which had been used on B-19, but not designed to fly such a wide range of flight conditions and extreme altitudes, was complicated and there was some qualms as to whether it might be overbalanced. Consequently, Erickson and his co-pilot, G.S. "Gus" Green, a native Texan who had also test flown B-24's and B-32's,

Wooden mockup of XB-36 complete fuselage and tail and left wing in the San Diego plant, 1942, later moved to Ft. Worth. **(Photo—Convair)**



put the XB-36 through a series of fairly sophisticated tests and maneuvers including simulated high-speed take-off runs with safely deccelerated stops. The highest speed test was 97 mph, just below take-off speed.

The XB-36 was a costly piece of machinery, to be handled with care. In a sense it was a fragile airplane and the Convair engineers did not wish to subject it to any unnecessary difficulties such as high-winds. Harvey Black was the Chief Meteorologist at the plant and he was routinely consulted as to the weather conditions for the day, standard practice for all experimental flights. One mid summer day, the airplane was parked outside its hangar in the yard north of the Experimental Building when Wes Magnuson noticed a gradually darkening cloud forming to the north. Calling Harvey Black, he asked if a storm might be coming, and was advised that it was only a "trough-aloft," no danger to the XB-36. As the cloud darkened and approached, Magnuson called again, but was assured there would be no difficulty. Finally, a typical "blue norther" Texan windstorm blew across the plant area and the nearby Fort Worth Army Air Field. Though not a tornado, but still damaging, it blew men, ground equipment, and debris all over the north yard. Personnel grabbed ropes and whatever they could to steady the XB-36, while one man deliberately ran his ground vehicle into a rolling work stand to stop it from smashing into the airplane. When Magnuson talked with Black after the incident was over, Black could only say . . . "It didn't go around us!!!" His weather forecasts in future were taken with both a little skepticism and a light-hearted comment or two.

Erickson, though having a dry sense of humor, was a serious person behind the controls of the XB-36 and took his participation in the project with professional determination. While he was conducting the taxi tests, I.M. Laddon, who had still been overseeing the work during frequent trips to Fort Worth from San Diego, asked Erickson on one occasion when he was going to stop running the plane around on the ground and get it into the air. Beryl replied that he would fly it only when he felt he was ready and that if Laddon wished to do so, he could take it up himself.

Having respect for Erickson and his judgement, the taxi tests continued through August 7. Erickson thought he might take the XB-36 up that afternoon, but as the day wore on and early evening approached, it would be too dark. At 10:10 on the next morning of August 8, 1946, the XB-36 would make it's maiden flight, but that is another story.

End of Part I

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7. Report, AAF Air Technical Service Command, Engineering Division. "Investigation of Workmanship on XB-36 Airplane" dated 3 August 1945. General Dynamics/Convair historical archives, San Diego.
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9. 689 Board is so-called because of the inspection report form number used in AAF mockup and engineering surveys.

ABOUT THE AUTHOR

Meyers Jacobsen, originally from San Francisco and now residing in San Diego where he is coordinator for a furniture sales company, submitted this as the first in a series of articles on the development and usage of the Peacemaker. His interest in the airplane ranges from the original concept to the final disposition as seen here and by previous notes on the existing B-36's on display (*JOURNAL*, Summer 1970). He was in the Air Force from 1954 to 1958 as a basic training instructor when the B-36 was then in its heyday as the great deterrent weapon. Feeling that this has been overlooked in recounting of history he undertook to research B-36 development upon joining the A.A.H.S. in early 1969. His interest has led to many tape recorded interviews of the principals involved in the design and manufacture, and to intensive study of the historical archives at Convair San Diego.