This article is presented as a verbatim reprint of a source document to offer unabridged research material to the AAHS membership Two articles published in the Winter 1981 issue of the *Journal are* also in this category They are *Design and Construction of the NC Flying Boats,* and *Case History Final Report—XP-77 Airplane.*

FINAL REPORT OF DEVELOPMENT, PROCUREMENT, PERFORMANCE AND ACCEPTANCE OF XP-39E AIRPLANES

by C.L. Hall

From the files of Gerald Balzer

SUMMARY-This report presents a chronological record of the development, procurement, inspection, testing and acceptance of the XP-39E series airplanes constructed by the Bell Aircraft Corporation, Buffalo, New York. Early in 1942 after the first airplane had been flown by the contractor for a short period of time, it was decided that this particular design did not warrant the procurement of a production quantity. The remaining airplanes were used to develop the Allison two-stage engine for use in the P-63 series airplanes.

OBJECT—The procurement of this series of experimental airplanes was initiated in order to further develop the P-39 type airplane with regard to performance, ease of maintenance, and firepower. This procurement was made under the Research and Development Program, F.Y. 1941.

PROCUREMENT-On 13 and 14 February 1941, representatives of the Bell Aircraft Corporation and the Materiel Command held a conference at Wright Field for the purpose of discussing the development of two improved models of fighter airplanes, the XP-39E and the XP-63. The histories of the XP-39E and the XP-63 airplanes are closely related due to similarity of engine installations. The XP-63 project, however will be the subject of a separate Technical Report.

About the time the XP-39E project was started, the Materiel Command was already committed to the preliminary development of the Continental 1430 series of engines. Also, the Allison Division, G.M.C., had at this time initiated the development of the E-9 engine which consisted of the basic V-1710 power section to which was attached an auxiliary stage supercharger driven by hydraulic coupling. The XP-39E airplane as originally proposed and described in Bell Model Specification No. 23-947-001 dated 1 March 1941 was powered with the Allison V-1710-E9 engine in accordance with Allison Specification 137A revised 14 September 1940 and equipped with a suitable intercooler. This same model specification provided space for the future installation of the Continental V-1430 two-stage upright engine. The subsequent long development period required by the Continental engine resulted in this installation being deleted from the model specification requirements.

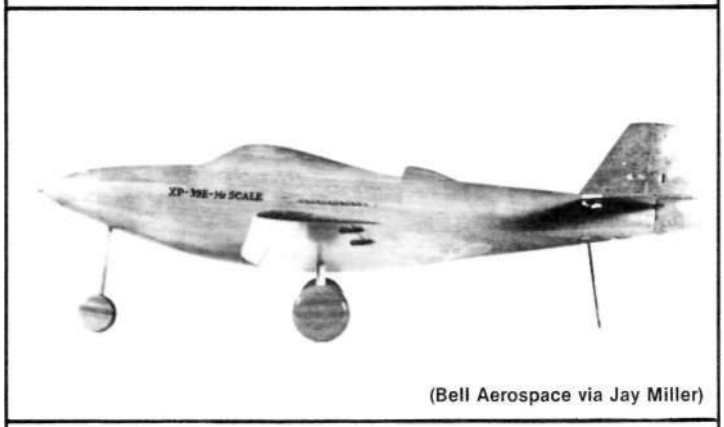
On 26 February 1941, an Authority for Purchase based on the contractor's letter of quotation dated 25 February 1941 was initiated for the procurement of two (2) XP-39E airplanes in accordance with the contractor's Model Specification No. 23-947-001 dated 1 March 1941, one wind tunnel model for tests in the Wright Field Five-foot Wind Tunnel, one free-spinning model, one skeleton airplane for static test purposes at: Wright Field, and Final Engineering Data. The airplanes described in this specification were equipped with one (1) 37 mm. cannon, two (2) synchronized caliber .50 machine guns in the fuselage, and (4) .50 caliber machine guns mounted in the wings. This Authority for Purchase, No. 182402, resulted in the preparation of Contract W535 AC-18373 approved 11 April 1941 which cost $513,750.00 and was broken down as follows:

Item 1	Two (2) XP-39E Airplanes	
	First Airplane	$295,000.00
	Second Airplane	$125,000.00
Item 2	Wind Tunnel Model for Wright Field 5 Ft. Tunnel	No Cost
Item 3	Free-spinning Wind Tunnel Model	No Cost
Item 4	Skeleton Airplane	$93,750.00
Item 5	Engineering Data	No Cost

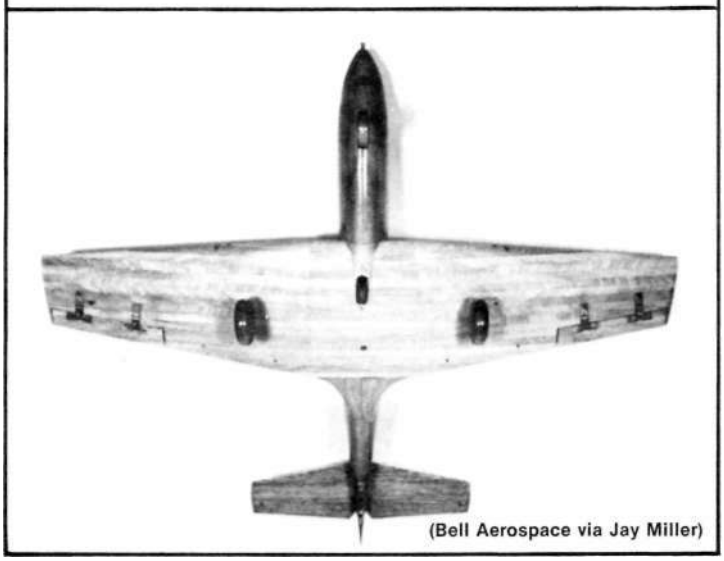
On 19 March 1941, A.F.P. No. 182406 was initiated for the purpose of procuring the two (2) XP-39E airplanes by means of a Change Order to the production P-39D Contract W535 AC-15675 in accordance with instructions issued by General Kenney. These instructions, however, were canceled and the original procedure of procuring these airplanes as presented in A.F.P. No. 182402 dated 26 February 1941 was followed. At the inception of this project very close coordination was maintained

The number three XP39E as configured and painted during engine development work at Allison Division, General Motors Corporation. (Detroit Diesel Allison)

(Bell Aerospace via Jay Miller)



(Bell Aerospace via Jay Miller)



(Bell Aerospace via Jay Miller)

Wind tunnel model of the Bell XP-39E (Model 23) showing the basic external characteristics of the airplane; notably the squared-off wing tips and empennage. This configuration is best represented by the second XP-39E, AF41-19502. Other variations of wing tips and fin were flown.

between the Production and the Engineering Divisions.

As a result of negotiating the XP-63 contract on the basis of a cost-plus-a-fixed fee the Bell Company submitted in their letter of 5 September 1941, a request that the XP-39E contract be changed from a fixed cost type to a cost-plus-a-fixed-fee type. Among the reasons advanced by the contractor for such a change was the fact that the XP-63 and XP-39E airplanes were in many respects very similar and the proper allocation of costs was being confused by operating with two different types of contracts. In order to accomplish this request, A.F.P. No. 182439 was initiated on 13 September 1941, resulting in a credit of $23,632.50 to this contract. This A.F.P., however, was canceled and superseded by A.F.P. No. 182446 dated 3 November 1941 which was initiated for the purpose of incorporating in the contract Model Specification, Revision No. 1 dated 20 October 1941 and putting the contract on a cost-plus-a-fixed-fee basis. This revision of the Model Specification was the result of a decision to revise the XP-39E airplane with the intention of improving the performance and military characteristics. Included in this revision was a change in the engine specification which was supposed to provide an E-9 engine with improved altitude rating.

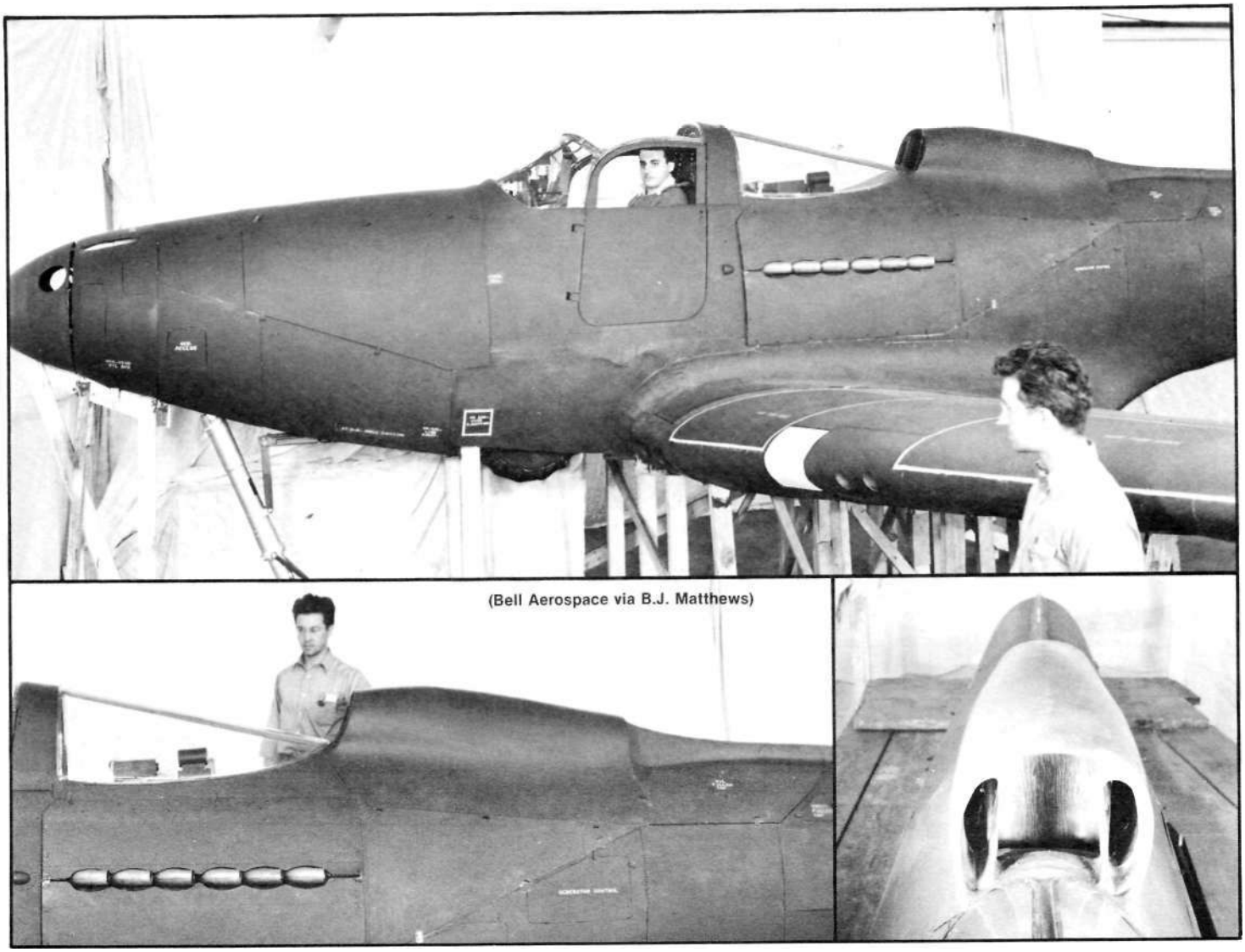
On 18 November 1941 a conference was held at Wright Field attended by Mr. Whitman of Bell Aircraft, Mr. Schwinn of the Contract Section and representatives of the Fighter Branch, Engineering Division. During this conference, it was decided that the contract should be continued on a fixed cost basis as originally planned and that A.F.P. No. 182446 dated 3 November 1941 should be cancelled in view of the recent additional changes required in connection with the development and construction of these two airplanes. For the purpose of consolidating all these changes, A.F.P. No. 179069 dated 4 April 1942 was prepared and amounted to $70,300.38.

In the months of November and December 1941, and January and February 1942, the experimental program at the Bell Aircraft Corporation was subject to a rather detailed examination by the Materiel Command. As a result of this examination, it was decided that the "no cost" contract, W535 AC-17506, which covered the procurement of the XP-59 airplane, would be terminated in view of the importance of other projects and lack of required engineering and shop personnel. Also, during this period the Production Division had entered into negotiations with the Bell Aircraft Corporation which resulted in the preparation of Contract W535 AC-20910 for a production quantity of P-39E airplanes.

In March 1942 the first XP-39E airplane serial No. 41-19501 was lost during spin tests by the contractor's pilot. Although the performance data obtained on this particular airplane were of a limited nature, it gave sufficient evidence that even though this airplane had more gasoline capacity, a stronger landing gear, more reasonable tire pressure, and a better armament installation than the P-39D, it was approximately 1600 pounds heavier and did not have sufficient additional horsepower to make up for this increase in weight. These conclusions together with the request that the Materiel Command be authorized to procure an additional XP-39E airplane to be used for developing the E-9 engine were transmitted in the form of a teletype to General Echols on 15 April 1942. This request resulted in the receipt of TI-1082 dated 22 April 1942 and Addendum No. 1 thereto dated 27 May 1942 which authorized the procurement of one (1) additional XP-39E airplane.

As a result of the developments outlined in the preceding two paragraphs, it was necessary to cancel A.F.P. No. 179069 dated 4 April 1942 and start negotiations for the procurement of the third airplane. With decision to buy the third article, it was also considered advisable to procure a number of spare parts that might be needed during the flight test phase and subsequent life of the airplanes. After a considerable number of conferences with the contractor and interchange of correspondence A.F.P. No. 217682 dated 3 July 1942 was prepared to cover the cost of the following items:

a. One (1) additional XP-39E airplane in accordance with Model Specification No. 23-947-001 dated 1 March 1941 and revised 20 October 1941 without the following items: armament provisions and installations, armor plate, recognition lights, rear



(Bell Aerospace via B.J. Matthews)

Photographs of the XP-39E mockup depicting an unusual dorsal carburetor air inlet possibly related to the installation of the Continental V-1430 engine. The peculiar features of the air inlet are the provisions for air flow from the aft end of the inlet and the long dorsal fin-like addition trailing aft to the vertical fin.

view mirror, propeller anti-icing, gun camera, blind flying hood, automatic oil temperature regulator and prestone radiator installation, belly tank, bomb shackle or release, formation lights, provisions for E-4 engine, alternate radios.
Total Price $271,735.04

b. Redesign and reconstruct the two (2) XP-39E airplanes in accordance with Model Specification No. 23-947-001 as revised 20 October 1941 and including installation of revised E-9 engine in accordance with Allison Specification 137-F as revised. (For work performed prior to the loss of Airplane No. 41-19501.)
Total Price $59,250.62

c. Temporary installation of Allison E-4 engine in first XP-39E airplane.
Total Price $5,332.80

d. Construction, performance testing and engineering labor in connection with 75 gallon form-fitting fuel tank.
Total Price $704.00

e. Installation of JH-5L starter in second airplane in lieu of original specification.
Total Price $1,161.16

f. Engineering services in connection with installation of gun-camera in first two airplanes and making provisions for in static test airplane.
Total Price $246.60

g. Engineering services and fabrication of parts in connection with installation in one airplane of automatic prestone shutter and oil temperature regulator.
TotalPtice $2,121.70

h. Armament rework, including engineering design and mock-ups.
Total Price $40,298.50

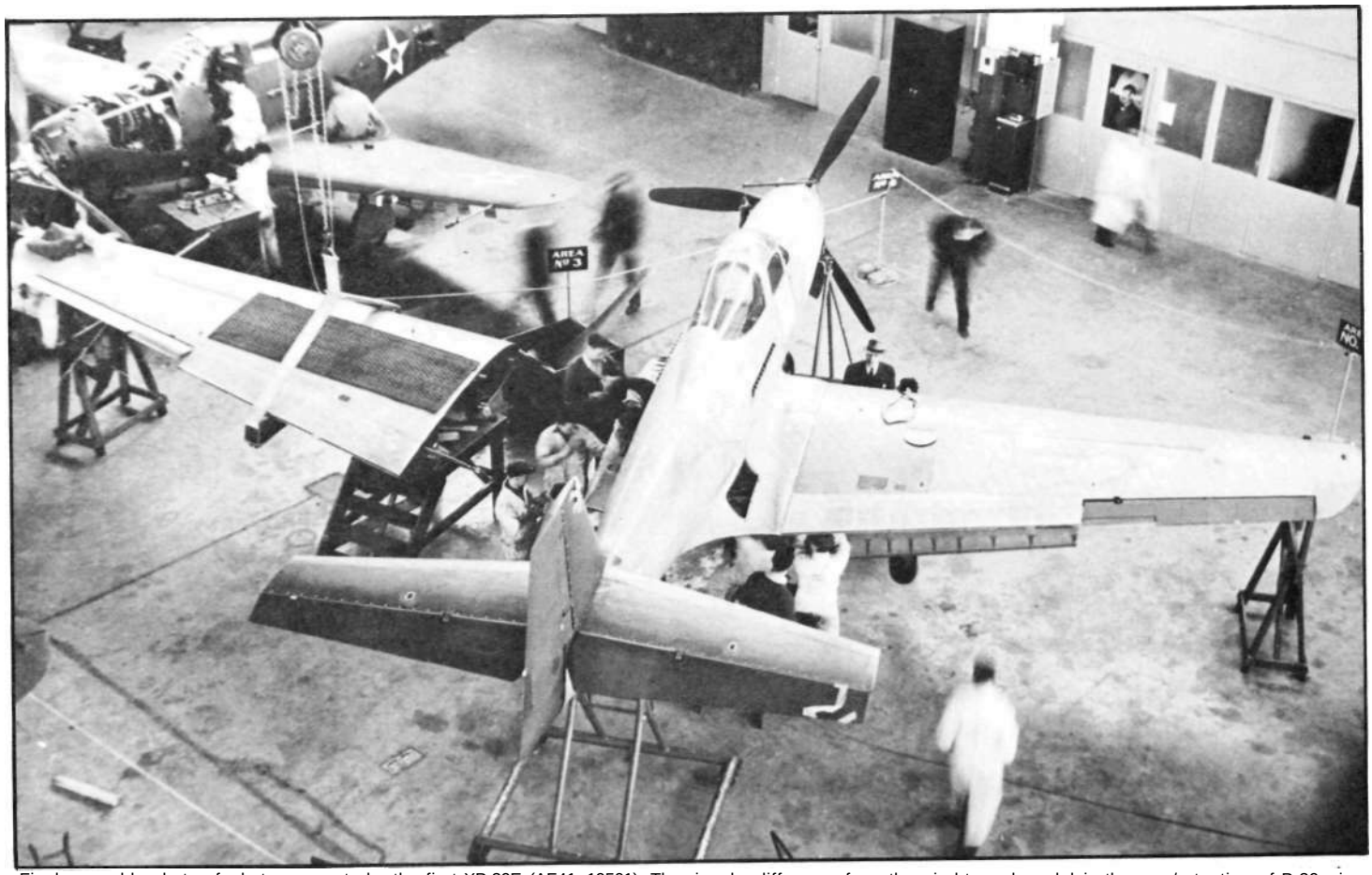
i. Spare Parts
Total Price . . . . . $ 28,282.57
Total Additional Cost $409,130.79

/'. Credit for non-completion of armament and gun sight installation on second airplane.
Credit $3,937.50

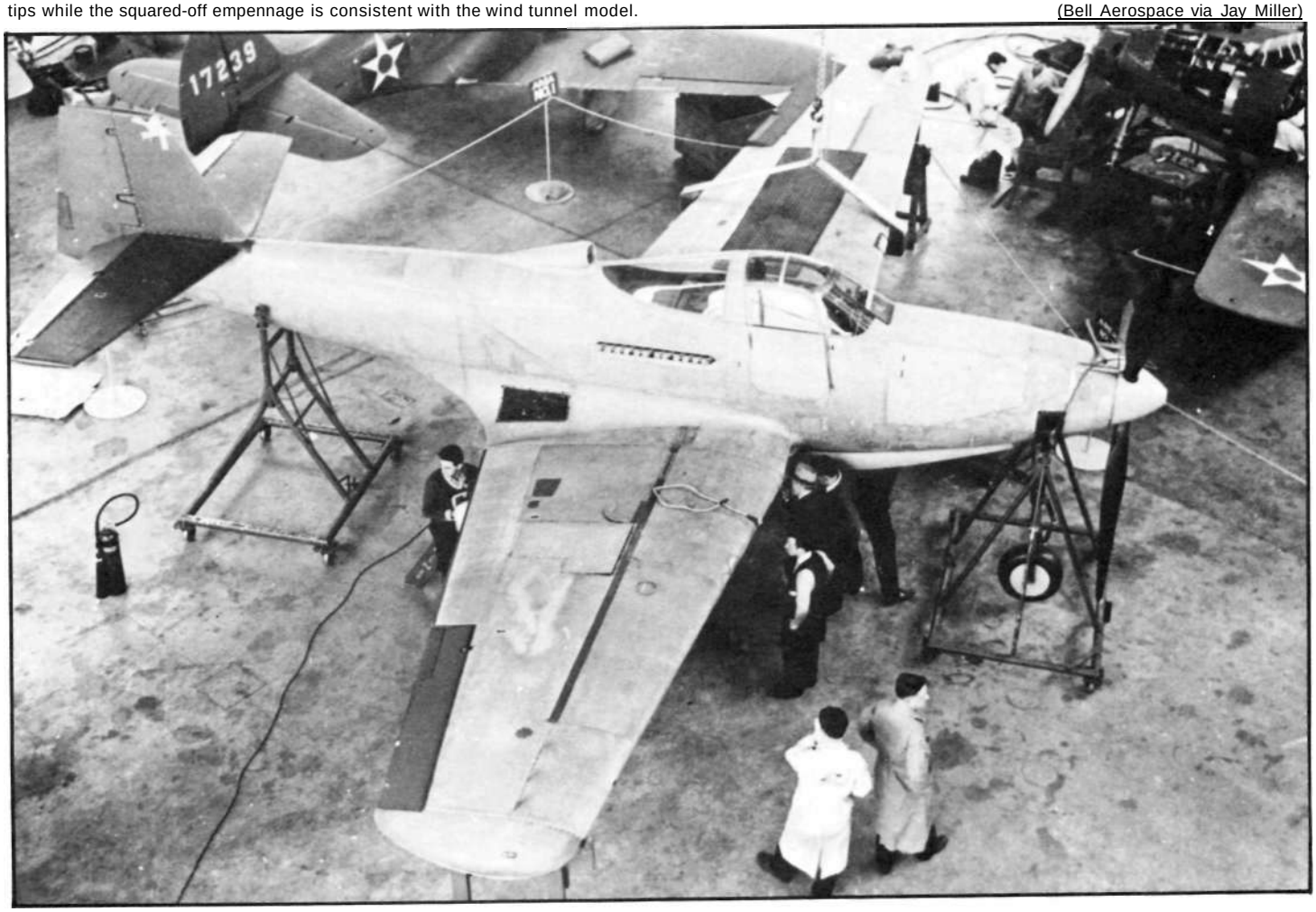
k. Credit for Cancellation of Flight Risk.
Credit $1,550.00

l. Elimination of two (2) standard type dirigible tanks (75 gallon)
Credit . . . . . $ 309.63
Total Additional Cost including credit $403,333.66

This Authority for Purchase resulted in the preparation of Supplemental Agreement No. 1 to Contract W535 AC-18373,



Final assembly photo of what appears to be the first XP-39E (AF41 -19501). The singular difference from the wind tunnel model is the use/retention of P-39 wing tips while the squared-off empennage is consistent with the wind tunnel model. (Bell Aerospace via Jay Miller)



which was approved 27 October 1942.

The preceding contractual changes and additions constituted the major procurement work done in connection with this contract. The following procurement changes are reported as a matter of record:

In order to conserve engineering effort and avoid subjecting the contractor's pilot to the risk of conducting dive tests on an airplane which was not scheduled for production, the Bell Corporation requested that the demonstration flight required by Article 17 of the contract be eliminated. The Materiel Command waived this requirement by teletype of 14 November 1942 on condition that an acceptable quote for reduction in cost be submitted and that the contractor guarantee to provide satisfactory cooling for these airplanes. This action was followed by Bell letter of 12 December 1942 quoting a reduction in cost of $2,327.16 and the preparation of A.F.P. No. 217607 dated 2 January 1943.

Early in February of 1943, XP-39E Serial No. 41-19502 suffered damage to the nose gear and adjacent structure during a forced landing by a Wright Field pilot. This damage resulted in extended negotiations between the contractor and the Procurement Division concerning the proper cost of repair. The actual cost of this repair was allowed on contract W535 AC-20910.

After the original action to procure spare parts on Supplemental Agreement No. 1 a number of changes to the spare parts list were made with the result that it became necessary to adjust the contract for a change in cost. This was accomplished by A.F.P. No. 352704 dated 14 June 1943 based on the contractor's letter of 7 June 1943 and resulted in a total increase in cost of $913.17.

The following table presents the actual delivery dares of contract items, exclusive of airplanes, which were procured under Article 16 of the contract.

ITEM NO.	ITEM	ACTUAL DELIVERY DATE
?	Five foot Wind Tunnel Model	3 Oct. 1941
3	Free-Spinning Model	15 Oct. 1941
4	Skeleton Airplane	13 March 1942
5 a	Shop & Working Drawings	15 Sept. 1943
5b	Final Weight & Balance Report	28 May 1942
5c	Vandyke of Final Model Specification	22 May 1943
5d	Pilots' Handbooks	11 June 1942
	Maintenance Handbooks	2 May 1942
14	Spare Parts	30 Dec. 1942 & 3 May 1943

TOTAL COST OF PROJECT
(Casts Charged Against Contract W535 AC-18373)

Original A.F.P. No. 182402 dated 26 Feb. 1941 for Contract W535 AC-18373. Two (2) Airplanes, Skeleton Airplane. Models and Data	$513,750.00
A.F.P. No. 217679 dated 16 June 1942, Repair and Replacement of Parts on XP-39E Ser. No. 41 -19502. Engine failure	1,522.92
A.F.P. No. 217682 dated 3 July 1942, third airplane. Spares and Engineering Services	403,333.66
A.F.P. No. 352704 dated 14 June 1943, Increase in Cost of Spares	913.17
A.F.P. No. 217607 dated 2 Jan. 1943, Credit for Cancellation of Dive and Maneuver Tests	-2,327.16
Total Cost	**8917,192.59**

MOCKUP INSPECTION-In view of the similarity between the XP-39E airplane and the production type P-39 airplane being constructed early in 1941 together with the intention of building the first XP-39E as rapidly as possible, it was decided that a complete and elaborate mock-up would not be made. In order to check instrument and control layout, radio, power plant, and armament installations, a rough mock-up of the airplane was constructed and inspected on 17 April 1941 by Majors Cook and Doubleday, Captain Bradley, Messrs. Austin, Bixby, Funderburg, Sommerfeld and Buchtel, all of the Materiel Command. The contractor prepared a mock-up report dated 21 April 1941 as a matter of record.

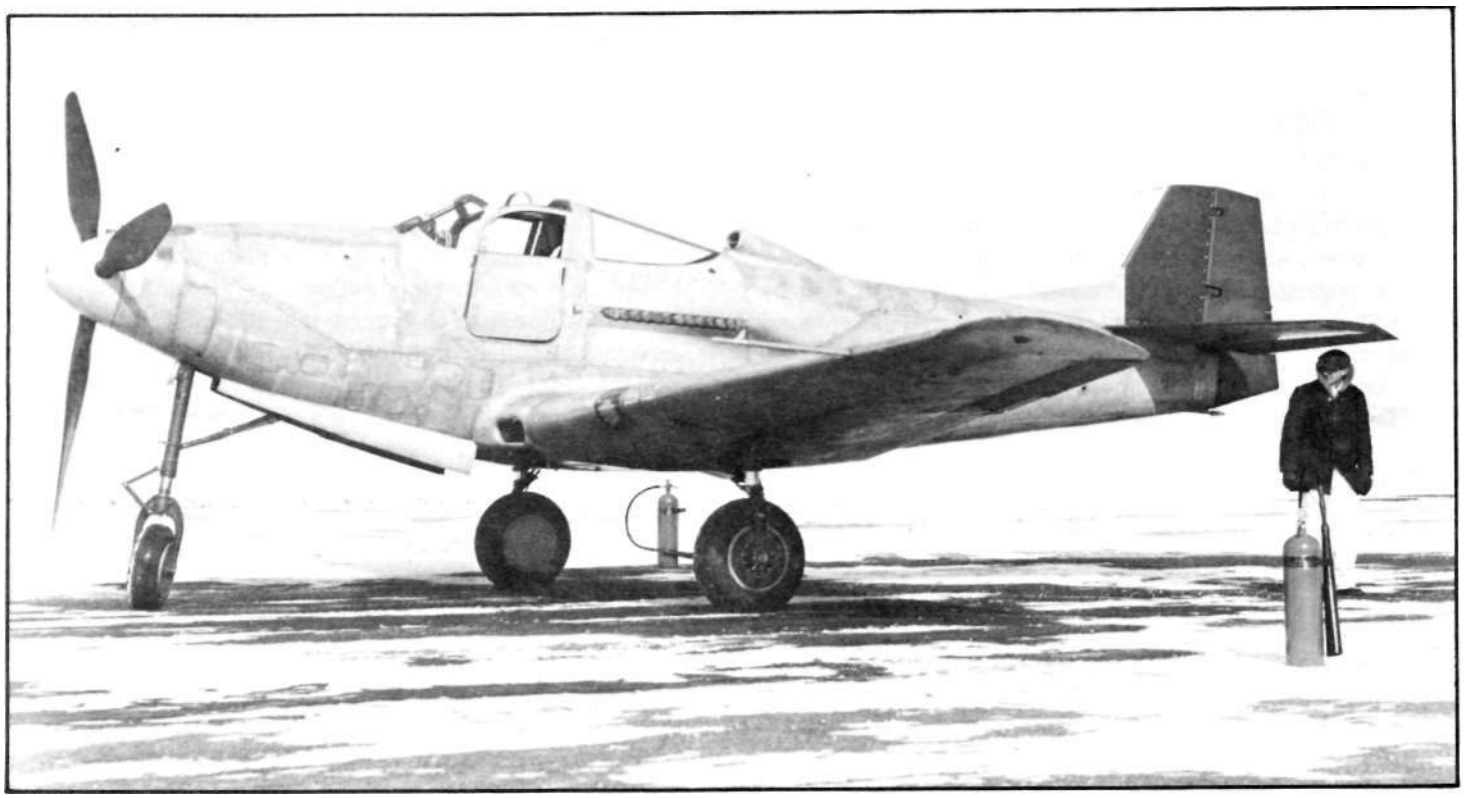
ENGINEERING INSPECTION-The decision to eliminate the XP-39E type airplane from further consideration as a production prototype led the contractor to request that the usual Engineering Inspection be omitted. In a letter of 2 July 1942, the Materiel Command stated that the inspection of these aircraft should be limited to a first article inspection, a report of which should be submitted by the A.A.F. Resident Representative subject to the responsibility of the contractor to remedy any obviously unsuitable conditions that arise or are discovered within a reasonable period following acceptance. This procedure was followed on both XP-39E airplanes.

GENERAL ENGINEERING-The actual engineering work on this project was started by the contractor early in January 1941 and the preparation of the model specification was closely coordinated by the Project Officer during frequent conferences at Wright Field and the contractor's plant. The first model specification was submitted to the Materiel Command by letter of 18 February 1941. On 27 March 1941 the Project Officer visited the N.A.C.A. Laboratories at Langley Field, Va., for the purpose of reviewing the tunnel testing program. Final conference to settle testing program was held 31 July 1941 at Langley Field.

By the latter part of April 1941, the Allison Division had submitted their Specification No. 137-D to Bell for comments and Bell had received drawings from Continental Co. with regard to the 1430 engine. On 25 April 1941 the contractor forwarded data showing the latest propeller performance calculations as worked up by the Bell Company and the Aeroproducts Division of General Motors Corporation.

Early in May 1941 the contractor was requested to study the possibility of incorporating maneuver flaps in the design of the XP-39E and XP-63 airplanes. This request arose from reports received from the European Theatre which at that time indicated the desirability of such a flap in combat. This study was made by the contractor and an actual installation of a set of maneuver flaps made in a P-39 type airplane. Flight tests were made by the contractor's pilot, the A.A.F. Resident Representative, and representatives of the Royal Air Force. The combined opinions of these pilots were unanimous in the recommendation that these flaps did not improve the maneuverability of the P-39 airplane and the project was discontinued. The results of these tests are contained in Bell Report No. 15-943-014 dated 12 January 1942, revised 1 April 1942.

As of the latter part of November 1941 the XP-39E project was approximately on schedule with various subassemblies substantially completed and a predicted first flight date of about 15 February 1942. This schedule was predicated upon the delivery of the first E-9 engine about 1 December to 15 December 1941. At this time, however, it appeared that the E-9 engine would not be available until January or February 1942. As a result of this delay the contractor removed a small number of personnel from the XP-39E project and stopped all overtime work in order to adjust their shop schedule to meet the anticipated engine delivery date.



A flight line view of what is considered to be a variation of the first XP-39E, i.e., the large dorsal fin. This assumption is based on the rather chilly and bleak surroundings; the snow and the obvious discomfort of the mechanic are in keeping with the 21 February 1942 first flight date of the first airplane. Installation of the Allison V-1710-E-4 engine instead of the E-9 version as planned, limited this airplane to handling, maneuvering and armament tests. The aircraft was destroyed a month later (26 March 1942) while contractor conducted spin tests near the Niagara Falls airport. (Bell Aerospace via Jay Miller)

During the Fall of 1941, various conferences were held with representatives of the Bell Corporation with regard to revising the original model specification to include changes agreed upon during the early portion of the project. On 9 December 1941, the contractor submitted Model Specification No. 23-947-001, Revision No. 1 dated 20 October 1941 which included the following changes and additions: Biermann blower installation with after-cooler, SCR-515 radio, rear-view mirror, identification lights, instrument panel change for filter installation, 22" low profile nose wheel, tire and tube, Edison engine gage unit, armor protection for oil and prestone tank, blind flying hood (automatic warning lights), and gun sight change. This specification was commented upon by the Material Command and certain changes made. This revision of the model specification was formally incorporated into the contract under the terms of Article 16, Item 7 of Supplemental Agreement No. 1 approved 27 October 1942.

Late in December 1941, when it became apparent that the delivery of the E-9 engine would be delayed, the Production Division requested that the contractor study the possibility of making a temporary installation of the Allison V-1710-E-4 engine. This proposal was made for the purpose of getting the first XP-39E airplane into the air in order that its flying characteristics could be evaluated. The changes involved in making this temporary installation included rerouting of fuel and oil lines, special carburetor air intake, special throttle and mixture control rods and ballast block and supports. The cost of this change was $5,332.80 and was included in Article 16, Item 8 of Supplemental Agreement No. 1.

Shortly after the E-4 engine was installed in the first airplane, the Production Engineering Section decided that the armament installation would be unsuitable particularly from a maintenance point of view. Consequently an engineer from the Armament Laboratory was dispatched to the contractor's plant with instructions to assist the contractor's armament engineers with the redesign of this installation. This work involved the construction of mock-ups and engineering design and was done at a cost of $40,298.50 which was included in Supplemental Agreement No. 1, Article 16, Item 13.

The first XP-39E airplane, Serial No. 41-19501, made its initial flight with the E-4 engine on 21 February 1942 from the Niagara Falls Airport. On 26 March 1942 this airplane was lost during spin tests being conducted by the contractor's pilot. Bell Report No. 23-943-033 dated 27 March 1942 presents the pilot's report of the loss of this airplane. A total of thirty-five (35) flights and fourteen (14) hours and fifty-five (55) minutes were put on this airplane before it was lost.

The skeleton airplane built in accordance with the requirements of Article 16 Item 4 of the contract was delivered to Wright Field on 13 March 1942. Static tests were completed on this airplane during the latter part of May 1942. Recommended changes in the structure are summarized in Memorandum Report Serial No. EXP-M-51/P753-28, Add. 15 dated 23 May 1942.

The second XP-39E airplane, Serial No. 41-19502, was delivered to the Niagara Falls airport on 23 March 1942 and made its initial flight with the E-9 engine on 4 April 1942. In view of the decision to conduct further spin tests on the free-spinning model at the N.A.C.A. Laboratory, the first flight tests on this second airplane were limited principally to engine tests. During Flight #27 on 12 May 1942, at which time approximately eighteen (18) hours total time had been put on this airplane, an engine failure was experienced at 30,000 ft. The immediate cause of the failure

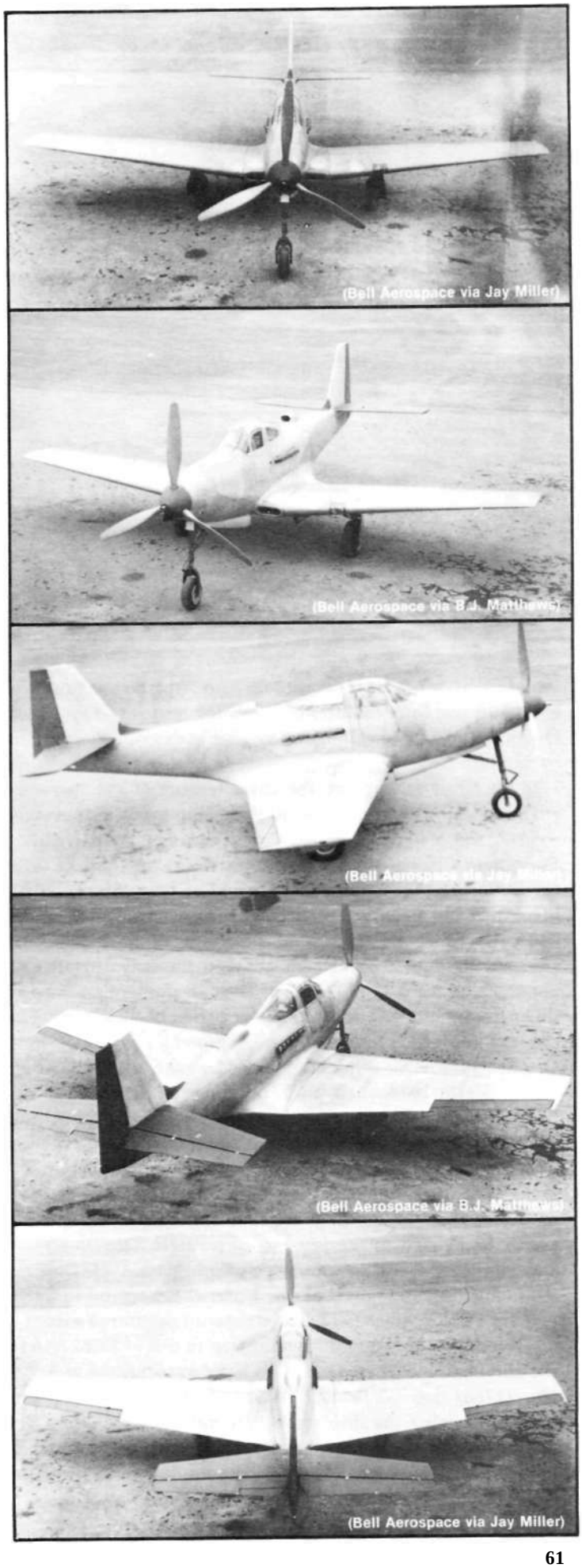
was found to be a broken connecting rod which came through the crankcase and damaged the engine supporting structure. A forced landing was made on the Niagara Falls Airport without further damage to the airplane. Action to effect repair of the airplane was taken in A.F.P. No. 217679 dated 16June 1942 for a total cost of $1,522.92.

In connection with these additional spin model tests, action was also taken at this time to improve the aileron characteristics by means of flight tests during which changes in the differential motion were made. These tests were considered necessary in view of the aileron buffeting experienced during flight tests of the first airplane. The aileron modification program is discussed in Memorandum Report Serial No. EXP-M-51/P753-31 dated 30 May 1942. Both of these programs were continued until it was decided to cancel the contract for the production P-39E airplanes. One important result of the spin tests was the decision to lengthen the fuselage of the XP-63 airplane in order to improve spin recovery characteristics.

During this phase of the project the contractor was requested by the Materiel Command to make certain changes in the XP-39E airplane which are mentioned here as a matter of record. One problem that existed from the very beginning of the design work concerned the installation of a suitable starter. This problem was caused by the location of the starter on the rear of the engine which is customary in the V-1710 engine but was complicated by the addition of the auxiliary stage supercharger which made starter removal extremely difficult. Finally with the cooperation of Jack & Heintz engineers a suitable installation was made. This change was included in the second airplane at a cost of $1,161.16 which was covered by Article 16, Item 10 of Supplemental Agreement No. 2. Also at this time the development of auxiliary droppable fuel tanks was being accelerated and the contractor was requested to construct and flight test a mock-up of a form-fitting 75 gallon auxiliary fuel tank. This work was accomplished on the second airplane at a cost of $704.00 and was included in Supplemental Agreement No. 1, Article 16, Item 9.

In July of 1942 the contractor requested permission to conduct a series of flight tests on the second airplane with Aeroproducts propellers of various diameters and blade sections. These tests were conducted not only in an attempt to better the performance of the XP-39E airplane, but also to check on the choice of the propeller for the XP-63 airplanes. These tests were completed during the latter part of October 1942. Considerable difficulty was experienced with the four-bladed propeller because of poor vibration characteristics on the ground. Engine operation, however, proved to be the greatest source of trouble especially in connection with the functioning of the auxiliary stage supercharger. The results of these tests proved the four-bladed propeller gave superior take-off performance than the three-bladed propeller. Details of the test results are given in Bell Reports Nos. 23-943-033 and 23-923-002.

The third XP-39E airplane, Serial No. 42-71464, made its



Round-the-clock views of the second XP-39E at the factory site (compare with the Wright Field photos of this airplane with the serial number 119502 on the vertical tail). Clipped wing tips and squared-off empennage are in close correlation with the wind tunnel model. The frontal views show enlarged cooling air inlets when compared to the prototype P-39D photo included for comparison. The increased cooling capability was the result of a requirement by the Materiel Command that the contractor guarantee to provide satisfactory cooling for the XP-39E airplanes. Further study of these photographs shows a wider, straight wing center section which would readily account for the increase in wing span.

A frontal view of the prototype P-39D is included here to provide ready comparison between the production P-39s and the XP-39E in the wing root area which housed engine coolant and oil radiators. (Bell Aerospace via B.J. Matthews)

initial flight on 19 September 1942. This airplane was flown for five hours and forty minutes before being ferried to the Allison Division, Indianapolis, Indiana, for tests as described in the next paragraph.

In an effort to improve the characteristics of the two-stage engine and work out the details of the automatic second stage control, the Materiel Command was requested by the Allison Division in October 1942 to be allowed to use the third XP-39E, Serial No. 42-71464, for a short period of time. Since the airplane had not been accepted by the Army Air Forces at this particular time, the matter of furnishing a ferry pilot was arranged by mutual agreement between the Bell Aircraft Corporation and the Allison Division. The Government assumed all flight risk for airplane and G.F.E. for period of these tests. This airplane was ferried to the Allison Division by a Bell pilot on 13 October 1942. This airplane remained at the Allison Division until 7 March 1943 when it was returned to Niagara Falls by a Bell pilot. Total flight time put on the airplane by the Allison Division pilots was seven hours and twenty-five minutes.

As a result of the earlier decision to cancel the production program for P-39E airplanes, the contractor, in September 1942, requested that the dive test requirements for the XP-39E airplanes be deleted in the interests of saving engineering effort and eliminating risk to contractor's flight personnel. Dive test requirements were waived by the Materiel Command in a telegram of 14 November 1942. The contractor submitted a letter of 13 December 1942, quoting a reduction in cost of $2,327.16 for the elimination of these tests. This letter was attached to A.F.P. No. 217607 dated 2 January 1943, to formally adjust the contract. In waiving the dive test requirement the Materiel Command directed the contractor to provide adequate cooling for both XP-39E airplanes. This was accomplished by installing larger prestone radiators on both articles.

In December 1942, the Assistant Chief of Staff (E) requested the contractor by telephone to run an accelerated service test on one of the XP-39E airplanes in order to further develop the two-stage Allison engine. At this time as a result of tests made by the Materiel Command and the Allison Division it was decided to install 8.08:1 engine stage supercharger gears in the production V-1710-93 engine instead of 7.48:1 gears originally used in the experimental V-1710-47 engines which were installed in the XP-39E airplanes. On 22 January 1943, the contractor was authorized to install the 8.08:1 gears in the XP-39E airplanes for use during accelerated service tests and official A.A.P. performance and cooling tests. Prior to starting the accelerated service tests it was considered advisable to conduct preliminary official performance and cooling tests and a Materiel Command flight test pilot and engineer were accordingly sent to Niagara Falls early in February 1943. On 8 February 1943 during performance tests, the second XP-39E airplane (Serial No. 41-19502) was damaged as a result of a forced landing near Spencerport, N.Y. The cause of this accident was faulty fuel gage indication, leaving the pilot insufficient fuel to return to the Niagara Falls Airport. The propeller and nose section of the airplane were damaged by this accident.

As a result of this accident it was necessary to return the third airplane, Serial No. 42-71464, from Allison to Niagara Falls in order to complete performance and cooling tests and to conduct the accelerated service test. This airplane was returned to Niagara Falls on 7 March 1943 and the engine was reworked to represent the production engine as closely as possible. On 2 April 1943, pilots from the Accelerated Service Test Branch at Patterson Field arrived at Niagara Falls to conduct tests on airplane number three (Serial No. 42-71464). These tests were completed on 11 May 1943 after the engine began to lose power.

About one hundred hours of the originally specified one hundred fifty hours of flight time were completed.

During this period the second airplane, Serial No. 41-19502, was repaired and turned over to the Wright Field flight test crew for performance and cooling tests.

The final revised Model Specification No. 23-947-001 dated 1 March 1941 and Revision No. 4 dated 15 April 1943 was submitted on 2 July 1943 and incorporated into the contract by Engineering Order Serial No. X-3645 dated 9 July 1943.

WIND TUNNEL TESTS-In view of the geometric similarity between the XP-39E and previous P-39 type airplanes, it was originally intended to limit the wind tunnel testing program to a minimum. The 1/12 scale model for the Wright Field Five-foot Wind Tunnel was delivered by the contractor on 3 October 1941 and tests accomplished between 17 November 1941 and 26 March 1942. The results of these tests are contained in A.A.F. Technical Report Serial No. 4830 dated 12 October 1942.

The 1/20 scale free-spinning model constructed for tests in the N.A.C.A. free-spinning tunnel was delivered to the N.A.C.A. on 15 October 1941 and tested in the Committee's new 20 ft. tunnel. The results of this test are presented in N.A.C.A. Memorandum Report entitled "Spin Tests of 1/20 scale Model of the Bell XP-39E Airplane" by Neihouse and Klinar dated 9 February 1942.

Subsequent to the loss of the first airplane during spin tests, it was considered advisable to conduct further tests at the N.A.C.A. in an effort to discover the reason for the accident and to decide upon an improved configuration. These tests were conducted in the same N.A.C.A. tunnel during the period of 4 April to 17 April 1942 and the results of the tests are contained in Memorandum Report Serial No. EXP-M-51/P753-32 dated 30 May 1942.

FLIGHT TESTS-Performance and cooling tests were conducted on the second airplane, Serial No. 41-19502 by a Wright Field pilot and are reported in Memorandum Report Serial No. FS-M-19-1597-A dated 27 May 1943. These tests were started in February 1943 but were interrupted by the forced landing discussed in a previous paragraph. Pilot's comments are recorded in Memorandum Report Serial No. ENG-19-1601-A dated 8 June 1943.

FERRY AND ACCEPTANCE-As reported in a previous paragraph, the first XP-39E, Serial No. 41-19501, was destroyed on 26 March 1942. This airplane was accepted in the crashed condition.

The second airplane, Serial No. 41-19502, was ferried to Wright Field from Niagara Falls on 12 June 1943 and the Supply Officer was informed by Inter-Office Memorandum of 16 June 1943 that this airplane was considered acceptable and requested that necessary action be taken to formally complete acceptance.

Similar action was taken in connection with the third airplane, Serial No. 42-71464, which was ferried to Wright Field from Niagara Falls on 9 June 1943 and formal acceptance action was requested of Supply Officer by I.O.M. of 12 June 1943.

After delivery and acceptance at Wright Field, both airplanes were loaned to the Allison Division, General Motors Corporation, Indianapolis, Ind., for development work to include flight testing of engine aftercooler, automatic engine controls, pistons and rings, use of water injection, investigation of functioning of the engine hydraulic coupling and studies of carburet ion, including a relocation of the carburetor from the inlet of the auxiliary stage to the inlet of the engine stage supercharger. Airplane Serial No. 41-19502 was loaned on Bailment Agreement W33-038 AC-411 and airplane Serial No. 42-71464 was loaned on Bailment Agreement W535 AC-40808.

RELATED DOCUMENTS

1. Bell Report No. 23-947-001—Model Specification for XP-39E Airplane.
2. Teletype E-988 dated 21 January 1941 —from Technical Executive authorizing visit of Bell representatives to discuss XP-39E proposal.
3 Contract W535 AC-18373—Approved 11 April 1941.
4. Supplemental Agreement No. 1 dated 27 October 1942.
5. Change Order No. 2 dated 29 January 1943.
6. Change Order No. 3 dated 7 May 1943
7. Memorandum Report Serial No. FS-M-19-1597-A dated 27 May 1943 (Flight Tests).
8. Memorandum Report Serial No. ENG-19-1603-A dated 7 June 1943 (Pilot's Comments)
9. Memorandum Report Serial No. ENG-19-1601-A dated 8 June 1943 (Pilot's Observations)
10. Supplemental Agreement No 1 Approved 27 October 1942.
11. Bailment Agreement with G.M.C.. W535 AC-40808.
12. Bailment Agreement with GMC W33-038 AC-411.
13. A.A.F. Technical Report 4830 dated 12 October 1942 (5 ft. Wind Tunnel Tests)
14. NACA. Report "Spin Tests of a 1:20-scale model of the Bell XP-39E Airplane." Neihouse & Klinar, February 1942.
15 N.A.C.A. Report "Supplementary Tests of a 1:20-scale model of the Bell XP-39E Airplane." Neihouse, August 1942.
16. Technical Report of Aircraft Accident Classification Committee dated 28 March 1942 (Report on crash of airplane Ser No, 41-19501)
17 Handbook of Pilot's Flight Operating Instructions for XP-39E Airplane.
18. Handbook of Erection and Maintenance Instructions for XP-39E Airplane,
19. Numerical Drawing List.

DESCRIPTION OF XP-39E AIRPLANE
Mfg. Model Spec 23-947-001

WING—Wing is of mono-spar cantilever construction of the stressed skin type. constructed principally of aluminum alloy. Outer wing panels are detachable from center section to facilitate inspection and repair. Fuel tanks are located in outer panels and prestone radiator is located in center section aft of main spar.

CONTROL SURFACES—Vertical and horizontal stabilizers are full cantilever. The external surfaces and internal structure are constructed principally of aluminum alloy, Rudder, elevators, and ailerons are fabric covered with aluminum alloy internal structure. Rudder, elevator and ailerons are equipped with trim tabs.

CONTROL SYSTEM—Control system is of stick type with adjustable stops located in cockpit for all surface controls. Ailerons and elevators are actuated by push-pull tubes while rudder is cable controlled.

FUSELAGE—Fuselage is built in two sections. The front section is constructed of aluminum alloy and consists of two built-up beams, with transverse framing and metal skin reinforced against local buckling by longitudinal stringers. The beams support the gear box, propeller guns, nose wheel, cockpit and engine aft section is of semi-monocoque construction.

ALIGHTING GEAR—Alighting gear is electrically operated, self-locking, with emergency manual control located in cockpit. Nose gear retracts concurrently with main gear

REPORTS SUBMITTED ON THE XP-39E

REPORT NO.	TITLE
23-943-001	Mean Aerodynamic Chord
23-947-002	Finish Specification
23-950-001	Mock-up Photographs
23-943-008	Stability Estimate
23-943-005	Compressibility Corrections for Spanwise Distribution of Wing Airloads
23-941-001	Basic Design Criteria
23-941-002	Determination 8. Distribution of Loads
23-941-003	Fuselage Analysis
23-941-004	Determination of Loads on P-39E, Landing Gear (Part I)
23-941-008	Flutter Analysis
23-943-002	Spanwise Distribution of Wing Airloads
23-941-005	Horizontal & Vertical Tail Stress Analysis
23-943-004	Terminal Velocity
BTR 41 -75	P-39E Wing Gun Feed
23-929-01 2	Static Test of Stabilizer and Fin Leading Edge Ribs
23-943-028	Gun Sighting Lug Adjustment and Gun Sighting Chart
BTR 41-65	Fatigue Tests—Stabilizer Leading Edge
23-941-006	Aileron & Flap Analysis
23-942-005	Actual Weight 8, Balance
BTR 42-36	Gray & Prior "Atlas" Universal Joints

Excerpts from Bell XP-39E Flight Test Report 23-943-039

Dated 1 May 1942, by Robert M. Stanley, Bell Engineering Test Pilot From the files of Birch Matthews, AAHS

(Bell Aerospace via B.J. Matthews)

INTRODUCTION—The XP-39E was built under the terms of Contract No. AC-20910-E and was first flown February 21, 1942. Actually two airplanes were built (in addition to a static test article). It was planned that the first airplane would be flown with the V-1710-E4 engine for the investigation of handling qualities, armament tests, and maneuvers, the No. 2 airplane being used for performance and power plant testing almost exclusively. This program was followed until the accidental crash of the first airplane on March 26, 1942. The report herewith will limit its discussion to the characteristics of the airplane as finally evolved as of the date of issuance of this report without enumeration of the changes and modifications which have been made.

The V-1710-47 engine as tested did not represent a complete installation due to several reasons. The automatic, aneroid-operated supercharger control was not installed, necessitated the pilot's controlling the auxiliary stage manually. The carburetor calibration was of a temporary nature and necessitated manual control in order to achieve maximum power at altitude. Although equipped with aftercooler radiators, no aftercooler was provided within the engine itself.

SUMMARY—At 393 mph at approximately 24,000 feet, the XP-39E is definitely faster than the P-39D. Only in speed, however, does it surpass the latter airplane. The XP-39E is inferior to the P-39D in regards to take-off distance, landing speed, rate of climb, ceiling and general handling qualities.

The take-off distance is at least 50 percent higher than was the case with the P-39D. The stalling speed is consistently 10 mph higher. Once airborne, a considerable greater time and distance is required for the airplane to accelerate to a given airspeed. This is, of course, important in combat.

Ample cooling exists at low altitudes but is a factor which restricts power application at and above critical altitude, even with air temperatures approaching standard. It is felt that considerably more cooling surface will be necessary for high altitude operation.

The power plant itself bears promise of ultimately being satisfactory and capable of acceptable performance after some rather minor problems, such as carburetor adjustment, have been solved.

The general handling qualities of the XP-39E are considered acceptable, although not as good as the P-39D. The aileron forces are high at high speeds and the aileron effectiveness at low speeds is marginal. The airplane possesses a satisfactory degree of longitudinal stability, both dynamic and static, and has excellent stability characteristics about directional and lateral axes.

The ground handling qualities are entirely satisfactory except for slipstream rotation and rudder control during take-off.

The armament installation is being extensively revised, and only a very small amount of testing was conducted. Gun fumes in the cockpit continue to be an extremely objectionable feature.

HANDLING QUALITIES—The general handling qualities of the XP-39E, although inferior to the P-39D, are considered acceptable at the airspeeds investigated. It was considered expedient to defer high speed investigations of handling qualities until a later date. A maximum indicated airspeed of 340 mph and an acceleration of 6.0-g have been satisfactorily reached, however. Maneuvers including loops, Immelmanns, and slow rolls have been demonstrated, although snap rolls and vertical reversements have not been tried. Spin tests thus far have proven unsatisfactory.

The stalling speed has not been accurately determined in flight, although the landing speed as indicated by the airspeed meter has been observed on numerous occasions, and with the stick fully back the airplane makes contact with the runway at 100 mph.

It is believed that the braking and ground handling characteristics are satisfactory, irrespective of whether the Goodyear or the

Bendix brakes are used, the former giving slightly less pedal pressure, and as a result are apt to promote excessive tire wear in the hands of impatient and overly enthusiastic pilots. It is possible to hold the airplane against rated power, and it is possible to lock the wheels and skid the tires during the landing run using either the Goodyear or Bendix brakes.

It is believed that the elevator area is a trifle too small for proper landing control, although it permits the nose wheel to be lifted off the ground at 65 mph with a C.G. of 26.0%. Approximately 5 pounds pull is required per g of vertical acceleration at speeds in the vicinity of 300 indicated mph. This is considered ideal.

The rudder is not quite sufficient to overcome slipstream rotation at military power during the initial stage of the take-off run. In the air, however, the rudder area seems adequate for all maneuvers except spin recovery. It is desired that more aerodynamic balance be incorporated.

The aileron control has not yet reached a satisfactory stage in its development. The forces increase greatly with speed, and the aileron effectiveness at slow speeds could be improved. The most objectionable feature, however, is a buffeting which sets in when the ailerons approach their full deflection. This is believed to result from elastic deflection of the aileron control system.

The rudder trim tab is not sufficiently large to give zero pedal pressure at all speeds and powers between rated power climb and power-off dive. A tab of higher aspect ratio is desired. The situation is further aggravated due to the great number of turns required of the cockpit control to effect alteration of directional trim. A lower gear ratio is desired on both the elevator and rudder trim tabs.

It appears likely that the elevator trim tab will be satisfactory even at high speed during dive. With wheels and flaps down, full tab will permit trim at approximately 130 mph with the C.G. at 26.0% MAC.

The change in longitudinal trim with power variation is not appreciable. It varies quite markedly with speed, however, and is comparable to the P-39D in that respect. The change in trim between flaps-wheels up and flaps-wheels down is, however, much greater than is true with the latter type airplanes, though not objectionably so.

Directional trim is greatly altered by changes in speed and/or power. Its characteristics in this regard are similar to the P-39D and considerably superior to the P-40F. It is hoped that more aerodynamic balance on the rudder will overcome this fault by reducing the pedal pressures involved.

With the standard P-39D dorsal fillet installed, the fin will not stall during full-rudder, powered sideslip in either direction. The directional and lateral control coordination is considered excellent. Yaw gives positive sideslip, and turns can easily be made using only aileron or rudder independently. The customary adverse yaw-due-to-sideslip is exceptionally mild and not readilv manifest on this airplane.

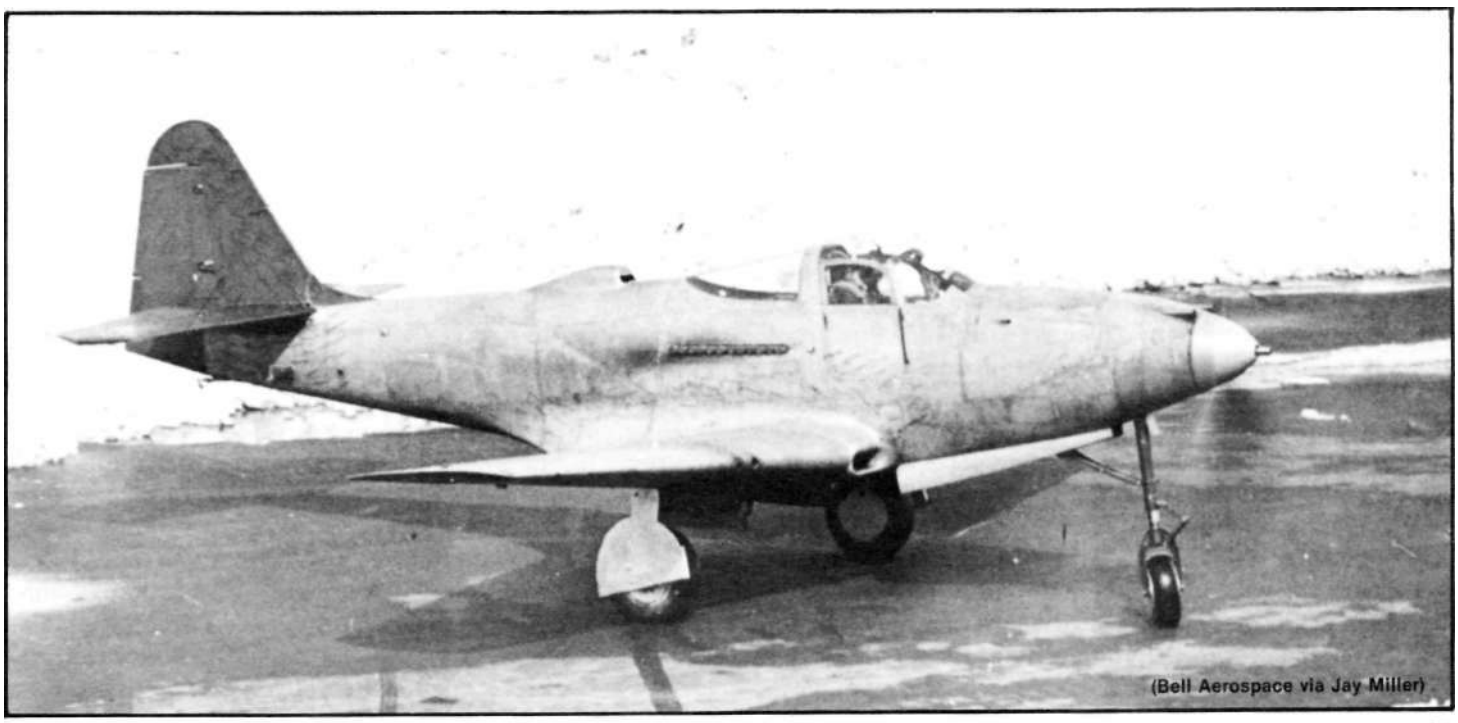
The stall characteristics of the airplane are not considered particularly bad, although a roll to the left invariably results following stall. This had been demonstrated to be due to the asymmetry produced by the landing light on the left leading edge of the wing.

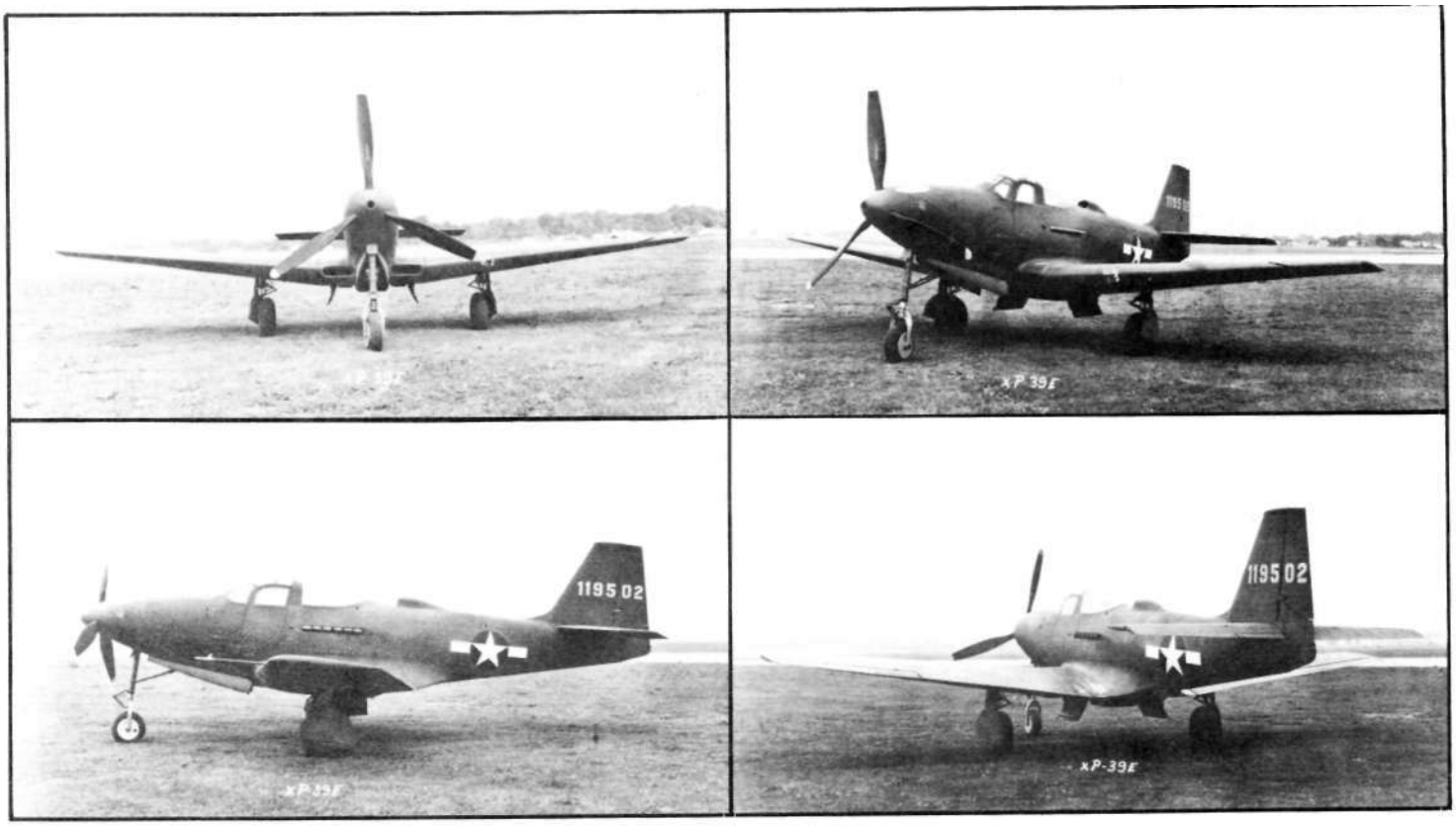
High speed stalls exhibited objectionable aileron displacement characteristics. The stick was invariably thrown violently to the right during a high speed stall and was associated with violent roll to the right.

The XP-39E's final approach for landing is much flatter than with the P-39D; it does not glide as steeply.

From a horsepower standpoint, the handling qualities of the XP-39E do not differ greatly from the P-39D, except that it seems considerably more sluggish. The thrust horsepower loading is apparently considerably higher, particularly at low speeds, giving rise to excessive take-off run and slow acceleration even after the airplane has become airborne. The rate of climb is

The process of elimination indicates this aircraft to be the third XP-39E. The main feature which differentiates it from the first and second XP-39ES is the taller, rounded vertical tail. Wing tip shape is similar to the first airplane. Streaking on the fuselage and empennage is not the result of poor photo processing, but shows tufting attached to help visualize airflow about the aircraft. The front view clearly shows the tufting on the upper surface of the port wing panel.





The second XP-39E photographed at Wright Field where it was accepted by the Army Air Force on 21 June 1943. This aircraft was used for official performance tests. (NASM, Smithsonian Institution)

measurably less than the P-39Ds and only on the basis of high speed does the XP-39E show any superiority.

POWER PLANT—To date, it has not been possible to employ rated military power for any appreciable time at altitude due to inadequate cooling and excessive oil foaming. The latter causes a considerable drop in engine oil pressure and slipping of the supercharger fluid coupling. All speed runs made in the interest of obtaining performance data were conducted immediately after attaining the desired altitude. It was not possible to continue these runs more than five or ten minutes.

The behavior of the Aero Products propeller has been in general satisfactory and is in all respects comparable to previous propellers of this type now in service. Its speed regulation is excellent, but it vibrates moderately at rated power. This is true irrespective of whether the V-1710-35 or the V-1710-47 engine is employed. RPM do not vary linearly with cockpit control position. A linear variation would be desirable.

Ample reason exists to believe that the V-1710-47 engine does not deliver rated take-off power. This belief is based on several factors. First, the Aero Products propeller was reputedly block tested at 1325 horsepower by the manufacturer and its low pitch setting derived accordingly. Upon its arrival for installation, however, the propeller had to be dismantled and the low pitch stops set down approximately 4° before the propeller would attain rated rpm at the engine's rated manifold pressure. This indicated that either the Aero Products propeller was improperly adjusted originally or that the V-1710-47 engine was delivering less than its rated torque.

It was further observed that rated take-off manifold pressure was obtained from a wide variety of throttle settings, the setting depending upon the time after starting the already warmed-up engine and upon the rate at which throttle was applied. If rated manifold pressure was applied immediately after starting the engine, considerably greater torque was available than was true if the engine's power was applied after the lapse of, say, a minute. In other words, if the engine were idle and then suddenly started up, it delivers more power at rated manifold pressure to the propeller for the first few seconds due to the fact that oil flow to the auxiliary supercharger fluid coupling has not yet caused the latter to engage sufficiently to reduce the brake horsepower of the engine. Hence it is felt that improper adjustment of the fluid coupling may be robbing the engine of some of its rated take-off power. (The minimum possible take-off distance of the XP-39E is approximately 155 percent of that required for the P-39D.)

There is a considerable time lag between adjustment of the supercharger control valve and attainment of stabilized manifold pressures when using the auxiliary supercharger at intermediate altitudes. At least 30 seconds are required for the latter to reach a stabilized speed. In general the operation of the auxiliary supercharger is exceedingly sluggish and has a considerable time lag, even greater than that obtained by turbo superchargers. It is not believed that this defect will ever be apparent to the pilot, however, once the automatic supercharger control has been perfected and installed.

The entire power plant vibrates excessively, particularly when the supercharger is fully coupled at powers near the military rating. The vibration is not a regular or high frequency vibration, but is more of an intermittent rumble as if several harmonics were interacting at once. At 2200 rpm with supercharger fully coupled, the entire airplane throbs, and vibrates as a unit.

The oil pressure regulation on the V-1710-47 engine is undesirable at best. At low altitudes the oil pressure frequently exceeds 80 psi and at high altitudes frequently drops below 50

psi. It is believed that this is attributable only in par to oil foaming.

At altitudes above 20,000 feet, it is necessary to adjust the mixture control progressively further toward the idle cut-off position as altitude is increased. At 25,000 feet, it is necessary to bring the mixture control within approximately 5/8" of idle cut-off in order to achieve maximum rpm and to improve the smooth running qualities of the engine. At 30,000 feet, the control must be even further leaned out and at 33,000 feet, the engine will run at all smoothly only if the mixture control is within approximately 3/8" of idle cut-off.

To avoid detonation, the maximum mixture temperature allowed by the Allison Engineering Company was set at 105°C. Temperatures were carefully watched during all flight tests. No evidence of detonation has been observed.

Employing rated military power at critical altitude on a day in which the atmospheric temperature was standard, 106°C was reached. On a later date when the atmosphere had become warmer, it was no longer possible to cool prestone to as low a figure as had previously been the case, and under the latter condition it was impossible to draw rated power without exceeding the danger limit on mixture temperatures. From this it is apparent that the aftercooler will be absolutely imperative for the ultimate development of this engine and that mixture temperatures will be adversely affected unless prestone temperature can be maintained at a reasonably low value.

The Delco Remy Automatic boost control was later installed. It does not control the manifold pressure during the initial stages of the take-off run and does not operate as reliably in flight as it does on the V-1710-35 engine. It is necessary to apply the throttle gradually during take-off due to the fact that manifold pressure for a given throttle opening during take-off continually decreases, necessitating controls being gradually pushed forward to maintain constant manifold pressure, and it is not until some time after the airplane has become airborne that a stabilized control is achieved at constant rated manifold pressure.

Flight tests were hampered, due to the inaccessibility of almost all power plant accessories, by the excessive time required to perform even minor adjustments thereto. The XP-39E represents from a serviceability and maintenance viewpoint the worst power plant installation that the writer has ever encountered.

TAKE-OFF DISTANCE—Six take-offs were made to determine the take-off distance of the airplane. Take-off was made into a 3.8 mph wind, and rated rpm and manifold pressure were employed.

The first three take-offs were longer than necessary due to the use of right brake to counteract propeller torque. The last three take-offs, however, were made by letting the airplane swerve to the left as it ran down the runway, and hence no brake was used, giving a faster acceleration and a shorter take-off run. During the early stages of the take-off, the airplane was headed approximately 20° to the right, swinging into the wind after it had rolled approximately 200 feet.

The fifth take-off was premature and although shorter than any of the others, it was necessary to drop back onto the runway in order to regain control of the stalled wing. The data from that take-off were discarded.

Take-offs No. 4 and 6 required 939 and 903 feet respectively, from which an average value of approximately 920 feet may be considered to be the optimum take-off distance before the wheels actually leave the ground. The corresponding time was 14 seconds average.

STABILITY—With a C.G. as far aft as 29.0% of the M.A.C., longitudinal stability both static and dynamic, is convergent for the standard airplane configuration, with blast tubes exposed, landing gear and flaps retracted. There is no tendency toward stick force reversal during pull-up or steep turns, and when displaced from a trimmed condition, the airplane always returns by a series of oscillations of diminishing amplitude to its original attitude.

Directional stability is felt to be adequate. When yawed in either direction to the maximum available rudder displacement, the airplane returns to un-yawed flight, when the rudder is released, by a short series of highly damped oscillations. The wings are maintained level throughout these tests. Irrespective of power or degree of sideslip achieved, fin stall was not encountered. Adverse yaw due to aileron action is very small. Yaw-due-to-roll is normal.

When the .50 caliber machine guns in one wing only are fired, the airplane yaws about 5° toward the guns. It is believed that accuracy of gunfire with asymmetrical gun operation will not be great.

Lateral stability was investigated by rolling the airplane to a bank angle of about 30°, maintaining a straight, level course using rudder and elevator control. With ailerons released, the airplane resumed level flight, and hence considered acceptable. The airplane's roll-due-to-yaw is considered to be of proper proportions.

In common with all pursuit aircraft (and most other military aircraft), the airplane is spirally unstable. This is normal.

The stability characteristics of the XP-39E are satisfactory about all three axes.

XP-39E/P/39D CHARACTERISTIC COMPARISON

Compiled by the AAHS Editorial Committee

	XP-39E[4]	P-39D-1	CHANGE
Span	**35'10"**	34'	+ 22"
Length	31' 11.3"	30' 2"	+ 21.3"
Height	**9' 9.5"**	9'3.25"	+ 6.25"
Wing Data			
Root Chord (in.)	100	98.66	+ 1.34
Tip Chord (in.)	50	50	-0-
Root Section'	**0018**	0015	—
Tip Section[1]	**23009**	23009	-
Area (sq. ft.)	**235.6**	213.2	+ **22.4**
Dihedral	**3.5° @ L.E.**	4° @ 30°C	[2]
Incidence	**2°**	2°	-0-
M.A.C. (in.)	**82.43**	80.64	+ 1.79
Stabilizer Span (ft.)	14	13	**+ 1**
Wheel Base (in.)	128.65	119.75	+ 8.90"
Wheel Tread (in.)	148.25	136.0	+ 12.25"
Empty Weight (lbs.)	7631	5599[3]	+ 2032
Gross Weight (lbs.)	**8918**	7847[3]	+ 1071

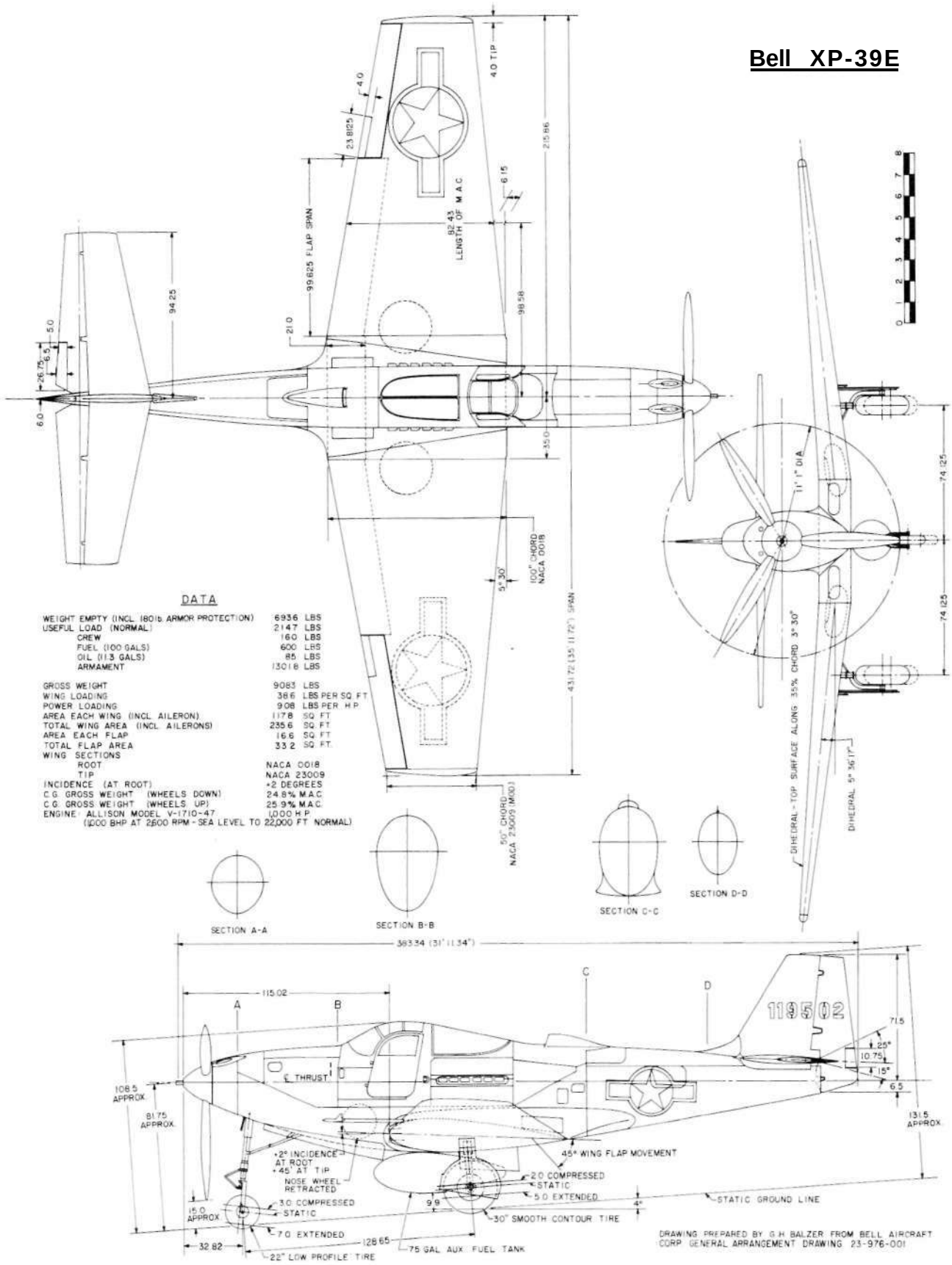
1. NACA section designations. Contrary to published information these are not laminar flow airfoils as defined by NACA NASA.

2. The 4° dihedral for the P-39D-1 at the 30% chord is measured on the upper surface of the wing. If it was measured at the leading edge (L.E.) it would be a greater angle, therefore, by comparison the XP-39E had less dihedral than the standard P-39.

3. Weight data is for P-39D-1 (AF 41 -28378) flown by the NACA.

4. The XP-39E has incorrectly been identified as the prototype of the P-63. Aerodynamically there is no reasonable relationship between these aircraft "Lessons learned" from flying the XP-39E were applied to the P-63 as a fallout of the "E" program. The most noteworthy carryover resulted in the lengthening of the P-63 fuselage to improve spin characteristics. The prop for the P-63 was also checked out on the XP-39E to verify their choice of propeller.

Bell XP-39E



GERALD BALZER