VOL. III  ENGINEERING DIVISION  Part  

VSB DESIGN BRANCH

The development of specific plane types through the experimental into the production stage. Part I. Organization is very sketchy and is confined to a brief discussion of the function of class dishes.

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111
On 12 June, 1933, Capt. Charles E. Hollen, USN, Chief of Bureau of Aeronautics, directed the Assistant Director's Organization of Airplane Design Section. "(2)" Encompassed in the formulation of this section was the organization of "Class Design", with Class Deck 8 having cognizance of VP(K), W(Air) and VS(carrier) airplanes. The duties, responsibilities, and authority assigned Class Decks follow:

- New Design - Drafting, competitions, and detail negotiations.
- Design contract changes.
- Deck-Master's and changes.
- Flight Test and trial board changes.
- Airplane Specifications and Requisitions.
- Check - General and Process Specifications.
- " - Technical Orders and Notes.
- " - Strength and safety factors (including flight restrictions).
- Trouble Report Action.
- Service Changes.

PART I

ORGANIZATION

Lt. Cdr. L.R. Richards was the first officer to be assigned the duties of Class Deck #8 officer. Lt. Cdr. A.C. Hites, USN relieved the former on 17 October, 1933.

Approximately three years after date of original organization cognizance of airplane types was reassigned among Class Decks. As of June 5, 1935, Class Deck #8, was assigned cognizance over VS (tote) and VS (carrier) types. This assignment was destined to remain essentially unchanged well through the early part of the present war.

Class Deck #8 incumbents, in addition to the two officers mentioned above, were:

Lt. Cdr. A. Gavin, USN 1 July 1936
Lt. E.L. Gleason, USN 29 July 1937
Lt. J.R. Murphy, USN 15 March 1941
Lt. Cdr. E.M. Fawkes, USN 9 October 1941

Concurrent with the nomination of Lt. E.L. Gleason, Capt. F.W. Cramer, USN, Head of Engineering Division, established the office of "Airplane New Design", "(4) The duties, responsibilities and authority of this new office were established to cover..."
Part I - ORGANIZATION

On 18 July, 1932, Rear Admiral W.A. Moffet, USN, Chief of Bureau of Aeronautics approved* the Material Division's "Organization of Airplane Design Section". *(2) Encompassed in the formulation of this section was the organization of "Class Desks", with Class Desk B having cognizance of VF(2), VB(dive) and VS(carrier) airplanes. The duties, responsibilities and authority assigned Class Desks follow:

New Design - drafting, competitions, and detail negotiations.
New Design contract changes.
Mock-Up Boards and changes.
Flight Test and Trial Board changes.
Airplane Specifications and Requisitions.
Check - General and Process Specifications.
" - Technical Orders and Notes.
" - Strength and safety matters (including flight restrictions).
Trouble Report Action.
Service Changes.

Lt. Cdr. L.B. Richardson (CC) USN was the first officer to be assigned the duties of Class Desk "B" officer. Lt. Cdr. A.C. Miles(CC) USN relieved the former on 17 October, 1933.

Approximately three years after date of original organization cognizance of airplane types was reshuffled among Class Desks. As of June 5, 1935*(3) Class Desk "B", was assigned cognizance over VSB (dive) and VS(carrier) types. This assignment was destined to remain essentially unchanged well through the early part of the present war.

Class Desk B incumbents, in addition to the two officers mentioned above, were:

Lt. Cdr. A. Gevin, USN 1 July 1936
Lt. E.W. Clepton, USN 29 July 1937
Lt. J.N. Murphy, USN 15 March 1941
Lt. Cdr. E.E. Fawkes, USN 9 October 1943

Coincident with the nomination of Lt. E.W. Clepton, Cdr. F.W. Pennoyer, USN, Head of Engineering Division, established the office of "Airplane New Design". *(4) The duties, responsibilities and authority of this new office were established to cover
"New Design", "Drafting, Design Approval and Airplane Specifications". The previously listed functions of Class Desks were modified accordingly.

On 7 October 1941, Rear Admiral J.H. Towers, USN, Chief of Bureau of Aeronautics ordered a general reorganization *(5) of that bureau. As a result Class Desk B, previously renamed VSB Design, was raised to the dignity of a section under Engineering Branch. Functions of Class Desks (this name, for Airplane Design Sections, continues in use to date) were not effected by this change. However a revised definition was written as follows:

"The Class desk officers function as assistants to the Head of Engineering in all matters pertaining to specific classes of airplanes as assigned. Responsible for seeing that action is taken by the specialist technical sections of Engineering on all trouble reports, RUDMs, Trial Board Recommendations and engineering data submitted for release by contractors. Maintain close contact with airplane manufacturers and operating units regarding construction and operation of airplanes under cognizance of the class desk."

A more complete discourse on Class Desk functions was set forth by the Bureau of Aeronautics in a letter to "The Chief of Procurement and Material" in January, 1943. *(6) It is quoted:

"Each "Class Desk" is in charge of an officer, experienced in the types of aircraft over which he has special cognizance. He is aided by such additional officer, engineering and clerical assistants as needed. Matters pertaining to a particular model are referred to the cognizant "Class Desk" which coordinates all activity required on the part of the various sections of the Engineering Branch. This includes the aerodynamic investigations and the material and structural tests which are conducted concurrently with the design stages of the prototype. Therefore each model is under individual direction during its entire life on the Navy Lists of Aircraft from its earliest design, through its development as a prototype and as a service type. This administration embraces design changes and modifications as required by service use, until such time as the model is declared obsolescent, then obsolete, and finally stricken from the Navy List of Aircraft. It is the further responsibility of the "Class Desk" to maintain close contact with the Procurement Branch, to recommend thereto contract changes, and to keep the Production Branch informed of these changes so that their effect upon production and prospective delivery may be predicted and schedules adjusted accordingly."
BuAer Office Order 25-43 *(7) established the Engineering Branch as the Engineering Division. As a result, Class Desks were elevated from the status of sections to that of branches.

The present organizational structure of VSB Design Branch is charted below:

Part I

References

*(1) Assistant Chief of Bureau of Aeronautics 1st Endorsement Aer-1-ML, A2-11/EN11(2) EN11, dated 18 July 1932 to


*(5) BuAer Office Order No. 1-41 Aer-AS-P GC, A2-11(3) EN11 dated 7 October 1941.


Part II References

* BuAer characteristics, weights and performance charts dated January 1932, 1 September, 1932 and 1 March 1933.

*(2) BuAer, Characteristics etc., dated 1 September, 1936.

*(3) BuAer, Characteristics etc., dated 1 August, 1941.

Part III References


*(3) NavAer Airplane Characteristics and Performance Charts, dated 1 June, 1944.
Part IV References

* BuAer. ltr. Aer-Pr-/BA/CW,VSB dated 8/6/38
  BuAer. ltr. Aer-Pr-BA,VSB dated 10/8/38

*(2) Engineering Division Confidential Memorandum Aer-E-102/GF/VSB, dated 12/30/38

*3 Type Specification for class VSB Airplane, SD-110-25, dated 29 June, 1938.

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PART I

DIVES BOMBERS, SCOUTS AND SCOUT-BOMBERS.

---

A AIRPLANES THROUGH THE 33D SERIES
B EXPERIMENTAL AIRPLANES SUBSEQUENT TO THE 33D SERIES
C PRODUCTION AIRPLANES SUBSEQUENT TO THE 33D SERIES
PART II
DIVE BOMBERS, SCOUTS AND SCOUT-BOMBERS

---

A. AIRPLANES THROUGH THE SBD SERIES
B. EXPERIMENTAL AIRPLANES SUBSEQUENT TO THE SBD SERIES
C. PRODUCTION AIRPLANES SUBSEQUENT TO THE SBD SERIES
A - AIRPLANES THROUGH THE USSR SERIES

Approximately four years later (2) on the second picture in the photographs and main features of the airplane, as under certain conditions, of State Bank No. Although the average and maximum performance of the higher, it will be noted that in general, it is operated in accordance with this production, despite almost consistent higher years results. Additionally, take-off distance is seen to suffer.

It may be well at this point to refer briefly to the general characteristics of different airplane types discussed in Part I, which occurred, in the case of certain class books, the reduced of responsibilities in current state of the year, airplanes; Valenciennes types were retained, and Valenciennes were redesignated Volga. The conclusion which follows indicates...
AIRPLANES THROUGH THE SBD SERIES

Records disclose that at the time of establishment of the airplane Design Section, Class Desk "B" inherited guardianship of numerous VF(2) (Two place fighters), VB(dive) and VS(carrier) airplanes. They ranged all the way from the lightweight XF8C-2 (G.W. 3548#) to the heavy weight XBY-1 (G.W. 6547#). The radial engines employed fall in various classes from 450 H.P. to 700 H.P. However, two features were common to all the airplanes involved; all were biplanes, and all had two tandem cockpits. The following tabulation lists the airplanes and those characteristics which are of primary interest:

<table>
<thead>
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<td>231</td>
<td>215</td>
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</tr>
</tbody>
</table>

Approximately four years later (2) we find a changed picture in the characteristics and main features of the airplanes under cognizance of Class Desk "B". Although the average and maximum horsepower values are higher, it will be noted that in general Vmax is improved in somewhat greater proportion, despite almost consistently higher gross weights. Admittedly, take-off distance is seen to suffer.

It may be well at this point to refer briefly to the reshuffle in airplane types discussed in Part I, which occurred in June of 1935. As a result Class Desk "B" relieved of responsibilities in connection with VF(2) airplanes; VS(carrier) types were retained, and VB(dive) types were redesignated VSB(dive). The tabulation which follows reflects
the change in types and reveals in addition a radical departure from conventional design of scout and dive-bomber airplanes.

Two of the airplanes listed, viz; the SB2U-1 and the BT-1 were low wing monoplanes. Moreover, except for control surfaces, the BT-1 was of all metal construction. (Note: The SB2U-1 was the first monoplane dive-bomber and the second monoplane (the TBD-1 having been the first) to be employed in the history of naval (carrier) aviation.) However, both the SB2U-1 and the BT-1 made their appearance at close interval, the first four SB2U-1 airplanes being delivered to the U.S. Navy in December, 1937, and the first four BT-1 airplanes in March, 1938.

<table>
<thead>
<tr>
<th></th>
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<td>795</td>
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<td>61.0</td>
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<td>235</td>
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</tbody>
</table>

"Pearl Harbor" embarrassed us with the following scout-bombers in service and experimental scout bombers in preliminary flight status or under construction: *3
It becomes apparent immediately that "scout-bomber" and "dive-bomber" have become synonymous terms for the same type of airplane, and that the types VS and VB have been discarded. The changes in Vmax, engine power, gross weight and take-off run in comparison with similar characteristics of previous tabulations is also obvious; and, noteworthy is the fact that the changing trend has left the SBC-4 as the only biplane scout-bomber in service. A new feature present in each of the experimental airplanes is the bomb-bay.

Taking stock of the situation at the time of this country's entry into the present war, the 9 January 1942 Status Report (included in Appendix "A") details the story of the U.S. Navy's dive-bombers in that fateful period. None of the models were modern combat airplanes. As a matter of fact they were a far cry from being either modern or combat ready. The SBC-4 was obsolescent beyond doubt and few were left in service. The SB2U series, all throwbacks to the SB2U-1 were little better off with their small 825 H.P. engine and fabric covering on portions of both the fuselage and wings. Of the latest model of this series, the SB2U-3, 57 had been procured for the U.S. Marine Corps. These airplanes were equipped with added internal fuel capacity over that of the SB2U-1 and -2, and provisions were incorporated for mounting two .30 cal. fixed guns in the wing in addition to the two .50 cal. guns.

Further, the airplanes were convertible to twin-float seaplanes. However, no such conversion was ever put to service use; and the first few Jap assaults left a very small number of these airplanes with which even to plan such changes.

Part III - Douglas Dauntless Dive Bombers

This then left the SBD series airplanes with which to engage the enemy in offensive combat. The SBD-1 came of good stock being a direct descendent of the BT-1. (In fact, the prototype of the SBD-1 was the XBT-2.) The major changes which were incorporated in the SBD-1 were the installation of the larger, 1000 H.P. R1820-32 engine in place of the 750 H.P. R-1535-94 engine in the BT-1, fully retracting main landing gear and redesigned tail surfaces.

The SBD-2 differed primarily from the SBD-1 in that the former had two additional fuel tanks installed, one in each outer wing panel to raise the total protected fuel capacity from 190 to 254 gallons.

The SBD-3 derived its dash number primarily from the change in engine from R1820-32 to R1820-52 which was effected to provide an improved carburetor. In addition numerous minor improvements were incorporated. The SBD-4 in turn, differed from the SBD-3 only in that a 24 volt electrical system was installed in place of the 12 volt system. Since these two models, therefore, were identical from a performance standpoint, and since these were the scout-bombers which constituted the U.S. Fleet's dive-bombing weapon from the start of the present war through the summer of 1944, it is of extreme interest

Declassified under NND 913043
to ascertain the Trial Board's findings relative to the SBD-3's characteristics and performance.

Quoting from the Board's report # we find the following facts:

"The performance of the model SBD-3 airplane as a 1000 pound bomber airplane --- follows:

Vmax. at engine rated power and alt. (mph) 250
Vmin. without power at sea level (mph) 73.5
Service ceiling starting with normal load (ft) 27000
Take-off distance in 25 kt. wind (ft) 294
Gross Weight (lbs) 8400
Position of center of gravity (%Mac) 28.5

"The airplane fulfilled the contract guarantees of maximum speed service ceiling, and take-off distance, and failed by only small margins the guarantees of delivery, weight empty and minimum speed. In general the stability and flying characteristics of the Model SBD-3 airplane were excellent. The Board recommends that the Model SBD-3 airplane, be accepted as a service type for use as a scout and dive-bomber."

In a subsequent report #(2) of overload take-off tests conducted by the NAS, Anacostia, D.C., BuAer was informed that the airplane when loaded to a gross weight of 10,209 lbs., with the center of gravity position at 31.4% MAC, exhibited satisfactory take-off, landing and control characteristics. The take-off distance in this condition, in a 25 kt. wind, was 420 ft.

The addition of a second .30 caliber flexible gun and increase in ammunition from 600 to 2000 rounds, and the installation of electronic identification and search equipment in SBD-3 and -4 airplanes made retention of good take-off and performance characteristics difficult. It was decided therefore to install an engine of higher horsepower, the R1820-60, and the airplane was redesignated SBD-5. This change was accomplished having in mind the plan to make still another engine change at a later date (upon development of that engine) to the R1820-66 in the SBD-6 airplane.

The increased internal fuel capacity worked in the tabulation below was made possible by the use of improved full tank cell and shell design.
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<tr>
<th>Model</th>
<th>Engine Power</th>
<th>G.W. W.E.</th>
<th>Armament</th>
<th>Normal Vmax</th>
<th>VS Combat</th>
<th>T.O. Radius</th>
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<td>1200</td>
<td>10403</td>
<td>6533</td>
<td>250 fix</td>
<td>1000</td>
<td>252 79.8</td>
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<tr>
<td>SBD-6</td>
<td>1300</td>
<td>10773</td>
<td>6627</td>
<td>230 Free</td>
<td>&quot;</td>
<td>253 80.9</td>
</tr>
</tbody>
</table>

*With 254 gallons fuel.
#With 300 gallons fuel.

In all, 4984 Model SBD series airplanes were procured from the Douglas Aircraft Co., apportioned as follows:

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<th>No.</th>
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<th>Model</th>
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</table>

Contract Nos 77114 89641 91397

Dauntless airplanes more than paid for themselves in terms of enemy ships sunk and crippled, and shore installations destroyed and damaged, to say nothing of enemy personnel casualties inflicted.
1. **XSB3C-1 AIRPLANES**

The contractor (Curtiss-Wright Corporation, Columbus, Ohio) submitted a design proposal in response to Bureau design competition letter Aer-PB-R 2489 dated 1 February, 1941. Five companies submitted proposals: Boeing, Douglas, Fokker, N.A., and Curtiss. Two airplane proposals were accepted for development, the Douglas XSB2D-1 and the Curtiss XSB3C-1. The XSB3C-1 airplane was chosen for the following reasons:

1. Similarity to SB2C-1 airplanes, and engineering and production experience of the Curtiss-Wright Corporation.

2. Flexible bomb and overload fuel tanks arrangement, with provisions for carrying two 1000# bombs for 1400 miles at an average overload gross weight of approximately 16,500 lbs.

3. Good power plant installation (W-335G engine - two speed).

4. Twin gun (50-caliber) turret for rear protection.

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**B - EXPERIMENTAL AIRPLANES SUBSEQUENT TO THE SBD SERIES**

The XSB3C-1 airplanes were developments of the SB2C-1, and were conventional in design, with the flexible gun installation, which was at the time considered undeveloped. The tricycle landing gear, while not new to Curtiss. The Board of Inspection of the XB3C-1 was completed 3-11 December, 1941.

Consideration is to be given over the takeoff run of this model. Approximately 2000 feet was removed from these airplanes as a result of a reduction in the weight of the protective armor. A reduction in the weight of the fuel tanks accounted for the weight saving. In spite of this action, the takeoff characteristics were not good.

The XB3C-1 airplane was a two-place dive bomber. A few of the characteristics are as follows:

(a) **General** - Wright R-1820-1 - low-winged, straight leading edge and tapered trailing edge, and folding outer panels and folding wing tips.

- Single-fin and horizontal stabilizer.
- Internal, protected fuel capacity for 365 gal.
- Tricycle landing gear.

(b) **Armament** - 2 fixed 50 caliber (400 rds.)

- Flexible gun installation (2-50 cal. (.50 rds.)
- Provisions for carrying 2-1600 15. bombs in bomb bay.
Experimental

1 - XSB3C-1 AIRPLANES

The contractor (Curtiss-Wright Corporation, Columbus, Ohio) submitted a design proposal in response to BuAer design competition letter Aer-PR-BA VSB dated 3 February, 1941. Five companies submitted proposals: Brewster, Douglas, Vought, NAF, and Curtiss. Two airplanes proposals were accepted for development, the Douglas XSB2D-1 and the Curtiss XSB3C-1. The XSB3C-1 airplane was chosen for the following reasons:

1. Similarity to SB2C-1 airplane, and engineering and production experience of the Curtiss-Wright Corporation.

2. Flexible bomb and overload fuel tanks arrangement, with provisions for carrying two 1000# bombs for 1400 miles at an average overload gross weight of approximately 16,800 lbs.

3. Good power plant installation (R-3350 engine - two speed).

4. Twin gun (50 Caliber) turret for rear protection.

5. Good stability.

The XSB3C-1 airplanes were developments of the SB2C-1, and were conventional in design except for the flexible gun installation, which was at the time considered undeveloped. The tricycle landing gear, while not experimental, was new to Curtiss. The Mock-up Board inspection of this airplane was conducted 8-11 December, 1941.

Considerable concern was felt over the takeoff run of this model. Approximately 225 pounds was removed from these airplanes as a result of an Engineering-Plans Conference. A reduction in protective armor thickness and a reduction in protected fuel tankage accounted for most of the weight saving. In spite of this action the takeoff characteristics were not good.

The XSB3C-1 airplane was a two place dive bomber. A few of the characteristics are as follows:

(a) General - Wright R-3350-8 - Low midwing with constant dihedral, straight leading edge and tapered trailing edge, and folding outer panels and folding wing tips.

- Single fin and horizontal stabilizer.

- Internal, protected fuel capacity for 365 gal.

- Tricycle landing gear.

(b) Armament - 2 fixed 50 caliber (400 rds.)

- Flexible gun installation (2-50 Cal. (800 rds.)

- Provisions for carrying 2-1600 lb. bombs in bomb-bay

Declassified under NND 913043
Production orders for these airplanes was not recommended until trials show their actual performance. Takeoff runs in a 25 knot wind were estimated to be as follows:

1 - 500 lb. bomb ( Normal fuel, 240 gals.) - 375 ft.
1 - 1000 lb. bomb ( 300 gals.)   - 450 ft.
1 - Torpedo ( 240 gals.)           - 510 ft.

Performance (1000# combat bomber - crew - two).

| Gross Weight | 14990# |
| Fuel/Oil gal. | 245/16 |
| Fixed guns/ammunition | 2-50 cal/400 |
| Flexible guns/ammunition | 2-50 cal/400 |
| Wing loading lb/sq. ft. | 33.23 |
| Power Loading - lbs/EHP (T.O. Power) | 6.5 |
| Vmax. S.L. - mph | 313 |
| Vmax/Critical mph. ft. | 349/16000 |
| Vstall (Gr. Wt. #) - mph | 78.4 |
| Vstall (W/O fuel) | 74.5 |
| Time to climb to 20,000 ft. (min) | 10.17 |
| Service ceiling - ft. | 29,800 |
| Takeoff distance - 25 kt. ft. | 348 |
| Rate of climb - S.L. ft/min. | 2817 |

A conference was called at the Bureau of Aeronautics 7 December, 1942, to discuss the proposal to modify or cancel the XSB3C-1 airplane contract. At this time it appeared that the SB2C-1 airplanes would prove satisfactory and in order to ease the engineering load at the Columbus Plant it was decided to cancel the contract and store the fabricated parts. This action was considered essential if the XSC-1 and XBTC airplanes were to be expedited. Another factor taken into consideration in this cancellation was the XSB2D-1 airplane resulted in a contract for the XSB3C-1 airplanes. Because of the lower performance of the XSB3C-1 as compared to the XSB2D-1 and since the guaranteed takeoff was very long no production order was contemplated before actual flight of the experimental airplanes.
B - EXPERIMENTAL

(2) XSB2D-1 Airplane

General (Prior to First Flight of the Airplanes).

Out of the same design competition which produced the XSB3C-1 airplane, came a Douglas design for a two seater scout and dive bomber airplane. This design was designated the XSB2D-1 airplane, being the second dive-bomber designed by the Douglas Company. As mutually arrived at by the contractor and the Bureau of Aeronautics in the summer of 1941, the airplane was designed with a bomb-bay large enough to take two one-thousand pounds or two sixteen hundred pounds bombs. The XSB2D-1 airplane was a two-seater, with an inverted gull wing, tricycle gear, wing dive-brakes (fence type), using the Wright R-3350-14 engine. The armament consisted of two .50 cal. non-synchronized machine guns fixed in the wings (or 2 .50 cal. guns in the overload condition) and two .50 cal. flexible guns, power operated, each one in a turret on top and bottom of the rear fuselage.

The normal design load of the aircraft was fixed at 1-500 lbs. bomb and 223 gallons of fuel, while its actual capabilities were to carry two 1,600 lbs. bombs in the bomb-bay and 350 gallons of fuel internally in three tanks.

The airplane was summarily described in Outline Specification OS-103 dated June 3, 1941. Based on this Outline Specification, the contractor was first sent a Notice of Award by the Bureau of Supplies and Accounts, dated 30 June, 1941, then the actual contract, Nos. 88707, dated 30 June, 1941. The contract called for two model XSB2D-1 airplanes at a fixed price of some $1,410,000. The contract called for the following:

(a) Weight empty of the airplane of 10,837#.
(b) Delivery of the first XSB2D-1 airplane at NAS, Anacostia, D.C., twelve months after date of contract, and of the second XSB2D-1 airplane one month later at the same place.
(c) Guarantees:
- Vmax at ACA of 377 mph with engine military rated power.
- Take-off in 25 kts. wind at 266 ft. with one 500# bomb and 223 gallons of fuel (14,248#).

The guarantees under the contract were based on the Wright R-3350-14 engine giving:

(a) 2100 BHP for normal power.
(b) 2250 BHP for military power.
(c) 2300 BHP for take-off power.

From the above, it can be seen that the model XSB2D-1 airplane was
to be a high speed airplane with a relatively low weight empty. However, the normal design load of one 500 lbs. bomb and 223 gallons of fuel was very conservative considering the service loading that was expected of this airplane.

The mock-up of the model XSB2D-1 airplane was held at the contractor's plant from 18 August to 21 August, 1941. The Mock-Up Board members were:

Cdr. L.C. Stevens  
Cdr. W.F. Boone  
Cdr. C.M. Bolster  
Lt. Cdr. S.B. Spangler  
Lt. Cdr. J.N. Murphy  
Lt. Cdr. D. Harris  
Lt. D.B. Young  
Lt. (jg) J.O. Christian  
Lt. (jg) N.R. Richardson  
Mr. W.Z. Frisbie  
Mr. W.W. Rust

Also present were:

Cdr. R.E. Jennings  
Lt. L.P. Carver

Experiments & Developments

Ship Installations  
Power Plants  
VSB Design  
Plans  
Armament  
Instruments  
Radio and Electrical  
Design Coordination  
Power Plants

Board of Inspection & Survey  
NAS, Anacostia, D.C.

As stated in the Mock-Up Board Confidential Report, Aer-E-12-EP, C-88707, dated 10 September, 1941, and approved by Rear Admiral J.H. Towers, "the mock-up was well constructed and showed all essential items of the design". The XSB2D-1 airplane was a new design with a considerable number of experimental features:

(a) **Flexible gun installation.** The guns were remotely controlled, power operated, one gun in each of two turrets.
(b) **Dive-brakes.** They were of the wing fence type. Extensive wind-tunnel tests were planned to obtain data on this type design.
(c) **Laminar flow wing.** This was a low drag wing; the only experience with it was on an Army pursuit plane.
(d) **R-3350-14 engine.** No engine with the particular gear ratio (16:9) was flying.
(e) **Tricycle landing gear.** No experience in catapulting with such gear was available.
(f) **Landing flaps.** They were double-slotted, of complicated design, and supposed to give a very high lift coefficient. No flight data with such a flap was available.
(g) Miscellaneous other features such as the hydraulic arresting hook and displacing gear.

As a result of the mock-up changes recommended by the Board (of which there were 35) the estimated weight increases were as follows:

(1) 76.5 lbs. in Weight Empty (bringing it to 10,913.5 lbs.).
(2) 5.0 lbs. in Useful Load (bringing it to 3,418.0 lbs. in the normal design load condition).

The total increase was 81.5 lbs.

The detail specification SD-288, dated 7 July, 1941, replaced the outline specification, OS-103, dated 3 June, 1941.

The engine, which was to be contractor-furnished, had not progressed by October, 1941, to the point where it could be rated at 2300 BHP. It was decided that the two XSB2D-1 airplanes would get two engines rated at 2200 BHP, and the contractor was allowed a delay in delivery to the extent that the airplanes were to be delivered for preliminary trials at NAS, Anacostia, by August 15, 1942. The airplanes were to be returned after trials to the contractor's plant for incorporation of the 2300 BHP engines. In the fall of 1941, due to misunderstanding between the contractor and the Bureau of Aeronautics, the XSB2D-1 airplane was slightly understrength according to BuAer's desires. To bring the airplane back to strength cost a delay in delivery of one week. The Status of VSB Design Projects dated 7 March, 1942, states "Delivery of these airplanes has been set back from 30 June, 1942, to 19 September, 1942. This delay is attributed to the following: six weeks due to delayed engines; one week due to revised stress analysis; and four weeks due to engineering changes required because of a shift from a four to a three bladed propeller. These airplanes are about 275 lbs. overweight."

Lack of engineering talent and changes in design dictated by wind tunnel tests (among them an increase in outer panel dihedral from 10° to 14° to improve the "wave-off" condition) further delayed the program to December, 1942.

Besides delay in delivery of the airplanes, another factor was giving serious trouble. The airplane was becoming overweight at an alarming rate. This overweight was on a continuously increasing trend: 275 in March 1942, 450 in July 1942, 600 in September 1942, 1340 in April 1943, 1375 in May 1943 and 1439 in July 1943. The Bureau of Aeronautics sent a 15866 TWX October 1942 to the contractor stating "Bureau seriously concerned at prospective high wing loading and stalling speed of the airplane. Addition of
wing area appears necessary. Suggest Douglas representatives visit Bureau prepared to discuss remedial measures and their effect on deliveries. In accordance with this request a conference was held in the Bureau of Aeronautics in the first week of November 1942; any change involving drastic redesign of the airplane to bring it back to its original weight would mean a delay of one year. It was therefore decided that the contractor would (1) redesign parts of the structure which were overweight; (2) submit proposals for the deletion of certain items of equipment such as automatic pilot, electrical conduit (35 lbs), catapult hooks and provisions (37 lbs), barrier crash structure and fittings (9 lbs), tell-tale system (9 lbs), heat or de-icing provisions, power operated turrets and their replacement by a 34" diameter 2-.50 cal. power operated gun truck and seat (decrease of 600 lbs.). These changes were to be made effective in the SB2D-1 airplanes (production having been allowed by that time) at whatever point necessary not to delay delivery. However, most of these changes were never made, since Fleet experience dictated their incorporation in combat airplanes.

In order to expedite the first flight of the first XSB2D-1 airplane, BuNo. 03551, the contractor was allowed to leave out of the airplane various installations not necessary for flight. Among these were the rear gun turrets, which were replaced by dummies to give the airplane the actual aerodynamic contour. After some three weeks delay due to the correction of minor deficiencies that were uncovered during the rigging and pre-flight inspection of the airplane, the first airplane, BuNo. 03551, made its first flight on April 8, 1943.

Due to results of flight tests on the first airplane, it was decided that the second airplane would have the following changes before first flight:

(a) Increased vertical tail surfaces.
(b) Increased horizontal tail surfaces.
(c) 10° dihedral in outer wing panels (instead of 14°).

Due to these changes and troubles with the power plant (which was also an R-3350-14 rated at only 2200 hp) the second XSB2D-1 airplane did not fly until August 11, 1943.

Flight Tests, General.

The first airplane, BuNo. 03551, made its first flight on April 8, 1943. The second one, BuNo. 03552, made it on August 11, 1943. Results of flight test on the first airplane were the cause for different configurations of the two airplanes. During the latter part of August 1943 the configurations were as follows:
Engine
R-3350-L4 rated at 2200 HP. No high blower. Same
No dynamic balancer.
Outer wing panels dihedral
Vertical Tail Surface 14° 10°
Horizontal Tail Surface Extended 10" Original
Dive Brakes On the airplane Not on airplane

By 23 August 1943, the first airplane had made 62 flights with the following results:

2. Take-off is long for carrier use.
3. Rudder is rather weak but appears satisfactory.
4. Poor visibility with cowl flaps open.
5. Aileron system friction too great.
6. All stick forces are high.
7. Buffeting experienced at diving speeds. Final configuration of dive-brakes not yet found.
8. Weak directional stability.

By the same date the following observations had been made from four flights on the second airplane:

1. Directional stability marginal in all conditions except at high speeds.
2. Lateral stability is good at moderate and high speeds, but only fair at carrier approach conditions.
3. Longitudinal stability good at high speed, fair at cruising, marginal in climb and carrier approach conditions.

In general, the configuration of the second airplane was considered superior to that of the first one. Take-off tests made with the first airplane, using a three-bladed propeller at 15,000 lbs., showed that the airplane would meet its guarantees. However, the normal design load of the airplane (1-500 lbs. and 223 gallons of fuel) was too fictitious and at operating gross weights (about 18,000 to 19,000 lbs) the take-off would be marginal (520 ft. in 25 Kts. wind at 18,000 lbs).

From August 1943 on, the two airplanes were used mainly for two purposes: flight stability tests on BuNo. 03552, and development of satisfactory dive brakes on BuNo. 03551. The elimination of carbon monoxide fumes was also a major problem in the flight test program.
On October 8, 1943, the second airplane made a forced landing due to a propeller failure and repairs held it grounded until December 11, 1943. The second airplane was then used: (1) for flight tests of revised rudders, elevators, ailerons, all designed to improve the stability of the model, (2) to eliminate CO from the pilot's cockpit.

The first airplane was used almost exclusively to arrive at a satisfactory dive-brake configuration.

After about eight months of tests the contractor stated that he had found the answer to the dive-brake problem. The dive-brakes were then composed of top and bottom wing "picket fences" and four fuselage plates, hinged at their forward edge, and disposed in a semi-circle around the bottom half of the fuselage at the trailing edge of the wing (these fuselage plates were the basis for the dive-brake configuration of the model XBT2D-1 airplanes). This dive-brake arrangement gave a terminal velocity of about 310 mph IAS in a 70° dive at about 17,000 lbs.

During the spring of 1944, some of the BTD-1 airplanes were flying (see SB2D-1 and BTD-1 airplanes) and flight tests on the two XSB2D-1 airplanes lost much of their priority and value. It was therefore decided that they should be prepared for delivery. Delivery configurations of the two airplanes were to be different, with miscellaneous installations missing, such as wing and fuselage dive-brakes, wingfold, and gun installation in BuNo. 03552.

In November, 1944, negotiations were started to terminate the contract and scrap the two experimental airplanes, because of their obsolescence and the expenditure of time and money which would have been required to successfully complete a reasonable demonstration. However, Model XSB2D-1 airplane, BuNo. 03551, was delivered to NACA, Moffett Field, for various tests under TED No. NACA 2331, with a three bladed Hamilton Standard propeller and an R-3350-14 engine without second order balancers. By endorsement to BuAer letter Aer-CO-6014-A, NOa(s) 4374, serial 24750, of 20 February, 1945, SecNav had previously approved acceptance of the two airplanes without compliance by the contractor with the demonstration requirements and without trials by the Board of Inspection and Survey.

On June 28, 1945, Amendment 1 to Contract NOa(s)-4844 (the original contract NOs 88707 had been renamed NOa(s)-4844 by Amendment 21) was issued to accept the two XSB2D-1 airplanes in their condition at that time and to waive demonstration and trials.

The second airplane, BuNo. 03552, was stricken at the contractor's plant in August, 1945.
Engineering Features

A detailed description of the XSE2D-1 airplane can be found in Detail Specification SD-288 dated 7 July, 1941. Following is a brief resume of its features:

**Engine:**
Wright R-3350-14 (single speed)

**Propeller:**
Hamilton Standard - 12' 8" diameter

**Armament:**
Two or four .50 cal. fixed wing guns (with 800 rds/gun).
Two .50 cal. power operated guns (800 rds)
one in each of two turrets (upper and lower)
Provisions in bomb-bay to carry up to two 1600 lbs. bombs. Provisions on each wing to carry up to one smoke tank (336 lbs.)

**Fuel:**
One self-sealing fuselage tank (120 gallon)
One left wing self-sealing tank (110 gallons)
One right wing tank (120 gallons)
Two bomb-bay drop tanks (52½ gals. each)

Two seater scout and dive bomber - Inverted gull folding wing.
Tricycle retractable landing gear - Large bomb bay - Wing "picket fences" - Arresting and catapult hooks.

**Dimensions:**
Length 38' 0"
Span 45' 0"
Span folded 20' 6½"
Height during folding 18' 2"

**Gross Weight:**
14,000 to 16,000 lbs (spec.)
16,500 to 18,500 lbs (actual).
C - EXPERIMENTAL

(3) - XBTC-1 and XBTC-2

Director of Planning and Head of Engineering Joint Memorandum, Aer-E-12-HSR and Aer-E-17-HSR, VBT, VTSB, dated 29 January, 1942, to the Chief of the Bureau of Aeronautics, is a report of a conference held on 21-22 January, 1942, to discuss the possibilities of the new VBT and VTSB airplane.

It was the opinion that the scout-mission should be transferred to the VTR type of airplane, making a conception of the single-seat dive bomber possible. The advent of radar had placed such a burden upon the radar operator that it was believed he could not be expected to serve as a look-out and rear gunner. This indicated the three-seater for use as a scout with radar search equipment. It was realized that this would make necessary a revision of the numbers of each type to be carried in the carriers, but only three types are needed. The proposed types would be VF, VBT, and VTSB. In this case the matter of carrier stowage and "spot" was discussed. The contemplated design would make possible a better distribution of the "spot": namely; VF (225 to 250 ft.), VBT (250 to 300 ft.), VTSB (350 ft.). In the matter of stowage the VBT would require no more room than the then current VSB with the expectation that the former airplane might be smaller. This would off-set the possible slight increase in the folded envelope of the proposed VTSB.

It was estimated that by removing the second man, protective armament, and scout radio, from the present VSB type, a weight reduction of 1500 lbs. would be possible. This difference could be used in two ways: (1) The airplane could be reduced in size with a resultant gain in speed, at no sacrifice in other performance items; or (2) the weight difference could be used to provide more range, heavier pilot armor, and more fixed armament in an airplane of about the same size. It was considered very probable that a very excellent compromise could be effected with a reduction in size corresponding to about 800 pound reduction in weight of an XSB2D-1, for example. A maximum speed of 390 mph was desired.

A recommendation was made that a single-seat type bomber torpedo airplane design be initiated immediately. It was further recommended that the Curtiss Wright Corp., Airplane Division, Columbus Plant, be requested to conduct a study of this design and to submit an informal proposal for the construction of two experimental airplanes.
Bureau of Aeronautics Confidential letter Aer-E-210-MMC
Serial C-1661, dated 9 Feb., 1942, to the Curtiss-Wright Corp.,
Columbus, Ohio, requested a preliminary design study and proposal
with estimates of cost and time delivery for two prototype
airplanes in accordance with the brief specification that
follows:

Primary Mission: Dive bombing attack.
Secondary Missions: Torpedo Attack
Smoke screen laying.

Crew: One.

Power Plant: R-3350—Single stage, two speed.

Military Load:
(a) One 500 lb. bomb, normal, or,
(b) Two 1600 lb. -AP bombs or,
(c) Two 1000 lb. bombs or,
(d) Four 500 lb. bomb (two external) or,
(e) One MK 13-1 or -2 torpedo (external).
(f) Four 20mm fixed cannons firing
forward, with 110 rounds per gun
(normal) (with provisions for 200
rounds per gun).

Radio: Standard Fighter type — GF.
Radar: ABA IPP Equipment.

Fuel and Oil:
Protected fuel for range of 1000 miles
with one 1000 lb. bomb.
Sufficient fuel in droppable tanks to
provide an additional 500 mile range
with 1-1000 lb. bomb. Range with torpedo
to be that which results from the above
total fuel load. Unprotected tanks must
be droppable when torpedo is carried.
Not greater than 250 feet in 25 kt. wind
with one-1000 lb. bomb and 1000 miles of
fuel. Take-off under maximum overload
with torpedo in 25 kt. wind — 350 feet.

Since the airplane was to have no rear gunner, the maximum
amount of armor protection was to be provided for the pilot.
Protection from .50 caliber fire from the front was specified, and
the rear protection was to exceed that necessary for .50 caliber pro-
tection, the exact amount depending upon the maximum obtainable speed
at the airplane critical altitude.

Curtiss-Wright Corp. originally submitted a proposal on
15 June, 1942, in accordance with the specification above, and an
alternate proposal with an XR-4360 engine and dual rotation prop-
eller. The design as originally submitted had certain undesirable
features, and the proposal was modified and resubmitted on 13
July, 1942.
The head of Engineering Memo Aer-E-2121MMM, L4-3(1), dated 25 June, 1942, to the Assistant Chief of the Bureau recommended that a contract be awarded the contractor for four experimental airplanes and engineering data.

Two of the airplanes recommended above incorporated a single stage, two speed, super-charged, R-3350 engine and Curtiss four blade propeller, while the other two incorporated a single stage, two speed, super-charged, XR-4360-8 engine with a dual rotation six blade propeller. The airplane with the R-3350 engine installation was a conventional low midwing mono-plane designed to carry one 500 lb. or one -1600# bomb internally and two 500# bombs externally. It had provisions for four 20 mm guns with 200 rounds of ammunition for each gun located in the wing center section, and an aiming angle bombsight installation was provided. Every attempt was made to eliminate experimental features which might temporarily complicate the design and yet provide an airplane with substantial increase in performance over the current VB and VT types. For design purposes, and for the performance shown below, the usual load included one 500 lb. bomb and two 20 mm guns with 200 rounds each.

VBT Performance Summaries (Below Bureau Estimates with NACA 23000 Series Airfoil)

<table>
<thead>
<tr>
<th>Engine</th>
<th>R-3350</th>
<th>XR 4360</th>
</tr>
</thead>
<tbody>
<tr>
<td>T.O. BHP/RPM</td>
<td>2300/2800</td>
<td>3000/2700</td>
</tr>
<tr>
<td>Mil/BHP/RPM/Alt.</td>
<td>1900/2600/14000</td>
<td>2400/2700/13500</td>
</tr>
<tr>
<td>Gear Ratio</td>
<td>1437</td>
<td>.381</td>
</tr>
<tr>
<td>Propeller</td>
<td>Single Rotation</td>
<td>Dual Rotation</td>
</tr>
<tr>
<td>Diam/No. of Blades</td>
<td>13 ft. 2 in./4</td>
<td>14 ft. 2 in./6</td>
</tr>
<tr>
<td>Gross Weight (1-500# bomb)</td>
<td>13,228</td>
<td>15,601#</td>
</tr>
<tr>
<td>Fuels (Gals.)</td>
<td>200</td>
<td>230</td>
</tr>
<tr>
<td>Vst.</td>
<td>75.4</td>
<td>79.7</td>
</tr>
<tr>
<td>Vmax</td>
<td>376/16400</td>
<td>405/16200</td>
</tr>
<tr>
<td>T. O. (25 kts.)</td>
<td>214 ft.</td>
<td>234 ft.</td>
</tr>
<tr>
<td>Maximum Range (miles)</td>
<td>955</td>
<td>1035</td>
</tr>
</tbody>
</table>
Gross Weigh (1-1000 lb. bomb)  13,765#  16,161#

Take-off Distance (25 kts.)  237 ft.  256 ft.

The airplane with the XR-4360 engine installation was externally the same as the basic design, except for increase in wing span from 48 feet to 50 feet, accomplished by extending the basic wing lines one foot at each tip. This design had a definite performance advantage by reasons of greater power, but at the stage of development of the engine and propeller the contractor was not willing to submit guarantees. It was considered highly desirable however, to bring both designs along simultaneously with the probability that production of the R-3350 airplane would be earlier and it would be changed to the R-4360 type, as this engine became available in quantity.

A letter of intent for Contract NXS-8719 was issued, dated 26 June, 1942, for the design, construction, and delivery of two Model XBTC-1 and two XBTC-2 airplanes, mock-ups, static test airplanes, and engineering data.

The mock-up on the airplanes was held at the contractor’s plant on 16 Dec., 1942.

Due to the necessity of delivering the SB2C-1 airplane to the Fleet in a combat ready condition, and the higher priority accorded the SC-1 airplanes, the XBTC-1 and -2 airplanes were lowered in priority. As a result the designs were pushed farther and farther behind. The contractor proposed to cancel the XBTC-1 airplanes and concentrated on the XBTC-2 airplanes. This proposal was accepted due to an overload in the contractor’s engineering department and troubles at the time with the R-3350 engine.

The XBTC-2 incorporated design ideas which were relatively new in 1942. In the wind-tunnel model tests of the XBTC-2, the NACA made certain basic discoveries relative to the effect of wing plan form on stability and control, particularly in the carrier-approach condition. The outer wing panels incorporating the duplex flaps were redesigned accordingly. Therefore, the XBTC-2 incorporates three advance design ideas, the full investigation and/or development of which are of great importance in current and future development of carrier-based aircraft, as follows:

(a) Dual rotation propeller.
(b) Full span duplex flaps.
(c) Wing of proper plan-form to give stability and control, particularly in the carrier approach condition.

Delays in development of the basic XR-4360 engine and the dual rotation propellers were circumstance which delayed the development of the XBTC-2 airplanes.
A few of the characteristics of the XBTC-2 airplanes are as follows:

(a) General -
- Pratt Whitney XR-4360 engine
- Dual rotation propeller
- Low mid-wing, no dihedral center section and 10 degrees dihedral on outer wing panel.
- Straight leading edge and tapered trailing edge (airplane No.1), swept back leading edge and straight trailing edge, with full span duplex flaps (airplane No.2).
- Single high aspect ratio fin and horizontal stabilizer.
- Semi-bubble type canopy.
- Internal protected fuel capacity for 540 gals.
- Folding outer panels.
- (1,000# combat bomb-crew-one AN/APS-4 radar).

Martinsville developed the XBTC-2 airplane in 1943 to January 1945 for Martin using a total of 1,540 man-hours for the development of the XBTC-2 model. The estimated cost of $3,800 for the project was all paid by Martin.

Performance*

- Gross weight: 20,563#
- Weight empty: 14,288#
- Fuel/oil gals.: 540/30
- Wing loading lbs/sq.ft.: 48.3
- Power loading lbs/hp: 9.2
- Vmax S.L. - MPH: 321
- Vmax critical alt., MPH/ft: 362/16,900
- Vstall Gr.wt., MPH, w.o. power: 87.9
- Vstall w.o. fuel, w.o. power, MPH: 80.8
- Time to climb 20,000 ft, min: 16.5
- Service ceiling - ft: 25,000
- Take-off dist. 25 kt. ft: 430
- Rate of climb - S.L. ft/min: 1620
- Combat Radius - naut.mi: 390

*Loaded condition - Full internal fuel, guns, ammunition and bombs aboard.

The XBTC-2 airplane (no.1) made initial flight on 20 Jan., 1945. Forty-seven subsequent flights were made prior to 13 August, 1945, which consisted of shakedown, preliminary work on stability, cooling, carbon monoxide, and propeller vibration survey. As a result of the vibration survey, the Curtiss Propeller was replaced with an Aeroproducts propeller. In August, 1945, the XBTC-2 airplane was grounded due to troubles developed in the XR-4360 dual rotation nose section, and resumed flights with a re-worked engine nose section in November, 1945.
General - The First Airplane

In the fall of 1943, two dive-bombers were under development as possible successors to the SB2C. These were the BTD-1 at Douglas-El Segundo and the XBTC-2 at Curtiss-Columbus. The latter incorporated many experimental features, and was months behind schedule because of the preoccupation of Curtiss-Columbus with the SB2C and SC airplanes. Accordingly, when the Glenn L. Martin Co. had engineering capacity available, and had the prospect of production capacity becoming available when the B-26 would go out of production, the Martin Co. was selected to "back-up" the XBTC-2 at Curtiss-Columbus by designing and building an experimental airplane around the same engine - the highly attractive XR-4360 - and of the same basic concept as the XBTC-2.

Martin was to "correct" the XBTC-2 situation by expediting the XBTM-1 all possible, and by keeping it as "un-experimental" as possible in order to get an airplane enjoying the advantages of the R-4360 engine into the war as soon as possible.

The Glenn L. Martin Co. submitted some designs from November, 1943 to January, 1944 for evaluation by BuAer. Their design of Martin using Model 210 was considered suitable. VSB Design wrote a Procurement Directive, number 4701, dated 7 January, 1944, for two model XBTM-1 airplanes and one static test article at the estimated cost of $2,800,000.00. On the basis of this Directive, Glenn L. Martin Co. was sent a Letter of Intent for Contract NOa(s)-2761, dated 15 January, 1944. On 31 May, 1944 the contractor was awarded a cost plus fixed fee contract (NOa(s)-2761) which superseded the Letter of Intent and called for the same items.

The mock-up of the Model XBTM-1 airplane, serial No. 85161, held at the contractor's plant at Baltimore, Md., on 7,8, and 9 February, 1944, gave a very good impression. The members of the Mock-Up Board were:

Capt. L.C. Stevens
Capt. J.V. Peterson
Cdr. J.S. Russell
Cdr. J.A. Haley
Cdr. J.P. Monroe
Cdr. D.W. Shumway
Cdr. E.E. Fawkes
Cdr. J.A. Thomas
Lt. Cdr. F.D. Pfotenhauer
Lt. Cdr. N.R. Richardson
Lt. W.M. Compton
Lt. B.F. Collins
Lt. H.P. Haley
Lt. D.J. Hardy
Lt. A.E. Doerr
Lt. (Jg) L.M. Kivell
Ens. N.B. Emmanuel, W(V)S
Mr. W.Z. Frisbie
Mr. A.P. Micotti

Experiments and Development
Board of Inspection & Survey
Military Requirements
Ship Installation
Armament
Military Requirements
VSB Design
VSB Design
Power Plant Design
Radio & Electrical
Equipment & Materials
Radio & Electrical
Armament
Instruments
Maintenance Division
Photography
Instruments
Design Coordination
Airplane Specifications

Declassified under NND 913043
Also present in an advisory capacity were: Lt. W.R. Wilson, BAGR, Eastern District, Lt. Cdr. F.H.E. Hopkins, RN, Lt. S.J. Miller, RNVR, British Air Commission, Capt. W.G. Logan, AC, Army Material Command.

The XBTM-1 airplane was a single-seat, folding wing, high performance general purpose attack dive-bomber and torpedo airplane designed to take-off with a heavy load from a CV carrier. The power plant was the Pratt and Whitney XR-4360-4 engine (rated at 3000 HP at 2700 RPM for take-off). No bomb-bay was provided. All stores (bombs, torpedoes, rockets, droppable fuel tank, droppable AN/APS-4 radar, smoke tanks...) were carried on three stations (the AAF types D-6 or AN-E10 shackles on the fuselage centerline, Mk. 51-7 bomb racks on the wings) and eight rocket launchers (four on each outer panel). The airplane was thus able to carry one 2000 lbs. bomb on the centerline, one 1000 lbs. bomb on each wing station and take off at a gross weight of about 22,300 lbs. in about 400 ft. with a 25 knot wind over the carrier deck.

The program had been undertaken on an expedited basis with the contractor quoting a flight date for the first airplane prior to August, 1944. To this end the mock-up was expedited and deviations allowed in that the power plant section and the instrument panel lighting were not mocked up. However, with these deviations accepted, the mock-up of the XBTM-1 airplane was considered generally satisfactory. Thirty-three recommendations made by the Board for changes in detail design added an estimated 62 lbs. to the estimated weight of the airplane (normal gross weight of 20,443 lbs). The report of the Mock-Up was approved by Capt. H.R. Oster, Director of the Engineering Division, on May 15, 1944.

The design of the airplane was conventional and as simple as possible in order to obtain flight articles at the earliest possible date and to reduce service maintenance. The only features of the airplanes which were considered as "unknowns" were:

(a) The XR-4360-4 engine with single rotation propeller.

This particular type engine had not been proven in service, and the effects of high power and propeller torque could not be accurately predicted.

(b) The dive-brakes - They were elements of the landing flap, aerodynamically balanced. This new type of dive-brake design had never been tested in a wind tunnel and therefore accurate prediction of their effect on aerodynamic qualities of the airplane was difficult.

(c) The airplane's linear dimensions - As heavy and high powered as the airplane was, it had to be designed within certain dimensions to enable it to be carried on the carrier elevators. It was known that these restricted dimensions would introduce difficult stability and control problems.

As originally conceived the model XBTM-1 was to have the following performance.
The detail specification for the airplane, SD-368, dated 11 January, 1944 was finally approved by the contractor and the Bureau on April 15, 1944.

The power plant and the cockpit lighting mock-ups were held respectively on 24 and 27 April, 1944, and found satisfactory. The power plant mock-up used on R-4360-8A engine since this was the only model available; however the only difference between it and the XR-4360-4 engine was its dual rotation nose-section. This difference did not affect the mock-up.

Numerous conferences and mutual visits were held between the contractor's representatives and those of the Engineering Division. This close cooperation proved very successful in expediting the engineering for the first airplane. On June 7, 1944, all engineering drawings necessary to put the airplane in condition for its first flight were released to the shop. The contractor at that date had high hopes of meeting his scheduled flight date of July 15, 1944. The contract delivery schedule was one airplane in July, 1944, and the second one in September, 1944. However, on 25 July the airplane had not flown, and, quoting from the Status of VSB Design Projects dated 1 August, 1944, "The airplane was on the apron minus the outer wing panels, the rudder and elevators, while the engine was being ground run. The outer wing panels are in the shop undergoing last minute installations and were scheduled to be assembled to the airplane July 26th. The ailerons are complete and the dive flaps should be completed very shortly. The airplane looks very good and workmanship on the skinning of the cowl, fuselage and wing is excellent. However, the skinning on the control surfaces is quite rough." At about that time the airplane was some 350 lbs. over the guaranteed gross weight.

The first airplane, serial No. 35161, made its maiden flight on August 26, 1944, a little over a month behind schedule. The first flight lasted 68 minutes, and was made by Mr. O.E. Tibbs, Glenn L. Martin's chief test pilot. The pilot's main comment after landing was that the airplane was sound. The main material difficulty was overheating of the brakes during taxi tests. An interesting item: On this first flight, at an altitude of about 7000 ft., and using only 67% power, the XETM-1 stayed even with an Army B-26 airplane which was using full throttle.
The first flight, although delayed about five weeks, occurred a little over seven months after the contractor had received the Letter of Intent. This was the shortest time in which an airplane company had ever built an experimental dive-bomber for the U.S. Navy; this was gratifying to all those who were connected with this project.

**Static Test Program**

The contract (NAe(s)-2761) called for a Static Test Article to be delivered at the contractor's plant ready for tests in October, 1944.

The efforts of the contractor were concentrated on the first airplane with the results that the construction of the static test airplane suffered a severe delay. By BuAer Confidential letter Aer-E-242-WPM-2/1-45, No(s)-2761, serial Co1391, dated 13 January, 1945, signed by Rear Admiral D.C. Ramsey, Chief of the Bureau of Aeronautics, the contractor was requested to expedite the static test program and his attention invited to the fact that if carried on a twenty-hours-per-day basis, the program would materially benefit BuAer Confidential letter Aer-E-12-EEF, serial Co4566, dated 13 February, 1945, again signed by Admiral Ramsey, told the Glenn L. Martin Co. that the model XBTM-1 airplane was an important part of the effort to outdistance the Japanese in the race for newer and better airplane. It stated also that although the static test article had been completed, tests were awaiting completion of static test facilities (a special test house costing some $40,000 was being built). The static tests started in February, 1945, with the airplane drop tests. The tests progressed satisfactorily through May, 1945, with only minor failures resulting. During June, 1945, the static test article suffered a fuselage failure at 80% ultimate load during unsymmetrical tail load tests. The failure in itself was minor, being in the uppermost fuselage longeron, but the damage carried through a large part of the fuselage, and necessitated an extensive repair program. The first airplane, which was flying, was reinforced to prevent this sort of failure. Decision was then made to release the airplane for unrestricted flight (June 29, 1945) and not wait for re-run of the unsymmetrical tail load tests. Tests for arresting and catapulting were completed during August, enabling the airplane to be released for platform tests. A few remaining tests are being completed, among them the re-run of the tail tests. All are scheduled to be completed by December, 1945.

**The Second Airplane.**

Although the contractor quoted a delivery date for the second airplane, BuNo. 85162, of September, 1944, it was delayed by the emphasis put on the first flight article and static tests. About March, 1945, flight tests on BuNo. 85161 revealed that a reduction in wing dihedral was necessary to improve the lateral stability. It was then decided to incorporate this change in the second airplane, together with a variable hinge fin and rudder combination (which was to be used to find the ultimate hinge line for satisfactory rudder characteristics). This delayed the first flight until 20 May, on which day, BuNo. 85162 made three flights.
Flight Tests.

Upon landing after the first flight on 26 August, 1944, of the first XBTM-1 airplane, BuNo. 85161, the pilot's comments were as follows: "Control on the ground during take-off was good, stability about all axes was good, engine overcooled, elevator control was marginal, cockpit is very windy with the ground with the hood open, the wheels retract and extend very rapidly." Tab linkages were changed to reduce control forces, and the wheel brakes replaced before the next flight on 29 August. The status report for VSB Design dated October 1, 1944, states that by that date the airplane had made eight flights totalling 10.5 hours. The following were the characteristics of the airplane as judged by Glenn L. Martin pilots (the flights test gross weight being only 18,500 lbs.):

(a) Apparently sound and stable about all three axes, at centers of gravity forward and aft of the normal center of gravity limits.

(b) Stick forces heavy, but along a good gradient.

(c) Marginal elevator control - both hands have to be used to get the tail down upon landing. Take-off control good.

(d) Engine satisfactory in flight but overheats on ground runs.

(e) Waver-off tests at altitude appeared satisfactory.

During October, 1944 the airplane went into the shop for the following reasons:

(a) To rework the trailing edge of the wing to bring to contour.

(b) To install a set of dive-brakes (which had been omitted for first flight).

(c) To install new fin and rudder, stabilizer, and elevator (alternate designs).

(d) To improve the ailerons seals.

(e) To magnaflux the propeller, which had not passed a flight vibration survey.

Due to labor shortage this shop rework, which was to last one month, was not completed until early December, 1944. The airplane was flown several times with the reworked surfaces and then sent to NATC, Patuxent River, on 11 December, 1944, for preliminary evaluation. BuAer Confidential letter Aer-E-12-EEF, serial C-34198, dated 8 December, 1944, had established, under Project TED No. PTR 1205, this preliminary evaluation which was desired by BuAer for the purpose of obtaining the reaction of naval test pilots early enough in the program to permit the contractor to correct the deficiencies.
The airplane remained at NATC, Patuxent River for five days, until December 16, 1944. During that time Navy pilots flew it a total of about 15 hours. On December 20, 1944, an informal conference was held in the Board Room of BuAer with the contractor's representatives present (See Memorandum of conference held in BuAer, 20 December, 1944, Aer-E-12-JAT). The main deficiencies reported were:

(1) Rudder reversal in level flight, clean condition, at 160 mph with about 13° yaw.

(2) Insufficient rudder effectiveness for full flap carrier take-off.

(3) High aileron forces at low speeds, and low forces at high speeds.

These deficiencies were to be corrected by the contractor by:

(1) Incorporating a dorsal fin (which was already built in anticipation of such trouble).

(2) Installed a rudder with smaller trim tab (original rudder).

(3) Relieving pressure on the ailerons by making the aileron seal a little less effective.

Some rough performance checks were made by NATC, Patuxent River, with the following results:

(1) The take-off run, with an interim propeller and an over-weight of 480 lbs., will slightly better the guarantee.

(2) The speed will be slightly below the guarantee.

(3) The stalling speed will be slightly over the guarantee.

As soon as the airplane was returned from NATC, the contractor started to rework the airplane to include a dorsal fin, the original rudder, improved aileron seals, operable dive-breaks, and the final propeller. The next flight was scheduled for January 10, 1945.

In order to get all the results of the preliminary evaluation, before receiving the final report which had to go through channels, a conference was held at NATC, Patuxent River, on January 2nd, 1945. The following complete deficiencies were reported:

(1) Directional stability unacceptable.

(2) Longitudinal control forces unsatisfactory.

(3) Lateral and directional control forces unacceptable.

(4) Lateral and directional control unacceptable.

(5) Take-off characteristics unacceptable.

(6) Ground handling characteristics unsatisfactory.
(7) Power plant cooling unacceptable.

(8) Miscellaneous defects which can be found in "Memorandum of a conference at Patuxent River on 2 January, 1945, Aer-E-12-EEF."

The confidential final report of this preliminary evaluation, Project No. PTR 1205, dated March 3, 1945, was forwarded to BuAer by NATC, Patuxent River Confidential letter NA83/45032, dated March 3, 1945.

Again labor shortages held the XBTM-1 in the shop for a longer time than scheduled. It did not fly until January 25, 1945. BuAer Confidential letter Aer-E-12-EEF, serial CO4566, dated February 13, 1945, signed by Rear Admiral D.C. Ramsey, requested that the contractor exert maximum efforts to accelerate the program, especially in view of the fact that he had received a letter of intent for 750 BTM airplanes, dated January 15, 1945.

On January 25, 1945, the XBTM-1 first opened its dive-brakes. Slight tail shake was reported at restricted openings. However, they were effective in checking the diving speed, and very little trim change was needed after the brakes were opened. From January, 1945, tests to improve the characteristics of the design and correct the deficiencies reported by NATC, Patuxent River, were conducted very thoroughly by the contractor. The airplane was completely instrumented, and very complete quantitative data was obtained. However the completeness and thoroughness with which these flight tests were conducted were partial causes for the slow progress of the program. During the latter part of March, the first XBTM-1 went into the shop for two weeks for reduction in the wing dihedral, incorporation of a variable hinge fin and rudder combination, installation of a new fin and several minor changes (the same changes that were incorporated in the 2nd XBTM-1 before its first flight).

By May 1 the contractor was satisfied that the deficiencies found during preliminary evaluation had been corrected, and decided that the airplane was ready for preliminary demonstration.

During June and July, 1945, engine cooling tests and bomb configuration tests were conducted. Engine cooling was unsatisfactory in military power climb. Several fixes are being investigated. These include wider opening of cowl flaps, possible use of spinner, and propeller cuffs. During the bomb configuration tests, a serious condition of shake or buffet was found to exist with a 2000# bomb, a 1000# bomb, or a torpedo on the centerline bomb station at speeds of and above 300 mph. The contractor has been spending considerable time and effort to correct this deficiency.

In August, 1945, one of the two flight articles was sent to NAMC, Philadelphia, for a brief platform evaluation. A few minor deficiencies were found and these have been corrected. Gun firing tests were conducted on the other plane about the same time. Rep-
representatives of Armament Test Section, Patuxent River, witnessed
the tests and found the 20mm installation satisfactory except for
certain deficiencies, the most serious of which was loading the guns
from beneath the wing. Study is being made to make a more satis-
factory method of reloading. Other deficiencies found were minor
and have been corrected. Preliminary demonstration dives are now
being conducted and work is continuing to correct the bomb buffet
mentioned earlier.

Engineering Features

A detailed description of the XBTM-1 airplane can be found
in Detail Specification SD-368 dated 11 January, 1944. However,
the following is a brief resume' of the features of the airplane:

Engine - Pratt & Whitney - XR-4360-4

Propeller - Curtiss Model C-6448-B with four 830 blades -
14'8" diameter.

Armament - Four 20mm guns (200 rds/gun) in the wings -
Provisions on three stations for stores up to
2000# bombs. Eight 5" rocket stations.

Fuel - Internal 500 gallons (140 gallons in hammock type
self-sealing tank, 360 in two identical self-sealing
wing tanks.)

External - 150 gallons drop tank.

Low single wing - bubble canopy - high horizontal tail -
folding wings - conventional landing gear - displacing gear -
latch type arresting hook.

Dimensions: Length 41'2½"
Span 50'
Span Folded 24'
Height (during folding) 20'6.4"
Gross Weight 18,000 to 23,000 lbs.
General - The First Airplane

In the fall of 1943, BuAer decided that a relatively light and small airplane should be built to offset the trend towards larger and heavier dive-bombers. Fleetwings Division of Kaiser Cargo, Inc., submitted some designs during December, 1943, and January, 1944. A design using the R-2800-22 engine showed promise. VSB Design Desk wrote a Procurement Directive, number 4706, dated 12 February, 1944, for two model XBK-1 airplanes and one static test article at the estimated cost of $2,725,280.00. On the basis of this directive, Fleetwings was sent a Confidential Letter of Intent, Aer-PR-22-RMW, C-NOa(s)-3081, serial C-04719, dated 23 February, 1944. On 31 March, 1944, the contractor was awarded a cost plus fixed fee contract (NOa(s)-3081) calling for the two flight airplanes and a static test airplane.

The mock-up of the model XBK-1 airplane, serial No. 44313, held at the contractor's plant at Bristol, Penn. on 3, 4 and 5 April, 1944, gave an excellent impression. The members of the Mock-up Board were:

Col. C.L. Pike, USMC
Capt. J.V. Peterson
Cdr. D.W. Shumway
Cdr. J.A. Thomas
Cdr. J.E. Dodson
Lt. Cdr. F.B. Pfotenhauer
Lt. Cdr. N.R. Richardson
Lt. D.J. Hardy
Lt. O.H. Lunde
Lt. E.P. Collins
Lt. W.M. Compton
Lt. B.E. Moore
Lt. H.P. Haley
Lt. W.J. Harris
Lt. (jg) J.W. Shaver
Ens. J.B. Kemmerer
Mr. W.Z. Frisbie
Mr. H.J. Stambaugh
Mr. P.H. Daugherty
Mr. A.W. Larson

Experiments & Developments
Exp. of Inspection & Survey
Military Requirements
VSB Design Branch
Power Plant Design
Power Plant Design
Radio & Electrical Instruments
Structures
Radio & Electrical Equipment & Materials
Ship Installations
Armament
Armor
VSB Design Branch
Photographic Division
Design Coordination
Ship Installations
Airplane Specifications
Power Plant Design

Also present in an advisory capacity were Lt. W.R. Wilson, BAGR, Eastern District, Lt. Col. L.B. Storm, AAF, and Major W.W. Parrott, AAF.

The XBK-1 airplane was a single-seat, folding wing, high-performance general purpose attack and dive-bomber designed around the Pratt & Whitney R-2800-22W engine (using water injection). No bomb-bay was provided. All stores (bombs, rockets, droppable fuel
tank, droppable AN/APS-4 radar, smoke tanks ...) were carried on three Mk. 51 bomb racks (one on the centerline, one on each wing) and eight aircraft rocket launchers (four on each outer wing panel).

The Board found the mock-up of the XBK-1 airplane generally satisfactory. Recommendations for changes in detail design added an estimated 35.45 lbs. to the original estimated weight of the design. The Report of the Mock-Up was approved by Captain T.C. Lonnquest, USN, for Captain H.R. Oster, USN, Director of the Engineering Division, on 6 June, 1944.

In order to obtain the airplanes as soon as possible, the design was made simple and conventional with only a few features heretofore untried:

(a) The dive brakes. - They were of balanced type, located at the trailing edge of the inboard panels of the wing. The lower brake was part of the slotted landing flap, the upper brake part of the wing immediately forward of the landing flap. The brakes were designed to open in approximately four seconds at 400 mph.

(b) The exhaust air aspirators. - This name applied to the special exhaust assembly designed to increase the net thrust of the airplane. The exhaust stacks projected into the flat-sided, constant cross-section, exhaust ducts (one on each side of the airplane) running from the engine section to a position aft of the pilot above the trailing edge of the wing. The exhaust ducts at the forward end were open to the engine section. The theory behind this design was that the exhaust gases discharging into the exhaust ducts would create a suction in the aft engine section thus reducing the cooling drag due to the airflow across the engine. The control of the air flow was provided by a small flap at the end of each exhaust duct.

Although not an entirely experimental feature, the XBK-1 airplane was also provided with an adjustable stabilizer, controllable from the pilot's cockpit, for trim purposes. The stabilizer and elevator were placed very high on the vertical tail to avoid the buffeting trouble that had been experienced on previous models when the dive-brakes were open.

The XBK-1 airplane was designed as a relatively light airplane; 14,850 lbs. with one 1000 lbs. bomb, 375 gals. of fuel, two forward firing 20mm cannons with 200 rounds per gun. At this weight, the combat radius was 365 nautical miles.
As originally conceived the model XBK-1 airplane was to have the following performance:

<table>
<thead>
<tr>
<th></th>
<th>1-1000# Bomber</th>
<th>Combat Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>375 gals. fuel</td>
<td>War Emergency Power</td>
</tr>
<tr>
<td>Gross Weight</td>
<td>14,850#</td>
<td>12,278#</td>
</tr>
<tr>
<td>Vmax, Sea Level</td>
<td>269 MPH</td>
<td>344 MPH</td>
</tr>
<tr>
<td>Vmax, ACA</td>
<td>309 mph/20,300 ft.</td>
<td>371 mph/16,500 ft.</td>
</tr>
<tr>
<td>Vstall</td>
<td>309 mph/20,300 ft.</td>
<td>371 mph/16,500 ft.</td>
</tr>
<tr>
<td>Take-off (25 Kts.)</td>
<td>86.4 mph</td>
<td>approx. 81 MPH</td>
</tr>
<tr>
<td>Combat Radius</td>
<td>362 ft.</td>
<td>240 ft.</td>
</tr>
<tr>
<td></td>
<td>365 naut. mi.</td>
<td></td>
</tr>
</tbody>
</table>

Owing to the fact that during the mock-up of the airplane, the power plant installation was considered incomplete, a supplementary mock-up of the power plant was held on 22 May, 1944, and found satisfactory.

The detail specification for the airplane, SD-367, dated 10 January, 1944, was finally approved by the contractor and the Bureau on 7 July, 1944.

Due to the urgency with which it was desired to introduce a modern dive-bomber in the field, it was decided that the necessary tests to prove this airplane should be expedited. However, in order not to jeopardize these tests, and to get a thoroughly proven airplane, the number of model XBK-1 airplanes on the contract was increased from two to twenty-two (by amendment No. 5 to No. s of January 2, 1944). It was the intent that these twenty-two XBK-1's be expedited and tested as fast as possible. This policy, forced by war-time urgency, was an important departure from the older policy to build only one experimental airplane and have it go through all the various tests one after another. The contractor was constantly told of the high priority of this project, the need for a modern combat single-seat dive-bomber, and was given all help possible to meet the shop completion dates as originally scheduled. The first two XBK-1 airplanes were to have been shop completed during November, 1944, and January, 1945, and the contract quoted respective delivery dates of February, 1945, and April, 1945. The next twenty airplanes were to be delivered as follows:

1 in March, 1945;
1 in April, 1945;
3 in May, 1945;
5 in June, 1945;
5 in July, 1945;
5 in August, 1945.
In order to expedite the tests of the airplanes, and avoid the towing of the airplanes from the Bristol plant to the nearest airfield at NAF, Trenton, N.J., the Bureau had gone to the extent of issuing to the contractor a Certificate of Necessity for the construction of an airfield at the Bristol plant (Certificate No. NC-5995 dated 19 June, 1944). By BuAer Confidential letter Aer-E-12-EEF, serial C33554, dated 30 November, 1944, (signed by Rear Admiral D.C. Ramsey, Chief of the Bureau of Aeronautics), Fleetwings was told that the progress of the airplane had created a bad impression in the Bureau. This bad impression was a detriment to the program for which high hopes had been held due to the soundness of the design and the under-weight of some 200 lbs. that the contractor was maintaining during the design. However, by October, 1944, it became evident that the first airplane would not be shop completed by November, 1944, in spite of the fact that the contractor had gone on a 24-hour working day. The delay in the program was attributable to the following:

(a) The contractor's very cautious design of the various airplane components for weight control purposes, with resultant slowness in engineering release to the shop.

(b) Lack of experience with Navy specification, procedure, etc.

(c) Lack of organization which resulted in poor production planning and follow-up on sub-contracts, causing shortages of sub-contracted machined parts.

(d) The fact that the plant was under divided inspection, the Army Air Forces having primary cognizance, and the excessive number of projects that the contractor had accepted without apparent consideration of the small force he had to work with. These projects included the TBM-1 wing panels, F4U-1 horizontal stabilizers, B-17 fins, wings for the Hughes F-11 photographic airplane, a helicopter, and the XBK-1 airplane.

(e) The experimental shop within which the XBK-1 was being built was too small for efficient operation.

The status report for 1 November, 1944 stated that "with good luck all the way..." the first airplane should be in the air in December, 1944. After November, 1944, the scheduled date for shop completion of the first airplane was constantly pushed back. As the program progressed it also became apparent that the contractor had too few skilled shop men and supervisors. This was evidenced by the abnormal amount of salvages which the Bureau of Aeronautics Resident Representative at the Bristol Plant was requested to approve; an example is the first center section which had over one hundred salvages, making it necessary to restrict the first airplane, BuNo. 44312 to 5g, instead of the original design requirement of 7.5g. This number of salvages, the poor standard of quality and the delay in the program were the reasons why the owner of the company, Henry J. Kaiser, transferred some of his best labor recruiting men from the West Coast to try improving the status of his contract. The Bureau of Aeronautics was all the more desirous
that this program accelerate since the wind-tunnel tests by NACA on a powered model of the XBK-1 were showing outstanding aero-dynamic characteristics for all flight conditions.

To improve the attack versatility and the usefulness of the airplane the contractor was requested in December of 1944 to make necessary changes to the design for the incorporation of a Mk 13 torpedo as part of the useful load to be carried on the centerline of the XBK-1. To reflect this new mission of the airplane as a torpedo bomber, CNO issued Aviation Planning Directive 12-A-45 dated 9 February, 1945, changing the designation of the model from XBK-1 to XBTK-1. Under constant pressure from the VSB Design Branch, the contractor finally shop completed the first XBTK-1 airplane, BuNo. 44313, on 15 March, 1945, and turned it over to the Bureau of Aeronautics Resident Representative for inspection on 24 March. It made its first flight on 12 April, 1945, six months after the scheduled flight date.

Static Test Program

About September, 1944, the first fuselage, which was approximately one week ahead of the second fuselage, was scheduled for the static test article in order to expedite the structural tests and incorporate the necessary revisions in the flight articles. The policy of the contractor to save weight where possible was sound, but was known to open the way for numerous static test failures; however, it was felt that the increase in length of the static test program would far be outweighed by the saving in weight and resultant performance gains.

In November and December, 1944, after the scheduled date of the first flight of the first airplane had passed, the contractor concentrated his efforts on this first airplane. This resulted in delaying the construction of the static test article. By BuAer confidential letter Aer-E-12-EEF, serial C-33354, dated 30 November, 1944, the contractor was told that "the program for static-testing is particularly a matter of grave concern" and that the demonstration of airplane BuNo. 44313 scheduled for February, 1945, could not take place until the restriction-raising structural tests had been completed. Delivery of the structural article to the laboratory was then scheduled by the shop for 1 February, 1945, and the restriction-raising tests were scheduled to be completed on 10 May, 1945. Due to the shortage of labor and the contractor's emphasis on the manufacture of the first flight airplane, these dates were further pushed back. On 28 March, 1945, the fuselage and vertical tail surfaces, instead of the whole airplane, were delivered to the laboratory, which had been waiting for several months. The possible tests with the structure available started on 9 April 1945; they included fuselage rigidity, fin rigidity, vertical tail maneuver and rudder control system. Only very minor failures occurred. On 3 May, 1945, the wing was delivered to the laboratory, but due to a few parts not
delivered by the experimental shop, the test set-up was delayed five
days. Wing tests, started 19 May 1945, included wing elastic
characteristics, positive low angle of attack condition, dive brake
operational tests, aileron control system and positive high angle
of attack condition. This latter test was completed to yield
load on 27 June, 1945. Tests on the horizontal tail started early
in July and revealed some important weaknesses in the fuselage
from the radio access door aft. At the same time spin conditions
tests were being run on the engine mount with resultant serious
failures in the dynafocal mounts. The manufacturer of these mounts
suggested and the Bureau approved a fix to avoid the failures; the
fix consisted of bolting the cover plate of the mount to the outer
casing to prevent thread stripping. Failures in the aft fuselage
are being repaired and tests on the horizontal tail will be resumed
as soon as the repairs are completed.

Incorporation of the necessary repairs are being made in all
airplanes subsequent to the first two - the latter airplanes will
have major reinforcements incorporated at a later date.

The Second and Subsequent Airplanes.

The history of the second and subsequent airplanes is similar
to that of the first one. Emphasis was placed first on airplane
BuNo. 44313, second on the static test article. Causes for the
delay in the program have already been given; but these delays
became greater on the remainder of the program since the contract-
or's effort was concentrated on getting the first airplane in the
air. After Contract N0a(s)-3081 was modified by the addition of
20 airplanes, the contractor increased the size of the experi-
mental shop and the number of sub-assembly jigs; however, due to
the shortage of labor, some of the jigs were left unmanned, and,
although labor was working on a 24-hour day, some others were
operating only part of the time.

After cessation of hostilities with Germany and Japan the
contract was reduced first to ten, then to five airplanes.

On 1 November, 1945, the second airplane was still in the
final assembly stage; shop completion, held up by installations,
and first flight was scheduled in November, approximately one
week apart. As of the same date, the third, fourth and fifth
fuselages were still in their jigs. The contractor's latest
estimated schedule showed shop completion for these three air-
planes of 30 December, 1945; 13 January, 1946; and 27 January,
1946, respectively.

Flight Tests.

Due to the incomplete status of the static tests, the first
airplane was restricted for flight by BuAer 271348 of March, 1945,
as follows: (1) Symmetrical load factors of 4 sea level to 20,000
ft. and 3 from 20,000 ft. up (2) 360 mph equivalent airspeed from

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sea level to 10,000 ft. and 300 mph from 10,000 to 20,000 ft.

The first XBTK-1 airplane, BuNo. 44313, made its first flight on 12 April, 1945, for a duration of 19 minutes.

Initial flights revealed three major deficiencies; right wing heaviness, bad vibration characteristics of the airplane as a whole, and over-heating of the engine accessory section. The contractor's immediate effort was to eliminate the vibration. This vibration was so bad that the instruments became difficult to read, the fuselage side walls strummed with about 1/8 inch amplitude, and the rudder pedals put the pilot's feet to sleep. A program to correct this situation was launched, consisting of various fixes. These included rubber mounting the exhaust ducts in position, using fibre glass as padding between the ducts and the side walls, installation of reinforced heavier skin ducts, and elimination of interference between the engine cowling (carried on cantilever beams projecting forward from the firewall) and the engine. Reinforcement of the exhaust ducts was also necessitated by their collapse on a ground run. Extensive flight and ground tests of all modifications to the exhaust assembly finally resulted in reduction of the vibration to an acceptable point.

Reported excessive aileron stick forces were corrected by reducing friction in the control system and connecting the aileron spring tabs.

The right wing heaviness was corrected by strengthening the aileron control system support brackets, re-rigging the aileron cables, and using a new aileron (the original one being out of contour). At the beginning of May, 1945, the airplane went into the shop for the correction of small mechanical difficulties, installations of specification items which had been originally omitted to accelerate first flight, reinforcement of the airplane to correct deficiencies reported by static tests, and general clean-up in preparation for the preliminary evaluation of NATC, Patuxent River, Md.

While in the shop, at the suggestion of the Bureau, the contractor also changed engines, installing an R-2800-34W engine in place of the R-2800-22W engine. This new engine had a few improvements over the -22W, the main one being a slightly different blower giving a higher critical altitude. The airplane remained in the shop until 1 July, 1945. After that date the contractor put the airplane through a summary and restricted demonstration designed to bring out any bad qualities that NATC, Patuxent River, was to seek. Flying and handling qualities were reported generally good, with only a few difficulties. One of these was the improper cooling of the aft engine section; as this was not entirely objectionable, it was not corrected prior
to the preliminary evaluation. Another difficulty which con-
tinually hampered flight tests was the failures of the various
superhydromatic propellers the contractor installed on the
airplane. The failures were two-fold:

(1) Improper governing; this was corrected by the propeller
vendor by replacement of an "O" ring in the hydraulic system of
the governing assembly.

(2) Separation of the rubber filler at the shank of the
propeller blades due to poor cementing procedures. The rubber
filler, under inertia forces moved towards the tips of the blades
creating bulges at the tips. Time did not allow correction of
this item prior to preliminary evaluation.

During this summary demonstration the contractor flight
tested the airplane in two main configurations: clean, and as
a 1-1000 lbs. bomber (including droppable APS-4 radar and 100
gals. tank). The tests included dives, stalls, carrier land-
ings and wave-offs, and restricted maneuvers. Except for power
plant cooling and the propeller failures, the contractor was
satisfied that the airplane was ready to go to NATC, Patuxent
River, for evaluation, and the airplane was ferried there on
8 August, 1945.

The preliminary evaluation under project TED No. BIS 2180.1
was established by BuAer confidential letter Aer-E-12-JWS, serial
CL6230, dated 4 June, 1945, to the President of the Board of
Inspection and Survey. In this letter an evaluation of the
exhaust air aspirators compared to a conventional exhaust system
(built for that purpose) was requested. While the airplane was
at NATC, Patuxent River, the superhydromatic propeller failed
and was replaced by a hydromatic propeller. On 9 October, 1945,
after a thorough evaluation, BTK-1, BuNo. 44313, was returned
to the contractor's plant. The major deficiency reported by the
Naval test activity was the poor stalling characteristic of the
airplane in the landing configuration with power off.

The airplane was also reported as having very good diving
characteristics; they were even considered to be better than
that of other experimental dive-bombers which had been evaluated
shortly before. After being told of the bad stalling of the
airplane and upon its return to the plant, the contractor set out
immediately to correct this defect. As of 1 November, 1945, he
had tried various means of improving the stall without beneficial
results. These means included the installation of slats at the
leading edge of the outer panels and the center section and
installation in various positions of various spoilers at the
leading edge of the center section.

As of 1 November, 1945, the report of the preliminary
evaluation had not been received in the Bureau of Aeronautics.
**Engineering Features**

A detailed description of the XBTK-1 airplane can be found in Detail Specification SD-367, dated 10 January, 1944, amended by Detail Specification SD-367-A, dated 1 June, 1945. However, the following is a resume of the specification:

**Engine:**
Pratt & Whitney R-2800-34W

**Propeller:**
Superhydrostatic - 13'6" diameter

**Armament:**
Two 20mm guns (200 rds/gun) in the wings.
Provisions on three stations for stores up to 1000# bombs (2000# bomb on centerline).
Eight rocket stations.

**Fuel:**
Internal: - 275 gallons (in hammock type self-sealing tank).
External: - 100 gallons drop tank.

Low single wing: - bubble canopy - large fin.

High horizontal tail - folding wings.

V type arresting hook - catapult hooks - conventional, retractable landing gear.

AN/APS-4 radar - AN/APX-2 IFF equipment - AN/ARC-1 VHF - AN/ARC-5 radio.

**Dimensions:**
Length 38'11"
Span 48'8"
Span folded 21'0"
Height (during folding) - 19'3"

**Gross Weight:** 12,000 to 16,000 lbs.

As previously stated, the airplane also incorporates:

Balanced type dive brakes.
Adjustable horizontal stabilizer
Exhaust air aspirators.

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E. EXPERIMENTAL AIRPLANES

(6) Model XBT2D-1 Airplanes

General - The First Airplane

After the model BTD-1 airplane was declared to be unsatisfactory for carrier operations the Douglas Aircraft Company was requested to submit a redesign for a single seat dive-bomber around the R-3350 engine. During July, 1944, the contractor submitted a design for a low wing, single seat dive and torpedo bomber which was accepted. This new airplane was designated the Model XBT2D-1 airplane and 15 of them were procured on the old contract for the Model BTD-1 airplanes, C-NOa(s)-743. Amendment 16 to Contract NOa(s)-743, dated July 21, 1944 was written as a contract itself and superseded the old Contract NOa(s)-743, dated August 31, 1943, with all its amendments previous to Amendment 16. This Amendment 16 called for delivery of those model BTD-1 airplanes which had not been cancelled (totaling 48, in addition to the 2 model XBTD-2 airplanes) under lot 1, and for 15 model XBT2D-1 airplanes under lot 2. Estimated cost plus fixed fee for these fifteen airplanes was $10,400,000.

This new dive-bomber was to be procured, like the XETK-1 and the XBTM-1 airplanes, on an expedited basis. The contractor, wishing to erase the unfavorable reaction to the model BTD-1 airplane, understood this desire for expediting the program and showed it by building a very complete mock-up in some 45 days. The mock-up was held at the contractor's El Segundo Plant in California from the 14th to the 17th of August, 1944. There were two mock-ups: (1) the mock-up of the whole airplane was for the greater part built of metal and included a complete power plant installation, a complete cockpit (with an instrument panel incorporating red instrument lighting) - (2) a separate mock-up of the cockpit only, made of wood, easy to modify, for the purpose of arriving at a final cockpit satisfactory to the Board. The mock-up was very complete and gave an excellent impression. The members of the Mock-Up Board were:

Capt. J.V. Peterson
Col. C.L. Fike
Lt. Col. E.E. Bard
Cdr. D.W. Shumway
Cdr. E.E. Fawkes
Cdr. J.E. Vose
Cdr. N.R. Richardson
Cdr. G. B. Chafee
Cdr. E.E. Stebbins
Cdr. F.D. Frothenhauer
Lt. Col. D.E. Canavan
Lt. Cdr. D.J. Hardy

Board of Inspection & Survey
Experiments & Developments
Aircraft Maintenance
Military Requirements
VSB Design
Armament
Radio & Electrical
Ship Installations
DCNQ, Training
Power Plant Design
Flight Test, NAS, Patuxent River
Instruments
Lt. A.H. Sallenger  
Lt. W.P. Montgomery  
Lt. B.F. Collins  
Lt. W.J. Harris  
Lt. G.A. Ryan  
Lt. L. Guy  
Lt. W.M. Compton  
Lt. J.W. Shaver  
Ens. S.L. Nichols  
Ens. P.W. Kerr  
Ens. J.B. Kemmerer  
Mr. W.Z. Frisbie  
Mr. M.M. Zeitlin

Power Plant Design  
Structures  
Radio & Electrical  
Armament  
Equipage, Maintenance  
Maintenance  
Equipment & Materials  
VSB Design  
Field, Service, Maintenance  
Photography  
Design Coordination  
Airplane Specifications

Also present in an advisory capacity were:

Cdr. A.P. Coffin  
Lt.Cdr. C.D. Tripolitis  
Lt.Cdr. V.E. Lohr  
Lt. Hockin  
Lt. A.S. Birss  
Lt. J.P.M. Reid  
Lt. J. Lawrence  
BuOrd  
BAOR, Western District  
BAOR, Western District  
BAOR, Western District  
BUORD  
RNVR  
RNVR

It should be noted that this was the first mock-up with full participation by members of the Maintenance Division. This was done in order to design into the airplanes features which would help handling and maintenance aboard carriers, as reported by Maintenance officers recently returned from the Fleet.

The XBT2D-1 was a single-seat, folding wing, high performance general purpose attack (dive-bomber and torpedo) airplane designed around the R-3350-24 engine (which later incorporated water injection). All stores were carried externally as no bomb-bay was provided. No displacing gear was used since Douglas Aircraft Co., had designed, developed and manufactured a powder type bomb ejector which it was decided would be incorporated in the XBT2D-1 airplane. Bombs were carried on three stations (bomb ejector in fuselage centerline, one Mk 51 bombrack in each wing) and 5" HVAR on 8 stations (4 Mk 5-3 launchers on each outer wing panel).

The Board found the mock-up in general very satisfactory. The recommended changes, all minor in nature, added an estimated increase in gross weight of 27 lbs.

Like the previously designed XBTK-1 and XBTM-1 airplanes the XBT2D-1 was made a conventional, simple model with the minimum of experimental features. These features were as follows:

(a) The dive-brakes. They were composed of three fuselage plates and the landing gear extended to the trail position.
The fuselage plates were hinged at the forward end, immediately aft of the trailing edge of the wing and were hydraulically operated. One each was hinged on the right side, bottom and left side of the fuselage. These brakes, in the extended position, would create an appreciable wake and possibly cause tail buffeting, even though the horizontal stabilizer was slightly higher than the top edge of the side brakes.

(b) The engine. The Wright R-3350-24 (BD) engine was still under development and its predecessor had given quite a bit of trouble, but hope was held that the newer version would prove to be a good engine.

(c) The airplane was slightly restricted in its dimensions since it was designed to fit on the elevators of all types of carriers.

(d) The adjustable stabilizer. The horizontal stabilizer was electrically adjustable between $-6^\circ$ and $+4^\circ$. The effect of adjustment on aerodynamic behavior of the airplane could be determined accurately from flight tests only.

The XBT2D-1 airplane was designed at a gross weight of about 16,300 lbs. with 1-1000 lbs. bomb and 350 gallons of fuel. The fuel was to give it a combat radius of 217 nautical miles. The performance of the airplane was to be as follows:

<table>
<thead>
<tr>
<th>1-1000# Bomber</th>
<th>Combat condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Weight</td>
<td>Military Power</td>
</tr>
<tr>
<td>16,244#</td>
<td>15,086</td>
</tr>
<tr>
<td>316.7 mph</td>
<td>337.2 mph</td>
</tr>
<tr>
<td>338.9 mph/18,000 ft</td>
<td>365.1 mph/18,500 ft</td>
</tr>
<tr>
<td>320 ft.</td>
<td>255 ft.</td>
</tr>
<tr>
<td>217 naut. mi.</td>
<td>---</td>
</tr>
<tr>
<td>Vmax, Sea Level</td>
<td>89.1 mph</td>
</tr>
<tr>
<td>Vmax ACA</td>
<td>85.9 mph</td>
</tr>
<tr>
<td>Vstall</td>
<td>217 naut. mi.</td>
</tr>
<tr>
<td>Take-off</td>
<td>---</td>
</tr>
<tr>
<td>Combat Radius</td>
<td>---</td>
</tr>
</tbody>
</table>

At the mock-up it was agreed that the first two model XBT2D-1 airplanes would use the main shock-struts of the FAU airplane, even though this would result in an understrength landing gear. This was approved, at the contractor's request, in order to expedite manufacture of the airplanes. The contractor was to put a full strength gear of his own design on the third and subsequent XBT2D-1 airplanes. The detail specification for the model XBT2D-1 airplane, SD-379-T-1, dated 7 June 1944, was approved in August, 1944. With practically the full engineering department of the El Segundo plant working on this project, engineering drawings were released to the shop with an amazing rapidity. On 31 December, 1944, a goal set by the contractor, all engineering necessary for the first flight of the airplane had been completed. Besides the rapidity of the engineering releases, another factor should be brought out which was
a credit to the contractor. Conscious that the BTD-1 airplane had been very strong but some 3000 lbs. overweight, he adopted a new policy for the design of the XBT2D-1. He decided that instead of building the strength into the airplane immediately and thus avoid static test failures, he would design the structure such that its strength would be as close to the requirements but on the negative side. This policy was evidently one which would cause many static test failures but the saving in weight, after the incorporation of fixes made necessary by the structural tests' results, would still be very large and would result in an optimum efficient structure. This sort of thinking proved to be very fruitful, as the underweight of the airplane became larger as the design progressed. While the weight control of the contractor was very efficient, the original position of the center of gravity shifted forward 4.8% MAC during the design. This resulted in a center of gravity too far forward and the ensuing decision to move the wing four inches forward. The relative effect was to cause an aft shift of the center of gravity of 2.1% MAC. It was also decided that if absolutely necessary some weights would be put in the aft fuselage to cause a further shift aft of 1.7% MAC.

Wind-tunnel tests of a model of the XBT2D-1 airplane dictated several changes which the contractor incorporated in the design: incorporating a 3° twist in the vertical fin for better wave-off control, reduction of the dorsal area, reduction of the elevator throw from 40° to 30°, deletion of the elevator pressure seal balance in favor of a round elevator leading edge with horn balance and adjustable tab.

The progress of the program was such that on 15 January 1945: (1) engineering was 100% complete (2) fabrication of parts was 71% complete (3) assembly was 46% complete. The target date for the first flight which had originally been scheduled for 1 May 1945 was now moved up to 31 March 1945. In view of the contractor's good performance and in order to fill the gap between the last of the fifteen XBT2D-1 airplanes then authorized and the first BT2D-1 airplanes (if a production order was to be given) the contract was amended early in 1945 to provide for an additional 10 XBT2D-1 airplanes (thus bringing the total number of experimental airplanes to 25). These additional 10 XBT2D-1's were released by Directive EN11-2658-45, serial 11918, dated 20 January 1945. By 1 March, 1945, in addition to the authorization for manufacture of an additional 10 airplanes, the contractor was sent a request for preliminary planning and design of production tooling and preliminary planning and design of line installation tooling for BT2D-1 airplanes. The Bureau of Aeronautics was also considering the contractor's proposal to obtain a release for 548 BT2D-1 airplanes to assure continuity of manufacturing.

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The target date for first flight was bettered. The first airplane, serial No. 09085, was shop completed the second week in March 1945, and made its initial flight on March 18, 1945, exactly seven months after the mock-up. The airplane's actual weight was some 1800 lbs. under the weight guarantee.

The shop completion and the first flight of the first airplane, BuNo. 09085, were consistent with the schedules as called for in Amendment 16:

<table>
<thead>
<tr>
<th>Shop Completion</th>
<th>Qty.</th>
<th>First Flight</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>March, 1945</td>
<td>1</td>
<td>June, 1945</td>
<td>1</td>
</tr>
<tr>
<td>May, 1945</td>
<td>1</td>
<td>Sept. 1945</td>
<td>1</td>
</tr>
<tr>
<td>August, 1945</td>
<td>1</td>
<td>Nov., 1945</td>
<td>1</td>
</tr>
<tr>
<td>Sept., 1945</td>
<td>2</td>
<td>Dec., 1945</td>
<td>1</td>
</tr>
<tr>
<td>Oct., 1945</td>
<td>2</td>
<td>Jan., 1946</td>
<td>2</td>
</tr>
<tr>
<td>Nov., 1945</td>
<td>3</td>
<td>Feb., 1946</td>
<td>2</td>
</tr>
<tr>
<td>Dec., 1945</td>
<td>5</td>
<td>Mar., 1946</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>April, 1946</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>May, 1946</td>
<td>3</td>
</tr>
</tbody>
</table>

Static Test Program

As stated above, the actual weight of the airplane was some 1800 lbs. under the weight guarantee. The manner in which this underweight was obtained has been explained above. It was normal, and everyone expected them, that failures of a possibly serious nature, should occur. The tests started in April, 1945 and it was hoped would be finished by the end of June, 1945.

Tests progressed satisfactorily, but at a slower pace than expected, until June, 1945. The fuselage failing load test showed a failure at 143% limit load in the second week of May, 1945 (150% required for ultimate). The fuselage was reinforced, and a rerun of the test revealed a failing load of 167% limit load. The reinforcement had cost only 4 lbs. in weight. After a few revisions to the structure the positive low angle of attack (PLAA) condition was completed to yield load (115% limit load) by 16 June, 1945. By the same date all yield load tests of the horizontal surfaces had been completed. By 23 June, 1945, the Positive High Angle of Attack (PHAA) had also passed yield load tests. However, upon continuing the test to ultimate load, the left hand outer wing upper spar fitting at the wing folding joint failed at 138% limit load. This was a very serious failure, especially with one airplane already flying. The contractor started to repair the damage to the center wing, and estimated that an outer wing with a new spar and fitting would be available by the second week in July. After the center section repairs were finished, the ultimate load tests on the horizontal tail were satisfactorily completed. In the PLAA condition the rear spar web in the left hand center wing failed near the

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wing folding joint at 137% limit load. By 7 July, 1945 the
following had been completed: (1) Main and auxiliary gear dynamic
yield load - (2) Auxiliary gear unsymmetrical ultimate load
-(3) Fuselage - (4) Horizontal stabilizer - (5) Wing NLA condition
(6) PHAA condition to 138% - (7) PLAA condition to 137%. During
the week of 7 to 14 July, 1945, the wing with the revised trunnion
location in the spar cap integral fitting satisfactorily withstood
ultimate load in the PHAA condition. However the reinforced wing
failed in the second run of the PLAA at 135% limit load in the
same manner as in the first test of that condition. Under the same
condition the wing failed at 113% in the rear wing spar folding
joint fitting (this was attributed to understrength part since
the same fitting had previously withstood 138%), and at 141% in
torque outboard of the folding joint. While repairs were being
made to the center wing, other tests were completed. Finally
during the week ending 31 August, 1945, the wing passed the structural
tests in the PLAA condition failing at 151% limit load.

Static tests suffered the same deceleration as the rest of the
program after the surrender of Japan. By the middle of October all
required primary structure static and dynamic load tests had been
completed except for a few tests on the landing gear, engine mount,
hoisting sling, ground handling devices, landing gear drop tests...
By 1 November, 1945, the structural tests were very close to being
100% complete.

When the spar failure occurred in the PHAA condition, the
catapult hook fitting on the right wing had also failed, at 140% limit load. At the time of the PHAA failure, the contractor had
already 15 sets of spars already built (in July, 1945). In order
not to delay the delivery of the experimental airplanes by request-
ing him to manufacture fifteen new sets of spars, the Bureau of
Aeronautics agreed to the following as communicated to the contractor
in BuAer 121421 TWX August, 1945: "...BuAer will take delivery of
first fifteen XBT2D-1 airplanes with deviations from strength
requirements as follows:

(A) Understrength catapult fittings in first fifteen airplanes,
excluding BuNos. 09087 and 09089.
(B) Understrength outer wing spar caps in first fifteen
airplanes excepting BuNos. 09088, 09091, 09094. The granting of
above strength deviations is subject to following:

(1) Contractor satisfactorily completes preliminary
demonstration of airplane with understrength spar cap to 7g and
500 mph at a gross weight of 14,100 lbs.
(2) Contractor satisfactorily completes preliminary
demonstration of full strength airplane to 7g and 500 mph at a gross

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The second and subsequent airplanes.

The second airplane, BuNo. 09086, unlike those of Fleetwings and Glenn L. Martin, followed very closely the first one. It first flew on May 8, 1945. It was first used for the flight vibration survey of the Aeroproducts propeller in conjunction with the R-3350-8 engine (the R-3350-24 engines not being available in time to meet initial flights of the first or second airplane). During June, 1945, it was sent to NACA, Moffett Field for full scale-wind tunnel tests.

The third airplane, BuNo. 09087, was out of the shop in May, 1945. However, in July, 1945 it had to return in the shop for incorporation of full strength catapulting and arresting provisions (see Static Tests). Also, due to the installation of very complete instrumentation to determine arresting and catapulting loads during platform tests at NAMC, Philadelphia, it did not fly until August 17, 1945. It moved East to Philadelphia, arriving at the NAMC on 1 September, 1945. It has been there since that date. On 1 November the tests which were to include carrier operation were only about 25% complete.

The fourth airplane, BuNo. 09088, made its first flight on 6 October 1945. It had been allocated for demonstration purposes; the Bureau of Aeronautics agreed to the contractor's suggestion to move the airplane to Palm Springs where the weather was consistently better than at El Segundo. The airplane returned to El Segundo in the middle of November, 1945.

By 15 October, 1945, the fifth airplane, BuNo. 09089, had not flown but was expected to do so in December 1945. It was allocated to the contractor as his "dog ship" to help him check installations, design changes, relocation of equipment... On the same date, 6 XBT2D-1's were in main line assembly jigs (three of them with the engines installed) three were in preliminary assembly jigs, and two were being assembled in fuselage jigs.

The Douglas Aircraft Co., which started behind the Glenn L. Martin and the Fleetwings Companies, thus made a better showing in designing, producing and testing a larger number of airplanes in a shorter time.
In order to expedite the tests of production airplanes, the contractor was requested by BuAer Change Request Aer-E-12-JWS, serial 288079, dated October 8, 1945 to build the last ten XBT2D-1 airplanes in accordance with the production airplanes detail specification. This will result in ten XBT2D-1 airplanes with a production configuration built on contract NOs(s)-743.

**Flight Tests - General**

The first model XBT2D-1 airplane, BuNo. 09085, first flew on March 18, 1945. On 29 March 1945 the airplane had made twenty flights with the following results as reported by the contractor:

(a) Rudder and elevator control and forces satisfactory.
(b) Aileron control good - aileron forces light at high speed, heavy at low speeds. Aileron snatch about 2 mph above stall.
(c) Stability positive about all three axes (including carrier-approach condition).
(d) Take-off characteristics good.
(e) Dive-brakes have been opened at 300 mph. Speed in dive is 265 mph with side brakes opened 30° and bottom brake opened 55° (at 11,500 lbs.).
(f) Structural vibration previously reported believed by pilot to be related to engine-propeller combination.
(g) Airplane has been successfully flown with eight 5" rockets or bombs up to one 2000# bomb; it was dived with 2000# bomb, dive-brakes open, in a 70° dive, with good aileron control.
(h) Airplane took off at 15,500# (2000# bomb plus full internal fuel) in 295' in a 25 kt. wind.
(i) 3000# hydraulic system not functioning satisfactorily;
faulty pressure regulator and some leaks.
(j) Center of gravity is about 3.5% MAC forward of design range.
(k) Elevator force per g in steady turn is 6-8#.

BuAer confidential letter Aer-E-12-JWS, serial C08339, dated 21 March 1945 to the President of the Board of Inspection and Survey, modified by BuAer Confidential letter Aer-E-12-JWS, serial C09451, dated 31 March, 1945, to the same addressee set up project TED No. BIS 2177.1 for the preliminary evaluation of the airplane by NATC, Patuxent River.

After only three weeks of flight testing the contractor declared that the airplane was ready for preliminary evaluation. It was flown East by a contractor's pilot to NATC, Patuxent River, where it arrived on 7 April 1945. This project was given a priority "A" by BuAer 121437 TWX April 1945. On 20 April 1945, a conference was called in the Board Room of the Bureau of Aeronautics for the purpose of discussing the preliminary report of the evaluation. Members of Flight Test at NATC, Patuxent River, Engineering, Douglas and the BAR's office were present. Following were the main
deficiencies discussed on that date:

(1) Power plant operation (restricted to the use of the main stage supercharger) was deficient in military power with the mixture control set at automatic rich. Under this condition carburetor air and cylinder head temperatures rapidly increased, excessive manifold pressure was required for rated power, rated power could not be maintained for a reasonable period, and engine operation was extremely rough.

(2) The cowl flap control was so located on the starboard side of the cockpit that serious interference existed between it and adjacent switches.

(3) The aileron and rudder trim tab control position indicators were not clearly visible to the pilot if he maintained normal position.

(4) The cowl flap actuating mechanism was deficient in that speed of operation was low.

(5) The oil filler cap was poorly located in that it was subjected to the hot engine exhaust gases.

(6) The pilot's shoulder harness was deficient in that the chest straps were too short.

(7) The position control of the adjustable horizontal stabilizer was of such shape and so located that it was easily confused with the tail wheel lock control when the latter control was in the engaged position.

(8) The check-off lists were mounted on the chartboard and no provision was made for mounting these lists in a readily visible location.

(9) At the lighter gross weights and more forward center of gravity locations, with the airplane held at rest, a three point attitude could not be maintained upon gradual application of rated take-off power.

(10) Speed of operation of the wing folding mechanism was too low.

(11) The airplane, in the clean or in the landing condition, at speeds in the region of those of stall, exhibited aileron snatch.

(12) The airplane, in the landing condition, exhibited excessive lightening of all control forces (particularly elevator control force) as the stall was approached.
(13) The airplane exhibited weak directional stability under all normal flight conditions, particularly with free rudder control.

(14) Slightly excessive longitudinal, and excessive lateral, and directional trim changes were developed by variation of speed over the normal range.

On 19 April, 1945, during a dive, the engine failed, but the airplane was close to the field and landed safely. The engine and propeller were replaced and the tests resumed. The XBT2D-1 airplane finished preliminary tests at Patuxent on 17 May, 1945, on which date it was ferried back to NACA, Moffett Field, for determination of flying qualities through flight test. NatC, Patuxent River confidential letter, serial C-411 dated 6 June, 1945, forwarded the report on the preliminary evaluation of the XBT2D-1 airplane, dated 6 June, 1945. The Naval Test Center made twenty four recommendations of which seventeen were considered to be necessary for a satisfactory service type. The main deficiencies reported were:

(a) Unsatisfactory power plant operation.
(b) Excessive longitudinal control forces in normal pull-out.
(c) Aileron snatch at near stalling speeds.
(d) Unsatisfactory free and fixed control directional stability in flight at small angles of yaw.
(e) Unsatisfactory free control directional stability at moderate to high speeds.
(f) Excessive changes in lateral trim over whole speed range.
(g) Miscellaneous items, like the relocation of the fuel tank selector valve, the oil filler cap and the rudder trim tab control.

BuAer 291705 TWX June 1945 to the BAR, El Segundo, referring to this report requested that the contractor take prompt action on all deficiencies. When the airplane, BuNo. 09085, returned to the plant from NACA, Moffett Field (which checked the results obtained by NatC, Patuxent) the contractor started various fixes to correct the bad features of the model. At the same time that the airplane was being used in this investigation, an evaluation of several propellers was being made. The original propeller as called for by the detail specification was the Aeroproducts with four blades, design V-20P-162-0, 13'6" in diameter. The blade was characterized by an extension of the trailing edge over the basic blade, design H-20P; this extension acted as a flap on an airfoil and gave the blade section more thrust but also more drag. In August, 1944, the Bureau of Aeronautics had requested that NACA conduct an investigation of the effects of engine-gear ratio, propeller blade section and propeller diameter on take-off distance and high speed performance. This investigation was to be conducted.
under project TED No. NACA 02331, using different propellers; among them the Aeroproducts with H20 blades, (13'6" diameter), the Aeroproducts with V20 blades (13'6" diameter), the Curtiss with 836 extended trailing edge blade (13'0" diameter). Tests on an XSB2D-1 airplane by NACA revealed that the Aeroproducts propeller with V20 blades and H20 blades gave the following performance:

<table>
<thead>
<tr>
<th>BHP</th>
<th>RPM</th>
<th>Vmax H-20</th>
<th>Vmax V-20</th>
<th>DVmax</th>
</tr>
</thead>
<tbody>
<tr>
<td>2100</td>
<td>2600</td>
<td>319 mph</td>
<td>295 mph</td>
<td>- 24 mph</td>
</tr>
<tr>
<td>1800</td>
<td>2600</td>
<td>300 mph</td>
<td>268 mph</td>
<td>- 32 mph</td>
</tr>
</tbody>
</table>

The speed loss due to the V-20 blade was considered much too high even though the same blade design gave a better take-off than the H-20 blade propeller (data obtained on XSB2D-1 and reduced to the XBT2D-1 airplane at 17,500# showed a gain in take-off of about 50 ft in 25 kts wind, using the V-20 blades). At about the same time that these results were obtained the first XBT2D-1 airplane, BuNo. 09085, was being used for a check of the Aeroproducts propeller with V-20 blades. However, the test results of NACA and the roughness experienced on the first airplane with that particular propeller were the cause for stopping the survey. It was then decided that the Aeroproducts propeller, 13'6" diameter with H-20 blades would be used until a better propeller, if any, was found. This was done to enable the propeller manufacturer to freeze on one propeller as far as the XBT2D-1 airplane was concerned. However, to find the ultimate engine-propeller combination (giving the best all-around performance) a request was sent to the contractor asking him to test various propellers on an XBT2D-1 airplane (results from the tests on the XBB2D-1 by NACA were difficult to reduce to the XBT2D-1 due to the large difference in configuration of the two models). The propellers to be tested include the Aeroproducts propellers and the 13'6" Curtiss propeller with 836 blades (same as 836 extended trailing edge blades). These tests have not been conducted to date due to higher priority flight test work. When the final propeller is decided upon, based on test results, it will be installed on the BT2D-1 airplanes.

After several months of testing, the contractor has made good progress on curing the deficiencies reported by NATC, Patuxent. In his letter B2-1973, C-No(s)-743, dated 25 September, 1945, the contractor gave a review of the program, the resume of which is as follows:

(a) Tests of power plant operation are continuing.
(b) Pull-out forces as tested by NACA are satisfactory. High elevator forces during landing as reported by NATC, Patuxent have been corrected by the incorporation of a down spring.
(c) Aileron snatch has been eliminated by providing a chordwise baffle on the upper wing surface about 3/4" high, between
the aileron and the flap, and running from the wing trailing edge to the rear spar.

d) Directional stability considerably improved but not yet entirely corrected.

e) Directional skidding has been corrected by the incorporation of a revised rudder spring tab mechanism.

f) Lateral trim change not eliminated in spite of thorough tests.

g) Miscellaneous items have been corrected to the satisfaction of BuAer.

During the month of September the contractor started to test the powder type bomb displacer in the first airplane, to determine clearance between the propeller and the bomb after release in a dive. On 21 September, 1945, the airplane was making its third bomb-releasing dive. The zero lift dive was entered at 12,500 ft. altitude with a 1000 lbs. AN-M-65 sand-filled bomb with reinforced fins, dive brakes open. Upon release of the bomb at 7000 ft. altitude and 300 mph IAS, the pilot felt the normal displacing jar to the airplane, and a moment later felt another jar. The XBT2D-1 immediately started tumbling end over end, the pilot bailed out at approximately 3500 ft. altitude, and the airplane crashed into Santa Monica Bay, approximately six miles west of El Segundo, California. All analyses and evidence point to the conclusion that, after the bomb was released, in order to obtain a photograph of the bomb clearance, the pilot kept the airplane in such a path that the propeller was struck by the bomb, causing loss of the airplane. The powder type bomb displacer had been thoroughly tested on the ground and on an SB2C-1 airplane prior to that test; however tests on the displacer are being conducted by the Bureau of Ordnance to discover any unsatisfactory characteristics of the equipment.

The second XBT2D-1 airplane, BuNo. 09086, made its first flight on May 8, 1945. At first it was used for flight tests of the Aero-Products propeller with V-20 blades in conjunction with the R-3350-8 engine. Propeller surging and roughness was experienced. On 13 June, 1945, the second airplane left the contractor's plant for full scale wind-tunnel test at Moffett Field under TED No. NACA 2376. This project has been established by BuAer Restricted Letter Aer-E-WSD, serial 59878, dated 11 April, 1945, to NACA which "requested that general stability, control and drag reduction be conducted on an XBT2D-1 airplane in the AAL Full Scale Wind-Tunnel. It is also desired that brief flight handling tests be made on this airplane as part of the committee's study".

By letter B2-1077, dated 3 May 1945, the contractor recommended to the NACA that the program under TED No. NACA 2376 embody the following tests:

1) Flight Handling Tests

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Declassified under NND 913043
Aileron snatch - directional snaking - lateral trim changes - longitudinal trim - aileron - roll-elevator forces.

(2) Full-scale Wind Tunnel.
(a) Stability and control tests.
(b) Spinner tests.
(c) Carburetor metering tests.
(d) Drag clean-up and maximum lift determination.
(e) Miscellaneous tests.

The above tests were requested by the contractor after he became cognizant of the deficiencies that had been uncovered on the first airplane, BuNo. 09085, at NATC, Patuxent River.

The preliminary reports of the NACA tests showed that their findings were in agreement with those of NATC, Patuxent River, except for the stalling characteristics which had been considered objectionable by the NATC and were acceptable to NACA. After tests in the wind tunnel were completed, the second airplane was put in flight test status for investigation of handling qualities. Part of this investigation was to test the airplane at rearward positions of the center of gravity to check its aerodynamic and handling qualities; this was requested by the Bureau of Aeronautics because of a new version of the model XBT2D-1 airplane which was being studied (see Night Attack Study under Special Studies). These tests were slow and were delayed by engine trouble about 10 September 1945. Replacement of the engine took about one week. On October 17, 1945, the second airplane made a landing with the wheels in the up position, probably due to pilot error. The contractor shipped an engine, a propeller and one set of inboard flaps to NACA. The ship was summarily repaired and returned to flight status. At present it is at the contractor's plant in El Segundo being completely checked over and thoroughly repaired. It is expected that it will be returned to NACA, Moffett Field, to find final fixes to the deficiencies as yet unsecured, and will also be used in the investigation of buffetng on high speed airplanes with external stores, under project TED No. NACA 2384.

The third airplane, BuNo. 09087, made its first flight August 17, 1945. This airplane was one of two, the other being a standby, which had the full strength catapulting and arresting provisions and was the first airplane to have full strength landing gear. At BuAer's request the airplane was thoroughly instrumented to obtain a record of the various loads and accelerations in the airplane structure and the hook assembly. Such information had never before been obtained. These platform tests were the first official Navy tests of the airplane under the Trials Clause of Section 10 of the Contract. These Service Acceptance Trials were established by BuAer confidential letter Aer-E-211-JCM, serial C-21118, dated 18 July, 1945, to the President of the Board of Inspection and Survey, and were to be conducted under TED No. BIS 2177.
The third airplane, BuNo. 09087, flew East and arrived at NAMC, Philadelphia on September 1, 1945. Tests were started after familiarization flights by the Navy pilots. The first preliminary report on Part I of the Service Acceptance Trials, dated 25 September, 1945, made some recommendations along with two conclusions:

1. Redesign of the tail cone section of the subject airplane to obtain clearance of the arresting hook and/or limiting further the maximum up-travel of the hook is considered mandatory.
2. Bumpers at all possible points of hook contact with the fuselage are required.

The contractor, by 1 November, 1945, was working on fixes consistent with the above conclusions. The third airplane was still under tests. Prior to these trials the airplane was conditionally accepted by the Navy.

The fourth airplane, BuNo. 09088, made its first flight on October 6, 1945. The first flight was delayed by the incorporation of instrumentation necessary for the formal demonstration of the airplane. This airplane was one of the three which was to have full strength wings as requested by BuAer 121421 TWX August 1945 (see Static Test Program). However at first flight the airplane incorporated the undersurface wing. By BuAer 292114 TWX August 1945 the contractor was requested to expedite the demonstration; it requested that the BAR at El Segundo recommend discontinuance of conditional acceptances of the airplanes should the progress of the program warrant it. The contractor, realizing the seriousness of the Bureau's stand, proposed a combined demonstration to be done in three phases. The demonstration requirements for the XBT2-1 airplane and the BT2D-1 airplane were outlined in Addenda 137 and 182 to NAVAER Specification SR-38C respectively.

In order to expedite the demonstrations, the contractor proposed that they both be conducted on XBT2D-1 airplane, BuNo. 09088, in three phases:

(a) Phase I and II - Preliminary acceptance of BT2D-1 airplane with the wing at 90% strength.
(b) Phase III - Demonstration of XBT2D-1 and BT2D-1 with the wing at 100% strength in accordance with Addenda 137 and 182. This preliminary demonstration procedure was approved by the Bureau of Aeronautics, and was started by the contractor on BuNo. 09088 at Palm Springs, California. BAR, El Segundo, 162350 TWX November 1945 stated that XBT2D-1 airplane, serial 09088 had been returned from Palm Springs after successful completion of all tests except two dives (one which is to be repeated due to yielding of structural rivets, the other to be conducted upon the receipt of a yawmeter necessary for the information to be obtained in that particular dive). The overall progress of the contractor on the demonstration was
highly satisfactory, and, after completion of the dives, the airplane is to be sent to NATC, Patuxent River, for final demonstration. During the dives performed at Palm Springs, the airplane encountered some severe buffeting troubles with certain external stores installed (especially the 2000 lbs. bomb on the centerline). This buffeting became such a serious problem in naval aircraft (was also experienced in the XBTW-1 and XBTK-1 airplane, besides fighter airplanes) that the Bureau decided to have NACA make a special investigation of this trouble. Project TED No. NACA 2384 was established for this purpose and will use the second airplane, BuNo. 09086, for part of the investigation.

The fifth airplane, BuNo. 09089, which at first, had been allocated to Accelerated Service Tests under the Service Acceptance Trials was later changed to become the contractor's "dog ship".

The sixth airplane, BuNo. 09090, first flew on November 15, 1945 and has been allocated to Power Plant Tests. It is the first XBT2D-1 airplane having the R-3350-24 two speed engine installed.

From the view points of:-

(1) Capabilities of the airplane,
(2) Progress of Service Acceptance Trials,
(3) Status of Preliminary Demonstration, which is almost 100% complete and
(4) Speed with which airplanes are being manufactured, the XBT2D program is in better shape than any other dive-bomber project.

Special Studies

Alternate Power Plant

At the beginning of the XBT2D-1 program, it was decided that the contractor should investigate the use of an alternate power plant, as insurance against the possibility that the R-3350-24 engine would not be developed to a satisfactory point.

The contractor was sent BuAer Change Request Aer-E-12-JAT, serial 9906, dated 17 January, 1945, for the study of a standby engine installation, in two model XBT2D-1 airplanes, of the Pratt & Whitney R-2800-34W engines. The contractor proceeded to study this installation and manufacture the necessary parts for its incorporation in two airplanes. However, as this study progressed, the R-3350-24 engine was developed (a two-speed clutch was finally designed which proved to be satisfactory) to a point where the standby installation had lost much of its reason for being. The contractor was therefore requested to cancel the actual installation of the R-2800-34W engine in two airplanes, but complete engineering and manufacture of parts and shelve them for future use should the need again arise.
Gas Turbine Installation

Recognizing the future role of gas turbines in aircraft, and in order to obtain a flying-prototype dive-bomber with such an engine, the Bureau of Aeronautics sent to the contractor a confidential Change Request Aer-E-12-JAT, serial C-10966, dated April 16, 1945, asking for the installation of a TG-100 engine in one XBT2D-1 airplane. Two inspections of the mock-up of this engine installation were made between 21 July and 17 August 1945. The contractor is to make the actual installation in XBT2D-1 airplane, BuNo. 09097.

Spin-Stabilized Rockets.

The Bureau of Aeronautics sent to the contractor a Change Request Aer-E-325-JNE, serial C-10713, dated April 12, 1945 for the development of a spin-stabilized rocket attack version of the model XBT2D-1 airplane to carry internally, feed and fire in a single burst fifty or more 5" spin stabilized rockets. The contractor proceeded to study this new version and found that only about forty of these rockets could be internally carried in the wings. The contractor is now building a wing modified for this purpose, which will be ground tested at NOTS, Inyokern, California. Later on an airplane will be flown with the modified wings, and air-firing tests will be conducted.

Night Attack Study

To provide two flying prototypes of a carrier-based night attack version of the XBT2D-1 airplane, the contractor was asked by BuAer Confidential Change Request Aer-E-12-JEF, serial C-21120, dated July 18, 1945, to study conversion of two airplanes to this new type. The night-attack version, officially designated as the XBT2D-1N airplane, is essentially to be the same as the basic airplane except that the main differences are:

(a) There are provisions in the aft fuselage for two men; one a radar operator and navigator, the other a radar counter-measures operator. These provisions include: seats, life raft, one exit door in each side of the fuselage.
(b) The fuselage brakes are deleted.
(c) Special electronics necessary to the mission of a night-attack airplane.

The loading for this XBT2D-1N gave it a center of gravity position which was aft of the design range. For this reason NACA had been requested to determine aerodynamic and handling qualities of
the XBT2D-1 airplane, BuNo. 09086, at rearwards center of gravity position.

A mock-up of the night attack airplane was held at the contractor's plant on 15 and 16 October 1945 and was found acceptable. The contractor is proceeding with the manufacture of two XBT2D-1N airplanes, their serial numbers being 09098 and 09099.

**Engineering Features**

A detailed description of the XBT2D-1 airplane can be found in Detail Specification SD-379-T-1 dated 7 June, 1944, as amended by Detail Specification SD-379-T-1A dated 1 December, 1944. Following is a brief resume of the specification:

**Engine:** Wright R-3350-24.

**Propeller:** Aeroproducts — 13'6".

**Armament:** Two 20mm guns (200 rds/gun) in the wings —
Provisions on three stations for stores up to 1000# bombs (2000# bomb on centerline) —
Eight rocket stations.

**Fuel:** Internal 350 gallons (in hammock type self-sealing tank)

External — 150 gallons drop tank

Low single wing — bubble canopy — high horizontal adjustable stabilizer-folding wing.

Latch type arresting hook — catapult hooks — conventional retractable landing gear.

**Dimensions:**

- Length: 39'5-1/4"
- Span: 50' -3/10"
- Span folded: 24'
- Height (during folding): 19'6"

**Gross Weights:** 14,000 to 17,000 lbs.
B - EXPERIMENTAL

(7) XBT2C-1 Airplanes

The contractor (Curtiss-Wright Corp.) submitted a proposal for a single seat dive bomber on 7 August, 1944. This proposal was basically an SB2C airplane with an R-3350 engine and a lengthened fuselage. A conference was held in BuAer on 14 Sept. 1944 to evaluate the proposal. On 18 September, 1944, the contractor was informed of the rejection of the proposal. The rejection was based on the fact that the proposal's performance characteristics were slightly inferior to other new single place dive bomber designs such as the XBT2D and XBTK airplanes. Curtiss was not capable of setting up a production line in addition to current commitments for SB2C and SC airplanes. A complete changeover from the SB2C type to the proposed single place airplane at the Columbus Plant would have been a dangerous plan since the SB2C was the only divebomber in production.

The contractor revised the proposal and re-submitted it to BuAer on 10 Feb., 1945. Many refinements were added and the weight was reduced. One of the striking features of the new proposal was the provision for carrying an auxiliary crew member - (radar operator) - abaft of the pilot, and buried inside the fuselage. This proposal met with favor from BuAer. Consequently, the contractor was authorized to proceed with the design and construction of 10 experimental models on 27 March, 1945.

The XBT2C-1 airplane is a single seat dive-bomber torpedo airplane. A few of the characteristics are as follows:

(a) General - Wright engine R-3350-24
Low midwing with constant dihedral, straight leading edge and tapered trailing edge, and folding outer panels. Single, high aspect ratio fin and horizontal stabilizer. Bubble type canopy - Bullet resistant glass as an integral part of the windshield and utilized as a gun sight reflector. Provisions for an auxiliary crew member (radar operator). Metal covered control surfaces. Latch type arresting hook. Internal, protected fuel capacity for 410 gallons.

(b) Armament - Two fixed 20mm, T-3L wing guns. Provisions for carrying Mk. 13-3 torpedo, 2000# bomb or 11.75" AR in bomb-bay.
Provisions for carrying 11.75 AR on 1000# bomb on each wing.
8 Mk. 9 R.L. stations.
Provisions for carrying 6-250# bombs in bomb-bay.

(c) Performance* - (1000# Combat Bomber - (Crew - one).

Gross weight
Fuel/oil gals.
Fixed guns/amunition
Flexible guns
Wing Loading - lbs/sq.ft.
Power Loading - lbs/BHP
Vmax S.L. - mph
Vmax/Crit. Alt. mph/ft.
Vstall (Gr. Wt.#) - mph
Vstall (w/o fuel#) - mph
Time to climb 20000 ft./
min.
Service Ceiling - ft.
Take-off Dist. 25 kt/ft.
Rate of climb** S.L. ft/ min.
Combat Radius - naut. mi.

NOTES: # Without Power
* Mock-up Board Changes included.
** Military Power.

To obtain a reliable airplane in the shortest possible time the greatest practicable number of design improvement features of the SB2C-5 airplane are utilized. Approximately 50% of the total number of parts and 68% of parts by weight are common with those of the SB2C-5 airplane. Incorporation of a large part of the combat-proven basic structure of the parent airplane will afford the advantage of the proven production tooling and interchangeability of spare parts with those of the SB2C series airplanes. Minimum training for fleet personnel should accompany this change. Equally important, however, is the fact that early production is made possible.

The XBT2C-1 is not a new airplane that incorporates great advances in any category; it is a development of the SB2C Series. The most significant advance beyond the SB2C-3, -4 and -5 is that the development of the R-3350 engine has permitted a power increase that more than compensates for the weight that has been added to the airplane to meet increased requirements.
The following table highlights the time history of the subject airplanes:

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Feb. 1945</td>
<td>Curtiss ltr. WWC/wc-185 Quote 580 Amendment 1, dated 10 Feb. 1944 accepted. Procurement Directive No. EN11-22; 249-45 issued this date for 10 Model XBT2C-1 airplanes, one static test airplane and one wooden mock-up airplane.</td>
</tr>
<tr>
<td>16-18 April, 1945</td>
<td>Mock-up Board convened at contractor's plant to inspect the XBT2C-1 airplane mock-up.</td>
</tr>
<tr>
<td>7 Aug. 1945</td>
<td>First Flight made this date by No. 1 XBT2C-1 airplane. Duration of 1:05 hours.</td>
</tr>
<tr>
<td>13 Sept. 1945</td>
<td>First flight made this date by No.2 XBT2C-1 airplane. Duration of 40 minutes.</td>
</tr>
<tr>
<td>25 Oct. 1945</td>
<td>First flight made this date by No.3 XBT2C-1 airplane. Duration of 50 minutes.</td>
</tr>
<tr>
<td>14 Nov. 1945</td>
<td>First flight made this date by No.4 XBT2C-1 airplane. Duration of 45 minutes.</td>
</tr>
</tbody>
</table>
C. PRODUCTION AIRPLANES SUBSEQUENT TO END SERIES

Part II

The 1936 biplane design competition resulted in awards of contracts to the Brewster Aircraft Corp. and the Curtiss Wright Corp. for one SB2A-1 and one XNSN-1 airplane, respectively. These designs were recommended to the Chief of Naval Aircraft Engineering Division Memorandum.

In selecting the question of price, the Curtiss A design is first by a reasonable margin with Brewster A and B following in order. These four designs use the R-2600 engine and it is the power of these engines which has a predominate influence on their superiority in speed, time of climb, service ceiling and take-off distance. The speed of the remaining airplanes is disappointing in comparison to the above four and are therefore not considered even for second choice. C - PRODUCTION AIRPLANES

The design competition required a Type Specification(1) which required the following characteristics and features:

1. SB2A Series
2. SB2C Series
3. BTN-1
4. BTM-1
5. BT2D-1

1. Single engine, twin propeller, coast and dive bomber land-plane designed to take off from an aircraft carrier with or without the aid of a catapult and land on the carrier deck in an arresting gear or on an ordinary landing field.

2. Gross Weight - Normal design load (1-1000 lb Bomber) not to exceed 9500 lb.

3. Bomb Load - 1-500 lb or 1-1000 lb bomb under fuselage; 2-1000 lb bombs on wings.

4. Fuel - 150% of the fuel required for a range of 1500 statute miles when carrying one 500 lb class bomb at economical speed.

5. Vmax - maximum practicable.


7. Service ceiling 20,000 ft.

8. T.O. Dist. in 25 kts. wind 250 ft.

The winning designs compared(2) as follows:

<table>
<thead>
<tr>
<th>Gross Weight</th>
<th>Curtiss</th>
<th>Brewster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel - gal.</td>
<td>102.9</td>
<td>105.3</td>
</tr>
<tr>
<td>Vmax 1500 lb</td>
<td>309.7</td>
<td>302.7</td>
</tr>
<tr>
<td>VS</td>
<td>78.9</td>
<td>78.2</td>
</tr>
<tr>
<td>Service Ceiling</td>
<td>10,000</td>
<td>9,500</td>
</tr>
<tr>
<td>T.O. Dist. (25 kts.)</td>
<td>446</td>
<td>428</td>
</tr>
<tr>
<td>Range</td>
<td>1000</td>
<td>1000</td>
</tr>
</tbody>
</table>

Declassified under NND 913043
C. PRODUCTION AIRPLANES SUBSEQUENT TO SBD SERIES

Part II

The 1938 scoutbomber design competition resulted in awards of two contracts, one each to the Brewster Aeronautical Corp. and the Curtiss Wright Corp. for one XSB2A-1 and one XSB2C-1 airplane respectively. These designs were recommended to the Chief of BuAer by Engineering Division Memorandum:

"Leaving out the question of price the Curtiss A design is first by a reasonable margin with Curtiss B and Brewster A and B following in order. These four designs use the R2620 engine and it is the power of these engines which has a predominating influence on their superiority in speed, time of climb, service ceiling and take-off distance. The speed of the remaining airplanes is disappointing in comparison to the above four and are therefore not considered even for second choice. The second choice is Brewster B as will be discussed later."

The design competition was based on a Type Specification(3) which required the following characteristics and features:

1. Single engine, two-place scout and dive bomber landplane, designed to take off from the deck of an aircraft carrier with or without the aid of a catapult and land on the carrier deck in an arresting gear or on ordinary landing field.

2. Gross Weight - Normal design load (1-500# Bomber) not to exceed 9500#.

3. Bomb Load - 1-500# or 1-1000# bomb under fuselage; 2-100# bombs on wings.

4. Fuel - 150% of the fuel required for a range of 1000 statute miles when carrying one 500# class bomb at economical speed.

5. Vmax - maximum practicable.


7. Service ceiling 20,000 ft.


The winning designs compared(2) as follows:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Curtiss</th>
<th>Brewster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Weight</td>
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<td>10313</td>
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<tr>
<td>Fuel - gal.</td>
<td>180</td>
<td>194</td>
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<td>Vmax @ 13000'</td>
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<td>302.7</td>
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<tr>
<td>VS</td>
<td>70.3</td>
<td>70.3</td>
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<tr>
<td>Service ceiling</td>
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<td>29,200</td>
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<td>T.O. dist. (25 kts.)</td>
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<td>261</td>
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<tr>
<td>Range</td>
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<td>1000</td>
</tr>
</tbody>
</table>

Declassified under NND 913043
1. A mock-up of the model XSB2A-1 airplane, BuNo. 1632, on contract 65990, was held at the Brewster Aeronautical Corporation plant at Long Island City, New York, from 14 to 16 August, 1939. The members of the mock-up board were:

Cdr. L.C. Stevens, USN
Cdr. V.H. Scheffer, USN
Lt. Cdr. W.F. Boone, USN
Lt. Cdr. C.L. Helber, USN
Lt. Cdr. S.B. Spangler, USN
Lt. Cdr. C.W. Smith, USN
Lt. Cdr. E.W. Clextan, USN
Lt. Cdr. A.B. Vosseller, USN
Lt. S.G. Mitchell, USN
Lt. J.A. Moreno, USN
Mr. W.Z. Frisbie
Mr. C.G. Blanding

The board was assisted by Cdr. G.R. Henderson, USN, of the Board of Inspection and Survey, Cdr. G.L. Compo, USN, Inspector of Naval Aircraft at the Long Island City Plant, Lt. I.E. Hobbs, USN of the Naval Aircraft Factory, Lt. J.S. McClure, USN, of the Bureau of Ordnance, and Lt. R.E. Dixon, USN, of the Flight Test Section, Naval Air Station, Anacostia, D.C.

The model XSB2A-1 was a single engined, mid-wing monoplane intended as a carrier based scout, dive-bomber and smoke layer. The engine was a Wright XR-2600-3, fitted with a non-icing carburetor. The armament installation consisted of two aircraft cannons (one in each wing) or alternately two .50 cal. guns in the wings and two 30 cal. synchronized guns in the fuselage, and one .50 cal. flexible gun in a power driven, fully enclosed turret in the rear cockpit.

The board considered the mock-up satisfactory subject to future approval by BuAer of several changes it requested. Admiral J.H. Towers, Chief of the Bureau of Aeronautics, approved the Mock-Up Board Report on 30 September, 1939.

The Status Report on Class Desk "B" projects dated 30 January, 1940, stated that a "considerable number of the studies requested by the Mock-Up Board have been received in the Bureau and changes made". While Contract 65990 quoted a delivery date of June, 1940, the inspector's estimated date of delivery was 24 August, 1940.

By BuAer Confidential letter Aer-E-2-EP, C-65990, dated 21 February, 1940, the contractor was requested to make a study to investigate the practicability of providing floats, increasing the fuel capacity for a 2600 miles range, altering the armament to provide...
four .30 cal. and two .50 cal. guns. This study, if it showed promise, was to be used by the U.S. Marine Corps. By BuAer Confidential letter Aer-E-211-GF, C-65990 of 22 July, 1940, the contractor was requested to submit in its final form, including costs, weight changes and performance. However, the seaplane version of the airplane lagged, the contractor not showing too much enthusiasm for the project. By BuAer restricted letter, C-65990, C-76492, serial 036805, dated 25 June, 1941, Brewster Aeronautical Corporation was advised that the Bureau had decided to drop the project. While the seaplane version was being studied and later dropped, a remock-up of the XSB2A-1 airplane took place on 26 February, 1940. All major items of equipment were now arranged in their proper location without interference. It was then estimated that the airplane would be delivered in late August, 1940. A major problem was the proper compromise in the design of the turret (to give maximum angle of down fire) and smooth aerodynamic flow over the aft section of the fuselage and the tail section. Design of the turret was slow, and to expedite first flight, the turret was omitted from the airplane.

In July, 1940, the contractor was requested to incorporate self-sealing gas tanks and armor in the XSB2A-1 to make it a combat airplane. However, the structure of the airplane was such that it cut up the integral tanks into minute sections and making the tanks self-sealing resulted in a loss of 50% of the fuel. This in turn necessitated the installation of a fuselage tank of 115 gallons capacity. The armor installation moved the center of gravity too far aft so that the engine had to be moved forward 10".

By the summer of 1940 the Brewster Company had, in addition to the Navy's order for the XSB2A-1 airplane, orders for about 100 dive-bombers from the British and the Dutch. These dive-bombers were similar to the XSB2A-1 and were known as the "export version". In August, 1940, negotiations were started which led to a production contract with Brewster for 411 SB2A airplanes. The pressure of the war in Europe caused the British and the Dutch to increase their orders for dive-bombers, such that the Navy's order for 411 SB2A airplanes was the smallest contract on the contractor's bookings.

The changes requested in the XSB2A-1 airplane, with their resultant effect as stated above, caused this airplane to become very different from its production version. It became so different that the first SB2A airplane was considered a prototype airplane itself. By early 1941, the following facts caused the Navy to reduce its order for SB2A airplanes from 411 to 203:

(1) Changes had caused a very large delay in the XSB2A-1 airplane program,
(2) Brewster was completely reorganizing its engineering department and management,
(3) Large differences existed between the XSB2A-1 and SB2A airplanes.
(4) Large orders for the "export version" were outweighing the Navy's order.
(5) The contractor was very lax in meeting the contract requirements as regards tests, data, and deviation from these requirements to expedite first flight of the XSB2A-1 airplane. These SB2A airplanes were being procured under Contract 76492, and were to be built in the contractor's new plant at Hatboro, Pennsylvania. The schedule called for deliveries commencing in June, 1941, and by February, 1941, the rate was to be 30 a month. The SB2A-1 airplane as contracted for in contract 76492 dated 24 December, 1940 was to meet the following guarantees:

1. Weight empty - 7723 lbs.
2. Vmax at ACA - 313.0 mph
3. Vmin - 72.0 mph

The last three of these guarantees were to be met with the loading of par. 10A of Detail Specification SD-269-1 (dated 25 July, 1940): that of a bomber carrying one 500 lbs. bomb and 194 gallons of fuel. The configuration of the SB2A-1 was to be as follows:

1. Wright R-2600-8 engine developing 1700 BHP for take-off.
2. Curtiss, 3 blade, electric, constant speed propeller, 12'0" diameter.
3. Fuel = 298 gallons - In three tanks: two integral wing tanks (129 gallons each); one auxiliary non-droppable tank (40 gallons).
4. One .50 cal. gun (400 rds.) fixed in each wing.
5. One .50 cal. flexible gun (400 rds) for the rear seat man.
6. Bomb-bay to carry up to 1-1000 lbs. bomb.

When the contract was cut back from 411 to 203, an additional number of SB2C airplanes were ordered from the Curtiss Co. to make up the difference.

The XSB2A-1 airplane, under contract 65990, made its initial flight on 17 June, 1941. Several flights revealed instability in certain speed-power combination; this instability was corrected by adding area to the vertical fin and the installation of a larger or "production" horizontal tail. During June, 1941, a remock-up of the turret and rear cockpit was completed, including the armor installation. Development on the turret was slow, the contractor first deciding to design it himself, then subcontracting it, then changing sub-contractors. The XSB2A-1 was modified to carry a Maxson turret by the construction of a new fuselage after section. Test flights with the turret revealed a bad breakdown of flow over the vertical stabilizer. The turret was returned to the vendor for the incorporation of the latest changes and a production dome.

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By March, 1942, the SB2A-1 airplane was running as much as 1,250 pounds overweight (some of it due to changes requested by BuAer). This necessitated moving the engine forward to recover proper center of gravity position. Besides overweight, the program was also suffering a large delay. In order to expedite the airplanes and get them into production, the Planning Division of BuAer decided to allow deviations from the detail specification in some of the airplanes. The airplanes were redesignated with the following differences:

SB2A-1 - Navy prototype to be finished in accordance with the specification, long engine mount, turret, folding wings, carrier provisions.

SB2A-2 - Modified British version. British free gun installation (Twin .30 cal. flexible guns), fixed wings, carrier provisions, Navy bomb installation, British .30 cal. fixed synchronized gun installation,

SB2A-3 - Same as SB2A-2 with folding wings.

Contract 76492 was therefore revised to call for one SB2A-1, 83 SB2A-2's and 119 SB2A-3's. In addition to these three models, the Navy acquired 162 airplanes of another model, known as the SB2A-4. These airplanes had originally been intended for the Netherlands East Indies Purchasing Commission. The SB2A-4 airplane was substantially the same as the British airplane (machine gun armament) with a different bomb installation and different radio equipment. These airplanes were procured under Contract NSs 10086.

By November, 1942, one SB2A-2 airplane and ten SB2A-4 airplanes had been delivered, the ten to tests at various naval activities. Due to the fact that the SB2C-4 series was fighting the war, the SB2C program was beginning to accelerate, logistics demanded the employment of as few types as possible, and the status of the Brewster airplanes was not good, the whole SB2A series was allocated to Operational Training.

Between March, 1942, and March, 1943, the XSB2A-1 airplane was used for flight and ground tests of the Maxson turret. These included investigations of flow over tail surfaces, pressure and vibration surveys on the dome of the turret, and firing runs. The tests were slow and the airplane was restricted to 6 load factors. When it was decided that this airplane has served its purpose, it was proposed in April, 1943, that it be delivered as a single-seater in a stripped condition. Work to ready it for delivery was practical-ly at a standstill for the next eight or nine months. The XSB2A-1 airplane was finally accepted by the Navy on November 10, 1943, and was delivered to NAS, Patuxent River, Md.

Delivery of the SB2A airplanes was much behind schedule. By January, 1943, one SB2A-2 had been given preliminary carrier acceptance trials at Philadelphia, and 13 SB2A-4's had been delivered to

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NAS, Jacksonville, for use as high performance trainers. The Flight Test Board recommended that certain deficiencies (poor directional stability, poor brakes, questionable aileron characteristics) be immediately corrected. However, the contractor was very slow in incorporating any of the preliminary trial board recommendations in the production line with the result that the SB2A-4 airplanes were being delivered in the same configuration as the airplane which went for trials. In February, 1943, it was decided that the SB2A-4 demonstration could be applied to the SB2A-2, but not to the SB2A-3, which had folding wings. Also, the model SB2A-4 airplanes (now under contract N0a(s)-152) were restricted to normal flight and 200 knots due to several cases of landing gear fairing failures in dives and to one case of a wrinkled fin in a dive.

From that date on, the history of the SB2A airplanes is one of structural failures, modification programs, delays, and poor overall performance of the contractor. Failures of horizontal stabilizer ribs at Vero Beach, Florida, which was using the SB2A-4 airplanes for dive-bombing training, together with failures in the horizontal stabilizer hinge bracket clips, elevator torque tube support bracket, wing leading edge attachment fitting to fuselage, required that a modification program be established at the contractor's plant. All airplanes were returned from service to the Johnsonville plant to have the necessary structural reinforcements incorporated. These same changes were incorporated in the production line. In September, 1943, some of the modified airplanes (mostly SB2A-4's) were returned to Operational Training. However, failures appeared in other parts of the horizontal tail, and NAS, Vero Beach, again restricted their airplanes to 200 knots and normal flight. Another modification was necessary; in November, 1943, some 75 SB2A-4 airplanes were awaiting modification for reinforcement of the tail surfaces.

Troubles on the SB2A series had reached such a peak, and delay in correcting these troubles was so long that Contract 76492 was cut back in the fall of 1943 by 62 model SB2A-3 airplanes. In February, 1944, all SB2A-3 airplanes had left the plant, seven SB2A-2 airplanes remained to be flown away, all SB2A-4 airplanes had been delivered but some 56 were still at the plant awaiting modification. By May, 1944, all SB2A-4 airplanes had left Johnsonville. One month later, by CNO Confidential letter to all ships, stations, and units, concerned with aircraft, OP-31-C3-MML, Serial 0126931, dated June 23, 1944, all SB2A airplanes were requested to be stricken from the Navy list.
A mock-up board composed of the following members inspected the mock-up of the XSB2C-1 airplane No. 1758, contract 66638, at the Curtiss Airplane Division, Curtiss-Wright Corp. plant at Buffalo, N.Y., from 23 May to 25 May, 1939:

Cmdr. L.C. Stevens, USN.
Cmdr. C.A. Nicholson, USN.
Lt.Cdr. O.A. Wellner, USN.
Lt.Cdr. J.E. Pixton, USN.
Lt.Cdr. C.W. Smith, USN.
Lt.Cdr. E.W. Cleston, USN.
Lt.Cdr. A.B. Vosseller, USN.
Lt.Cdr. W.E. Cleaves, USN.
Lt. L.W. Johnson, USN.
Lt. J.M. Lane, USN.
Mr. W.Z. Frishbe, BuAer.
Mr. C.F. Blanding, BuAer.

The board was assisted by Lt.Cdr. D.V. Gallery, USN., of the Bureau of Ordnance, Lt.Cdr. W.C. Gilbert, USN., Inspector of Naval Aircraft at Buffalo, Lt. I.E. Hobbs, USN., of the Naval Aircraft Factory, and Lt. R.E. Dixon, USN., of the Flight Test Section, Naval Air Station, Anacostia, D.C.

BuAer approved the contractor's request to increase the wing area from 385 square feet to 422 square feet on 19 August, 1939, by confidential letter Aer-E-12-EP, C-66638, HR(1). A report forwarded by the contractor's letter indicated the thorough and painstaking research the contractor carried out to insure that the XSB2C-1 airplane would have satisfactory aerodynamic characteristics. The BuAer letter invited the contractor's attention to the fact that the terms of the contract did not permit any change in the performance or weight guarantees.

The flexible gun installation as originally conceived in the XSB2C-1 airplane design informally submitted by the contractor was an improvement over the mounts used in service at the time, but did not approach the type of mount considered essential for adequate protection. The flexible gun installation mock-up was extremely cramped for even a medium-sized gunner, and the effective angles of fire were only fair. The gun was offset in the turret to allow room for the gunner, and consequently firing angles were considerably less on one side of the airplane than on the other. The experimental nature of the entire flexible gun mount design, including the power control, did not permit the contractor to properly estimate the weight of the installation at the time of the original proposal. After a complete redesign subsequent to the airplane mock-up the contractor requested that he be allowed 25 extra pounds due to the greatly enlarged installation in both size and scope. A fire interrupter device was conceived to prevent the gunner from inadvertently firing through the airplane tail, wing,
or other parts. This device further increased the weight and complications of the flexible gun installation.

The contractor's weight report submitted to BuAer on 22 May, 1940, indicated an overweight of two-hundred-sixty-two pounds in the XSB2C-1 airplane. On 17 January, 1941, BuAer received information indicating that the XSB2C-1 airplane was overweight six-hundred-nineteen pounds, and on 10 June, 1941, information was received, based on actual weights, that the airplane overweight had reached eight-hundred-fifty-seven pounds. BuAer advised the contractor by restricted ltr. Aer-E-12-LHM, C-66638 Serial 034289 dated 14 June, 1941, that the overweight was very disturbing inasmuch as the production SB2C-1 airplanes might be overweight. Further, it was pointed out to the contractor that overweight would have a serious effect on the military usefulness of the airplane, and that every precaution should be taken to insure efficient weight control.

In an effort to speed up the delivery date for the XSB2C-1 airplane and to determine at the earliest practicable date whether this model would be an acceptable service type, the Bureau informed the contractor by letter Aer-E-12-EP C-66638 dated 27 August, 1940, that numerous tests requirements would be waived or delayed. These waivers were as follows:

(a) Extensive test for CO contamination.
(b) Unit disassembly time and removal of various assemblies.
(c) Delay of installation of de-icing equipment.

The omission of tests and equipment was primarily to permit the contractor to start flight tests to check oil cooling, engine cooling, tail buffet at stall and in a dive, operation of all controls, devices, etc., so that the general aerodynamic characteristics of the airplane would be demonstrated as being satisfactory, and the essential mechanisms such as wheels retraction devices, flap operation system etc., would be checked. After satisfactory completion of the flight the flexible gun, fixed guns, oxygen, fire interrupter, etc., were to be installed, and the preliminary demonstration completed at the contractor's plant, followed by the final demonstration at Anacostia and preliminary acceptance of the airplane.

The Bureau requested that during the course of the contractor's flights BuAer be kept informed of all difficulties encountered and also notified of the status of the equipment not installed (flexible gun installation, fire interrupter, oxygen and etc.) so that delays might be avoided where BuAer action was necessary.

The XSB2C-1 airplane crashed 9 February, 1941, at the Buffalo Airport while undergoing contractor's preliminary tests. During the tests, considerable carburation trouble had been experienced.
but it is felt that the underlying cause of the crash was pilot error in permitting the engine to cool too much in a long glide without power, followed by opening the throttle too fast, which resulted in the engine cutting out. The landing was made short of the runway. One wing, both landing gears and the entire tail section of the airplane were severely damaged. The airplane was repaired and returned to a flight status early in May, 1941. On 13 May the XSB2C-1 airplane, piloted by Curtiss test pilot Lloyd Childs, suffered the following damage due to a landing gear failure:

(a) Both lower left landing flaps badly damaged.
(b) Landing gear retracting strut broken.
(c) Upper landing gear fairing damaged.
(d) Lug broken from wingfold fitting at Sta. 102.
(e) Landing gear retraction piston broken.
(f) Left wing rib crushed at Sta. 112 and lower skin surface torn about 5 inches.
(g) One rod broken on slat mechanism.

The airplane was repaired and returned to flight test status in approximately three weeks. However, on 29 May, 1941, the engine connecting rod carried away necessitating an engine change.

Bureau of Aeronautics personnel conducted studies to reduce weight and complication in the XSB2C-1 airplanes and authorized the elimination of certain items of weight empty and useful load. The following items were authorized for permanent elimination:

(a) Flight controls and instruments for the rear cockpit, with the exception of the radioman's clock and altimeter.
(b) Engine controls, except the wobble pump, for the rear cockpit.
(c) Confidential publication locker in rear cockpit.
(d) Hand fire extinguisher.
(e) Provision for C.F. radio.
(f) Frequency meter.
(g) Smoke grenades.
(h) Flash light and bracket.
(i) Emergency rations. Retain 5 lbs. water per man to be stowed in life raft.
(j) Ammunition rounds counter.
(k) Emergency flotation equipment. Provision shall be made for automatic and manual ejection of the life raft water and a 2 lb. first aid kit. The airplane must remain afloat long enough after a crash to permit the escape of personnel.
(l) Hoisting sling shall be carried as an overload item, attachment fittings retained.
(m) Stowage provisions for wing jury struts.
(n) First aid kit.
(o) Baggage compartment.

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Provisions were made to readily remove the following equipment for combat:

(a) Flare holders.
(b) Bombing racks and displacing gear.
(c) Float light racks.
(d) Target tow fitting and release system.
(e) Camera gun and mount.

No provisions were made in the airplane for the following equipment (equipment so designed that it will be carried in the airplane):

(a) Tool kit.
(b) Engine and cockpit covers.
(c) Tie-down equipment.
(d) Wing jury struts.

The CO₂ pressure fire extinguisher was installed in the XSB2C-1 airplane. However, provisions were readily removable, and that portion of the equipment was eliminated from the design weight.

At the request of the U.S. Army Air Corps, authority was granted to the Inspector of Naval Aircraft and the contractor to discuss with the Air Corps representatives any details in regard to the XSB2C-1 airplane and for the Army Air Corps representatives to make such inspection of the mock-up and construction as desired. This authorization was granted by BuAer ltr. Aer-E-EP/GB, C-66638 dated 8 June, 1940. The Air Corps request was the first indication that the Army was interested in securing an airplane from the basic design of the Model XSB2C-1.

SB2C1A (A25) airplanes for the Army Air Corp.

The Army Air Corps originally procured 100 A25 airplanes to be built from the basic design of the Navy Model SB2C-1 airplanes. Later procurement was initiated by BuAer for 6000 additional SB2C-1 airplanes from Curtiss. Of these, 3000 were to be built by Curtiss-Wright-Columbus plant (Navy), and three thousand to be manufactured by their St. Louis plant, for Army use. The airplanes were standardized with the Army. Non-standardizations in these airplanes were as follows:

(a) Larger wheels (34X9) in A-25's to accommodate the Army.
(b) Provisions in all airplanes for additional forward and underneath armor required by the Air Corps for ground attack missions.
(c) The Air Corps did not require Navy radio.
(d) Pneumatic tail wheels on the Air Corps airplanes.
On 23 December, 1941, a conference was held at the Curtiss Wright Corporation Plant regarding the urgency of expediting the first four SB2C production airplanes. Present at this conference were Mr. Williams, Mr. S. Vaughn and Mr. R.C. Blaylock of the Curtiss Wright Corporation and Lt.Cdr. J.N. Murphy, USN, Bureau of Aeronautics. At this conference it was pointed out that due to the crash of the XSB2C-1 airplane prior to trials it was necessary to obtain early delivery in order to permit tests prior to the introduction of large quantities of the SB2C-1 airplanes into service. The crash of the XSB2C-1 left the Navy the bulk of the new VSB production without a prototype. It was agreed that:

(a) SB2C would get highest possible priority.
(b) Curtiss was to provide a revised detailed schedule of the first four airplanes, and a complete picture of the SB2C-1 program.
(c) Due to the internal organization and arrangement, no delay to the XSB2C-1 airplane would occur.
(d) Curtiss was fully cognizant of the desirability of bringing out these four airplanes as promptly as possible, and would cooperate to the utmost.

On 25 July, 1942, VSB Design Branch initiated a memorandum to plans, which expressed concern over several features of the model SB2C-1 airplane which it was believed might cause difficulty when the airplane entered combat as follows:

(a) The Fuselage Vapor-Diluted Fuel Tank. In an attempt to save weight, this airplane was originally designed with the right and left center section tanks self-sealing and the fuselage tank (90 gallon) vapor-diluted. The Model SB2C-2 and the Army Model A-25 airplanes were to be delivered with 110 gallon self-sealing fuselage tank. The increase in weight empty necessary to provide this protected tank was 135 lb airplanes, approximately. The two tanks could be interchanged with very little effort. The increase in weight would increase the take-off distance by approximately 13 feet. There also would be detrimental effect on balance due to a rearward movement of the center of gravity.

(b) The Power Operated .50 Cal. Flexible Gun Turret. VSB Design Branch has had a study made in the Bureau with regard to the possibility of replacing this turret with a twin, thirty caliber, hand operated, continuous feed, flexible gun installation.

The real concern was not whether the twin, thirty caliber gun would be more effective than the single gun, but rather the question of vulnerability of the turret which was driven from the main hydraulic system.

(c) Dive Flaps. The dive flaps as originally designed some years ago were operated by mechanical means, driven by Vickers Hydraulic Motor. This system was rugged and appeared to be
reliable but had a serious disadvantage in that closing of the flaps required an appreciable time. A complicated hydraulic system had been designed by Curtiss to replace the mechanical system. This redesign would permit quick opening and closing of the flaps.

It should be noted that the above mentioned changes became necessary during the third modification program in July, 1943, with the exception of (c) above which was initiated in production with the 201 SB2C airplane (later designated model SB2C-1C).

The preceding portion of this history has been devoted to the design development of the XSB2C-1 airplane. The following pages of this report are devoted to the production articles. Experience gained from the war in Europe in 1940 and 1941 dictated many military necessity design changes in the first production version of the SB2C series airplane. Further experience in the Pacific dictated additional changes.

Description of Design Features and Major Changes in Design in SB2C Series Airplane

The SB2C series airplane is composed of several models; SB2C-1, -1C, -3, -4, and -5. The order of production of these models and the number in each model are given in the following table:

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<th>Model</th>
<th>No. of Airplanes</th>
<th>Serial No.</th>
<th>Production Lot No.</th>
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<tr>
<td>SB2C-1C</td>
<td>778</td>
<td>00201-00370, 01008-01208, 18192-18598</td>
<td>1</td>
</tr>
<tr>
<td>SB2C-3</td>
<td>1112</td>
<td>18599-19710</td>
<td>2-7</td>
</tr>
<tr>
<td>SB2C-4</td>
<td>2044</td>
<td>82858-83127, 64993-65286</td>
<td>3-13</td>
</tr>
<tr>
<td>SB2C-5</td>
<td>970</td>
<td>83128-83751, 89120-89465</td>
<td>14-18</td>
</tr>
</tbody>
</table>

It is the purpose of this report to identify the major design differences between the above models and to describe any major design changes made during the production of any of these models.

The production of the SB2C airplanes has been controlled by a "lot" system representing the quantity of airplanes scheduled for a month's production. To standardize the incorporation of necessary design changes in production whenever possible these changes were made effective on the first airplane of the first lot in which
the change was incorporated without delaying production. However, in the case of the first lot of airplanes (SB2C-1 and -1C), design changes were incorporated at favorable points of production without regard to the lot system.

**SB2C-1**

The Curtiss SB2C-1 Helldiver is a two-place midwing monoplane designed primarily for dive bombing. It has a wing span of 49 ft. 8-5/8 in., and is 36 ft. 8 in. long in flight position. Its height in a three-point attitude is 13 ft. 1-1/2 in. With the wings folded, the span is 22 ft. 6-1/2 in., and the height is 16 ft. 10 in. It is powered by a Wright R-2600-8 double-row fourteen cylinder radial engine which develops approximately 1700 horse power, and a three bladed Curtis electric variable pitch propeller. It's retractable landing gear is carried in the center wing panel. The SB2C-1 is capable of carrying any of the following loads in the bomb-bay:

1. Smoke tank MkV-3.
2. 1600 lb. armor piercing bomb Mk-1.
3. 650 lbs. depth bomb Mk-37.
4. 650 lbs. depth bomb Mk-38.
6. Auxiliary fuel tank 130 gallons.
7. 1000 lb. A.F. AN-M-33.
8. 500 lb. G.P. bombs AN-M-64.
9. 325 lb. depth bombs AN-Mk-17-2.
10. Fragmentation bomb clusters MiAl.
11. Torpedo Mk-13 (Torpedo carried externally on adapter).

The SB2C-1 is also capable of carrying any of the following bomb loads in the bomb-bay:

1. 1000 lb. DAP bomb AN-M-59.
2. 500 lb. SAP bombs AN-M-58.

Two wing bomb racks are provided on the wing center section, outboard of the landing gear and inboard of the folding line, each of which can carry any of the following loads:

1. 100 lb. bomb.
2. 50 Gal. drop fuel tank.
3. Smoke tank Mk-7-1.
4. 325 lb. depth charge Mk-17-2.
5. Fragmentation bomb cluster MiAl.
6. Miniature practice bombs Mk-5-1 (To be used with special bomb rack).

The armament of the SB2C-1 consists of 4-50 Cal. machine guns mounted in the center panel, with provisions for 400 rounds of ammunition for each gun. The observers armament consists
of 2-30 Cal. machine guns mounted on manually trained gun ring. Provisions are made to carry 1000 rounds of ammunition for each of these guns.

In construction the SB2C-1 is conventional. It has a single tail consisting of a fin and rudder as vertical surfaces, and a stabilizer and elevator in two sections as horizontal surfaces. The elevator and rudder are provided with tabs to trim the ship to a neutral position in flight attitude. The elevator and rudder are constructed so that all flight loads are transmitted to a rigid nose or leading section rigid nose. Aside from this section the remainder of the skeleton is lightly constructed and the entire assembly is cloth covered and doped. The fin and stabilizer are all metal, being constructed of sheet metal beams and ribs and covered with thin sheet metal.

The fuselage of the SB2C-1 is built up around an "M" frame and four heavy longerons originating at the engine mount attachment fittings on the firewall. The upper pair of these longerons extend aft to the end of the fuselage and lie along the upper edge of the fuselage proper. The lower pair of these longerons extend aft to the opening which accommodates the center panel where the center panel is spliced to the fuselage. A longeron on each side of the lower surfaces of the center panel splices to these lower fuselage longerons. The "M" frame is a large forging installed in the manner of a bulkhead directly aft of the pilot's cockpit. This structure transmits the greater portion of the flight loads from the wing section. The "M" frame is also attached to upper fuselage longerons through a fitting. The remainder of the fuselage structure consists of regularly spaced sheet metal bulkheads and longitudinal stringers parallel to the longerons. This fuselage skeleton is covered with sheet metal skin, flush riveted.

The fuselage group is completed by a windshield, a set of cabins, and a turtleback. The turtleback is collapsible to widen the gunner's field of fire. The center or fixed cabin covers the area between the pilot and gunner, which contains the life raft, fuselage fuel tank, radio equipment and turnover structure. The pilot's cabin rolls aft and the gunner's cabin rolls forward. Escape hatches and jettisoning provisions are built into the cabins for emergency use.

The wing of the SB2C-1 consists of an outer panel on each side of the center section. The outer panel folds upward to provide compactness. The center section is built-up around two beams. Two extruded "T" section capstrips at top and bottom, joined by a web of sheet metal form each beam. At the inboard end of the main beam on each side is a large fitting known as the "A" frame, which bolts to the fuselage "M" frame and carries a major portion of the wing loads into the fuselage. At the inboard end of the
rear beam of the center panel is a forged fitting known as the "bridge" frame, which sweeps upward and attaches to the corresponding bridge frame on the opposite center panel at the center line. The upward sweep of this fitting provides an uninterrupted area in the bomb bay for the carrying of bombs. Both beams of the center panel terminate with large hinge fittings for folding the wings. The remainder of the structure of the center panel consists of longitudinal ribs built to the contour of the airfoil section supporting the metal skins which are attached by flush rivets, or screws. There are provisions built into the center panel for the attachment of landing and diving flaps which lie along the trailing edge of the wing. These flaps are operated by jack screws working from a shaft attached to a hydraulic motor at the center of the ship. In landing, the lower flaps only are lowered 52°. In diving, the upper and lower flaps are each opened approximately 25°.

Each side of the center panel contains a self sealing fuel tank, a landing gear, two .50 caliber machine guns with ammunition boxes, and a wingfold mechanism.

The outer panel, like the center panel, is built around two beams of extruded "T" section capstrips, top and bottom, joined by a sheet metal web. At the inboard end of these beams are large hinge fittings mating with the center panel fittings. The wing tip is removable for easy servicing. The wing tip carries a running light and a formation light. Recognition lights are installed in the lower surface of the outer panel. The outer panel carries a slat on the leading edge which is extended as the landing gear is lowered, and retracted as the landing gear is retracted by a cable and pulley system inter-connected to the landing gear. The outer panel is equipped with a set of flaps which operate in the same manner as the center panel flaps. The jack shafts are routed into a gear box at the wing fold line, thus permitting the wings to be folded without interfering with the operation of the flap mechanism.

The outer panel contains the hydraulic mechanism which folds the wing. It consists of a large hydraulic cylinder mounted span-wise in the outer panel immediately aft of the main beam.

The aileron is located along the trailing edge of the outer panel, outboard of the flaps. Its construction is similar to that of the elevator and rudder; that is, a rigid nose section of sheet metal construction with light trailing ribs. The upper surface of the aileron is metal and the lower surface is cloth covered. A trim tab is provided on the lefthand aileron. A balance tab is provided, centrally located, along the trailing edge of each aileron.
The bomb bay is enclosed by a pair of bomb doors hinged to a structural longeron on the under surface of the wing center section. These doors close completely around any load carried in the bomb bay except a torpedo. When a torpedo is carried a special adapter is added which carries the torpedo below the fuselage.

The landing gear is of the conventional retracting type. The hinge line about which the landing gear is retracted and extended is located near the outboard edge of the center panel and the landing gear folds outward when lowered, giving the airplane a trend of 16 feet. The landing gear is contained entirely in the center panel and attachment is made through large forgings bolted to the main beam of the center panel. The wheel is supported by an oleo which serves as a shock absorber. This is braced to take longitudinal and lateral loads by a large drag truss forging. The landing gear is actuated by a hydraulic strut controlled by a valve in the front cockpit. A cable compresses the oleo as the landing gear is retracted, to fit into the wheel well. The tires are 32 x 8. The brakes are of the internally expanding type, hydraulically actuated. Two sections of fairing are attached to the landing gear which fits the contour of the wing when the landing gear is retracted. One of the predominant features of the SB2C-1 is its extensive hydraulic system. Nearly all operating mechanisms are actuated or controlled hydraulically. Hydraulic pressure is obtained from an engine driven pump. Operating pressure of the SB2C-1 hydraulic system is 1000 p.s.i. Units actuated by the hydraulic system are the landing gear, the wingfold, the wing hinge pins, the bomb doors, the turtleback, the dive-brakes, and the landing flaps.

A 24 volt D.C. electrical system is provided in the SB2C-1 for the operation of starter, lights, radio, gun camera, torpedo training camera, fuel gauges, warning signals, propeller pitch control, and instruments.

The radio installation of the SB2C-1 consists of the following units:

**RECEIVERS**
1 ANB receiver (Medium high frequency)
1 Pilot's control box
1 Pilot's remote tuning head and mechanical linkage.
Note: The control box, tuning control and mechanical linkage listed above are for use during ferrying to enable the pilot to use the radio equipment.
1 Filer F-6/AR
1 ARA receiver
1 Pilot's control box
1 W.E. 233A radio telephone unit (Transmitter and receiver) (Very high frequency).
1 W.E. 39A pilot's control box
1 W.E. junction box
1 AN/ARR-2 (ZEX) receiver for high frequency homing
1 Pilot's control box and mechanical linkage

TRANSMITTERS
1 ATC transmitter (Medium high frequency)
1 Dynamotor
(W.E. 233A radio telephone unit listed above under receivers)

INTERPHONE
1 RL-5 interphone amplifier unit
1 Pilot's control box
1 Operator's control box

RADAR
ABK recognition system (IFF)

ASB Search Equipment

The fuel system of the SB2C-1 consists of two 105 gallon wing tanks in the center panel and a 110 gallon fuel tank located in the fuselage immediately aft of the pilot. Provisions are made for two 58 gallon tanks carried on the wing bomb racks and one 130 gallon auxiliary tank in the bomb bay. The wing tanks, fuselage tank and the supply hoses are self-sealing. A fuel selector valve is provided in the front cockpit.

The air controls on the SB2C-1 are conventional. A system of cables and pulley brackets connects the stick to the aileron. A system of chains, cables, sprockets and pulley brackets connect a wheel control in the front cockpit to mechanical actuators which operate the trim tabs in the rudder, elevator and aileron. Controls are provided only in the pilot's cockpit.

The displacing gear is a device which causes the bombs to clear the propeller when released in a steep dive. It consists of large tubes hinged at the firewall, extending aft, and are held to the bombs by fitting which contact the bomb trunnions. Thus, when the bombs are released, the displacing gear falls with the bomb forcing it to clear the propeller. The displacing gear trips a hydraulic valve, causing the displacing gear to retract within the fuselage when the bombs have fallen clear.

The SB2C-1 is provided with a retractable arresting gear which, during carrier or platform landings, is extended from the aft end of the fuselage immediately above the tail wheel. The hook is controlled by a handle in the front cockpit which operates a cable and drum mechanism which causes the forward end of the hook to roll aft on a track, locking at the end of the track with the hook extended. An oleo is provided to prevent the hook from bouncing
clear of the deck or platform.

Another design change made on the SB2C-1 model was the adoption of a more effective packing ring in all hydraulic struts. The previous packing rings had a chevron-shaped section while the new rings are circular-shaped in section.

SB2C-1C

The SB2C-1C was the first major model revision of the SB2C. In most respects, it was identical to the SB2C-1, changes only having been made where absolutely necessary in order to improve the operating efficiency of the airplane or to increase its effectiveness as a military weapon. In outward appearance, there was little difference between the SB2C-1 and the SB2C-1C, the only noticeable difference being the presence of cannons in the wing instead of machine guns.

One of the outstanding characteristics of the SB2C-1C was the changeover from these machine guns to two 20mm cannons, one on each side, with provisions for 200 rounds of ammunition for each gun. The observer's armament consisting of two .30 caliber machine guns on a flexible mount, manually trained, was not changed on this model.

Other differences, characteristic of all SB2C-1C airplanes, were the addition of a torpedo training camera and a changeover to hydraulically-operated wing flaps. The SB2C-1C flaps were operated by 12 hydraulic struts installed at intervals along the rear beam. This mechanism was designed so that the same hydraulic struts were designed to operate the diving flaps as well as the landing flaps. This new flap operating feature required extensive design changes in the hydraulic system and in the wing trailing section. The principle reason for changing the flap design was to permit the diving flaps to be opened at higher speeds.

Throughout the production of the SB2C-1 model and partially on the SB2C-1C, the sub-contracted source of the wing center sections was the Curtiss St. Louis Plant. Subsequent center sections were obtained from the Chrysler Corporation. For the sake of interchangeability, however, all major parts fit interchangeable on one panel as well as the other.

The landing gear drag truss, a large forging supporting the landing gear structurally by absorbing landing gear loads and the "bridge" frame, a large forging which terminates the center panel rear beam at the center of the ship, were redesigned to be built-up from component members in a bolted assembly rather than a single forging, thus alleviating the large forging's procurement problem.
SB2C-3

The principle feature of the SB2C-3 was its new power plant, which incorporated the 1900 horsepower Wright R-2600-20 engine in lieu of the 1700 horsepower Wright R-2600-8 engine.

Other significant changes which appeared for the first time on all SB2C-3's were as follows:

(1) The turnover structure was removed.
(2) The movable cabins were designed so that they now lap over the windshield, fixed cabin and turtleback instead of flush fitting. This facilitates the installation of these cabins and provides a better seal when they are closed.
(3) The oxygen system was revised to incorporate the more efficient Diluter Demand Pressure Regulation System.
(4) A four-bladed Curtiss propeller replaced the three-bladed Curtiss propeller.
(5) The fuel vent system was redesigned to use Kenyon low pressure valves instead of open vent tubes.
(6) A valve ("Quick Defueling Valve") was added to the fuel system to permit draining all fuel tanks simultaneously.
(7) The emergency bomb door operating mechanism was redesigned to use a series of springs instead of a rubber shock cord bungee.
(8) Provisions were made for filtering the air entering the carburetor by adding a series of filters to the upper forward area of the inside of the speed ring, which may be used if needed.
(9) Heavy duty brakes.
(10) The message carrier was relocated from the lower section of the fuselage to the right side of the fixed cabin.
(11) Additional armor plate protection was provided for the pilot's head and shoulders by increasing the armor plate area aft of the pilot.
(12) At a later point in production of the SB2C-3, (effective on Navy Serial No. 18921 and up) a series of changes were made in the hydraulic system to improve its operation. These changes consisted of redesigning the pressure accumulator bracket to be interchangeable for two different sources of accumulators, eliminating the valves which release the pressure in the bomb door system when it is necessary, in an emergency, to open the bomb doors mechanically, since this pressure can be released by another valve, of redesigning the displacing gear valves for more efficient operation, and of adding a pressure gauge for the brake system accumulator. Effective on the later SB2C-3's (BuNo. 19111 and subsequent) and all future models, provisions were incorporated into the SB2C-3 for a new radio installation introducing the AN/ARC-5 communication reception and transmission system and the AN/APX-2 recognition equipment which replaced several of the previously used radio units. This change was effective in the field on all airplanes.
delivered prior to production incorporation.

With the incorporation of these new changes, the radio equipment of the SB2C-3 consisted of the following units:

**RECEIVERS**

1 AAR receiver (Medium high frequency)
1 ARA receiver (R-26/ARC-5)
1 W.E. 233A radio telephone unit (Transmitter and receiver) (Very high frequency) (RT-19/ARC-4)
1 AN/ARR-2 (ZEX) receiver for high frequency homing (R-4/ARR-2)

**TRANSMITTERS**

1 ATC transmitter (Medium high frequency) T-47/ART-13 (W.E. 233A radio telephone listed above under receivers)

**INTERPHONE**

1 RL-5 interphone amplifier unit

**MISCELLANEOUS EQUIPMENT**

1 Pilot's control box
1 Pilot's remote tuning head and mechanical linkage
Note: The control box tuning head and mechanical linkage listed above are for use during ferrying.
1 Filter F-5/AR
1 W.E. 39A pilot's control box (C-52/ARC-4)
1 Pilot's control box (C-87/ART-13)
1 Dynamotor (DY-/ART-13 or DY-12/ART-13 or Dy-12A/ART-13)
1 Junction box (J-17/ARC-5)
1 Pilot's control box (C-38/ARC-5)
1 Operator's control box (C-48/ARC-5)
1 Jack box, Pilot's (J-22/ARC-5)

**RADAR**

AN/APX-2 recognition system (IFF)

**SB2C-4**

Like the previous model, the SB2C-4 incorporated several design refinements, foremost of which was the introduction of perforated flaps to supersede the smooth contour flaps of previous models. The purpose of the perforated flaps was to increase the angle of opening of the diving flaps to 35°, thus producing a more effective brake in dives. The landing flap angle was changed to 52°.
The target approach doors were eliminated from the SB2C-4. Armor plate was added to the speed ring to protect the engine. A spinner was added to streamline the hub of the four bladed Curtiss electric propeller.

**SB2C-5**

The SB2C-5 is the fifth major model revision of the Helldiver series. In the most respects this model is identical with the previous models in external configuration. Changes have been made where necessary in order to improve the operating efficiency of the airplane, or to increase its effectiveness as a military weapon. Like the previous models, the SB2C-5 incorporates several design refinements, foremost of which are the pilot's cockpit rearrangement, increased armament flexibility, and the fuel tank rearrangement. Details of these changes, plus additional items, are enumerated as follows:

A. **Cockpit Rearrangement**
   
   (1) Pilot gun sight, when not in use may be stowed out of line of the pilot's vision.
   (2) Installation of left hand console.
   (3) Installation of right hand console.
   (4) New all glass canopy over pilot.

B. **Armament**

   (1) The centerline fuselage bomb rack was moved forward 6.6 inches in order (1) to accommodate a 2000 lb. bomb, and(2) to reduce the adverse effect on the c.g. location of carrying a bomb at this station.
   (2) Improved gun camera installation. The gun camera installation is improved in that the switch, when on, is so wired as to operate the camera when the wing cannons are fired.
   (3) Bomb racks on wings have been strengthened to permit carrying maximum bomb load of 1000 pounds.

C. **Fuel Tank Arrangement**

   A reduction of the fuselage fuel tank capacity from 110 gallons to 55 gallons for Model SB2C-5 airplanes concurrent with the installation of two new 45 gallon wing fuel tanks, and elimination of centrifugal fuel pump from fuselage fuel tank. This change results in a total capacity of 355 gallons of internal protected fuel, which is an increase of 35 gallons over preceding SB2C series airplanes. This change is intended to accomplish the following:

   (1) Maintenance of performance (including take-off characteristics) as nearly the same as that of the SB2C-4 as possible.
(2) Increase of combat radius to 300 nautical miles (internal protected fuel only).
(3) Maintenance of same c.g. location as that of the SB2C-4 without the use of propeller ballast weights, under-engine armor, and spinner. Provisions for carrying the 100 gallon standard droppable fuel tanks on bomb bay centerline and two external wing bomb racks. The forward movement of the centerline bomb rack precludes the possibility of using the Curtiss 130 gallon bomb bay tank.

D. Power Plant Group

(1) The engine installation for the SB2C-5 is the R-2600-20, the same as in the SB2C-3 and SB2C-4 airplanes; however, the hub, spinner and blade of the propeller have been changed.
(2) Installation of hydraulically controlled cowl and oil cooler flap mechanisms.
(3) Installation of new starter to permit direct cranking operation.
(4) Installation of a new 37 gallon capacity oil tank.

E. Radio and Electrical Group

(1) AN/APS-4 radio equipment has been installed in lieu of the ASB equipment.
(2) Open wiring throughout the airplane in lieu of conduits has been provided thereby resulting in considerable weight saving.
(3) External power receptacle has been relocated in the right wing wheel well, it is used as a contact for auxiliary power when starting the engine.
(4) RL-9 interphone equipment replaced with RL-7.
(5) Provisions for installation of intervalometer.
(6) Provisions for installation of SD-1 Station distributor.
(7) Yardeny spot tuner is installed in AN/ARC-5 radio equipment.
(8) Voltmeter is installed in lieu of voltmeter giving a reading when generator is running.
(9) Installation of attitude gyro giving angle of dive and angle of roll, and addition of standby compass.
(10) Installation of cowl flap indicator.

F. Changes in Hydraulic System.

(1) Installation of hydraulic flap selector mechanism in bomb bay controlled by flap selector handle in pilot's cockpit to permit pre-selection of desired amount of landing flaps or diving flaps. When flaps reach the selected angle they remain at this position until selector is changed back to "closed" position or reset to
another angle. The mechanism incorporates a series of ball stops which prevent inadvertent selection of landing-flaps when diving-flaps are desired or vice versa. Thermo relief valves are also incorporated in this mechanism to counteract the expansion of oil due to changes in temperature. This mechanism facilitates "inching" of flaps closed as desired after take-off.

(2) Changed wingfold control to operate by a separately controlled hydraulic valve.

G. **Alighting Gear Changes**

(1) Increase of stroke of main landing gear eleo from 8-1/2 inches to 11 inches.
(2) Installation of 32 x 8.8 wheels and tires with demountable pins in lieu of 32 x 8 size.
(3) Installation of new arresting gear hook.
(4) Upper landing gear fairing link rods redesigned with left and right hand threads to facilitate adjustment.

H. **New Oxygen Installation in Pilot's Cockpit.**

I. **Wingfold Doors Redesigned for Improved Contour and Access.**

J. **Emmennage.**

(1) Strengthening of the vertical tail, stabilizer fittings and fuselage.

K. **Provisions of Structural Strength for 17000 lb. Gross Weight.**

The SB2C-5 airplanes are basically similar to the previous SB2C airplanes. They differ, however, in that reinforcements are made to provide for increased flight catapulting, arrested landing and landing loads. Provisions are also made for accommodating a 2000 pound bomb in the bomb bay, increased bomb loading on the external bomb racks and additional wing fuel tanks. The additional flight strength is accomplished by increasing the wing beam cap-strip areas in those regions where the calculated margins and previous wing tests indicated insufficient strength for the increased loading.

Additional catapulting strength is accomplished by increasing the strength of the lug at the catapult hook, the bolt attachment to the wing rib to the rear of this lug, and reinforcement of the upper fuselage longeron aft of the rear gunner's turret.
Increased arrested landing loads are accommodated by redesign of the arresting gear installation, and by reinforcement of the local arresting hook carry-thru structure of the fuselage. Landing loads are provided for by redesign of the landing gear structure to obtain a 2-1/2 inch increase in oleo stroke over the previous SB2C models as well as some increase in wing skin thickness inboard of the landing gear on the upper surface.

Additional strength has been provided in the vertical tail surface, and the fittings, and carry-thru structure to which the vertical tail surface loads are applied. Increased strength in the fin is accomplished by addition of .051 flange angles on the front and intermediate beams, .064 flanges on the rear beam, one gage increase in thickness of all outer skins except the nose skin, one gage increase in the beam webs, redesign of the fin attachment flanges and some increase in rib gages. Increase in rudder strength is accomplished by an increase of one gage in the beam web and reinforcement at the upper two hinges. The stabilizer to fin and stabilizer to fuselage fittings have been redesigned for the increased loads.

The following table highlights the time history of the subject airplanes:

<table>
<thead>
<tr>
<th>Date</th>
<th>XSB2C-1</th>
<th>SB2C-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug. 8, 1938</td>
<td>Request for designs of new VSB</td>
<td></td>
</tr>
<tr>
<td>Dec. 6, 1938</td>
<td>Competition opened.</td>
<td></td>
</tr>
<tr>
<td>May 15, 1939</td>
<td>Contract 66638 entered this date calling for one model XSB2C-1 to be delivered 365 days after date of contract. (May 15, 1940)</td>
<td></td>
</tr>
<tr>
<td>May 22-25, 1939</td>
<td>Mock-Up at Buffalo.</td>
<td></td>
</tr>
<tr>
<td>Aug. 2, 1939</td>
<td>Mock-Up report approved by Captain M.A. Mitscher, Acting Chief of BuAer.</td>
<td></td>
</tr>
<tr>
<td>Aug. 19, 1939</td>
<td>Bureau approves increasing wing area from 385 to 422 ft. This would cause delay although it does not appear that any was requested or authorized.</td>
<td></td>
</tr>
</tbody>
</table>

Declassified under NND 913043
Date
Aug. 31, 1939
Mock-Up reinspected by Armament Section.

Jan. 24-27, 1940
Inspection of XSB2C-1 remock-up at Buffalo (for redesign of flexible gun and cannon installation).

Feb. 15, 1940
INA, Buffalo estimates delivery date as Sept. 1, 1940. Delay requested by contractor for cannon installation not allowed. Delay for contract change "F" (Redesign of arresting gear installation and fuselage structure to comply with Change No. 6 instead of Change No. 5 of Spec SD-21A) allows 45 days extension or June 29, 1940 delivery date.

May 15, 1940
INA, Buffalo estimates delivery date will be November 1, 1940.

May 24, 1940
Contractor believes XSB2C-1 will be ready for flight test October 15, 1940.

Aug. 27, 1940
In order not to delay the delivery, the Bureau waives certain tests (CO, disassembly time of various assemblies) until after the trials.

Nov. 15, 1940
INA, Buffalo estimates delivery date will be January 2, 1941.

Nov. 19, 1940
Contract 79082 entered this date calls for 370 model SB2C-1's (serial numbers are Nos. 00001 to 00370). First airplane to be delivered Dec. 31, 1941.

Dec. 9, 1940
INA, Buffalo Mailgram 091805 states that flight tests will be limited to applied acceleration to not more than 4g. Should be ready for flight 11 December 1940.
Dec. 31, 1940

XSB2C-1

SB2C-1

Supplementary contract of this date calls for additional airplanes:
208 SB2C-1's (Nos. 01008 to 01215) and 100
SB2C-1A's (A-25's) for the Army.

Jan. 31, 1941

Undergoing flight tests
at Curtiss airport.

Feb. 9, 1941

XSB2C crashes while undergoing flight test. Plane
goes to plant for repairs.
The fuselage was broken
in this crash, not due to
fault of airplane. Approxim-
ately three months delay.

Mar. 31, 1941

Progress report from INA,
Buffalo states that contract
dates are advanced 105 days
as a result of changes E
(Installation of a Hispano-
Suiza-Birkigt cannon instead
of the Madsen gun), F (Re-
design of arresting gear and
fuselage structure), and H
(Incorporation of Mock-up
Board changes).

Apr. 30, 1941

Plane back in commission
for flight test.

May 31, 1941

Delay in deliveries of
airplanes due to (1)
Delay in completion of
Columbus plant, (2) Delay
in receipt of certain
machine tool requirements
(3) Lack of adequate
labor and experienced
personnel.

June 30, 1941

May 31, 1941

INA estimates delivery
date will be August 7,
1941 due to flight tests
failures.
Date
Oct. 21, 1941

Oct. 31, 1941

Dec. 21, 1941

Jan. 12, 1942

Jan. 29, 1943

Jan. 1943

June 4, 1942

June 30, 1942

XSB2C-1

SB2C-1

Revised contract as of this date. Calls for 578 SB2C-1's for the Navy and 100 SB2C-1A's (A-25's) for the Army. Also second supplementary contract of this date calls for 278 additional SB2C-1's (Nos. 03862 to 04148).

IN A, Columbus Progress report - Contractor believes airplane will be delivered to Anacostia latter part of December 1941.

IN A, Columbus Progress report - Contractor believes airplane will be delivered to Anacostia latter part of December 1941.

IN A, Columbus Progress report - Contractor believes airplane will be delivered to Anacostia latter part of December 1941.

Airplane crashes to total destruction while undergoing flight tests by contractor at Columbus, Ohio. This crash occurred in a clean high speed dive, under conditions not encountered in ordinary combat flying. The tail of the production airplane was redesigned and strengthened as a result of this accident, resulting in a necessary delay in production.

Supplementary contract of this date consists of entire contract as revised. Calls for the following: 3865 SB2C-1's for the Navy and 3100 SB2C-1A's (A-25's) for the Army.

IN A, Columbus estimates delivery of 00001 will be on 31 July 1942. #00001 is first flown this date, will undergo demonstration flights prior to delivery.
Oct. 31, 1942

Navy test on 00001 is 91% complete. Four airplanes (00005, 00006, 00007 and 00008) have been delivered this month.

Nov. 1942

Ten airplanes delivered this month.

Dec. 1942

Thirty Navy and one Army airplane (s) delivered.

Jan. 12, 1943

00001 having completed its preliminary demonstration at contractor's plant is delivered to Anacostia for final demonstration.

Jan. 25, 1943

00001 crashes to total destruction while undergoing flight tests by a Curtiss pilot, at Anacostia. This crash was, in general, similar to that of the XSB2C-1 but at a considerably higher speed.

June 24, 1943

Fifteen airplanes delivered this month.

Jan. 1943

Twenty-eight Navy and four Army airplanes delivered.

Feb. 1943

The contractor's proposal to establish the production effectiveness for the Model SB2C-3 airplane was approved and set at the 979th production article.

June 2, 1943

Conference held at Norfolk between Curtiss representatives, BuAer and ComAirLant to discuss deficiencies in Model SB2C-1 airplanes resulting from shake-down cruise of USS Yorktown.

June 14, 1943
Date

June 19, 1943

May 10, 1944

June 23, 1943

June 12, 1944

June 24, 1943

July 3, 1944

Oct. 7, 1943

July 21, 1944

Nov. 6, 1943

Oct. 5, 1944

9 Feb. 1944

Conference held at Norfolk between Curtiss representatives, BuAer and ComAirLant to discuss deficiencies in Model SB2C-1 airplane and take remedial action to ready airplane for VB-17 shakedown cruise on USS Bunker Hill.

Conference held in Board Room, BuAer, ComAirLant, VB-17, VB-7, VB-4, INA, Columbus to examine the results of the first carrier operation with SB2C-1 airplanes and determine the possibility of making this model an airplane satisfactory for combat.

Conference continued to establish list of items for modification program to make airplanes serviceable and combat ready.

BuAer directed the contractor by 07TWX2230 Oct. to incorporate at the earliest practicable date, perforated dive flaps and provide flap opening of thirty-five degrees.

Model designation SB2C-4 established by Planning Directive 88-A-43 Serial C-20003, which covered major changes beyond the SB2C-3.

The contractor was authorized to proceed with the expedited conversion of two SB2C-3 airplanes into XSB2C-6 airplanes. Ref. BuAer 09TWX1100.
Contractor authorized to proceed with the incorporation of additional internally protected 45 gal. wing fuel tanks.

Contractor authorized to cancel installation of 150 CH-2 turret by BuAer 10TWX1030. SB2C-3 flexible gun installation shall continue in SB2C-4, SBF-4 and SBF-4 airplanes.

VSB Design Branch recommended to CNO(Progranms & Allocation Branch) that the 10 pilot-line SB2C-4 airplanes be devoted to the expedited test program. Service activities recommended to receive these airplanes included NAS, Patuxent River, NAMC, BAR, Columbus, ComAirLant.

The contractor was authorized by 03TWX1432 to change the finish of the SB2C airplanes to all over glossy sea blue lacquer.

The design and incorporation of a new pilot's cockpit enclosure to eliminate the horizontal strength members and kickout panel, and the addition of a positive "open" locking device.

In an effort to reduce the gross weight of the model SB2C-5 airplanes the contractor was authorized by BuAer Change Request Aer-E-12-EAL, Serial 172031, to reduce the capacity of the fuselage fuel tank from 110 to 55 gals. and remove the propeller balance weights under engine armor and spinner.
Aug. 5, 1945

To implement the production of dive bomb production facilities were obtained from the Canadian Packard Co. The main assembly of the SBF-2C-1 plant was at the St. Hyacinthe, Quebec, plant, with many other facilities throughout the Dominion. A similar arrangement was made with Fairchild of Canada for the construction of SBF-2C-1.

Aug. 14, 1945

The 5000# SB2C airplane (the 865th SB2C-5 BuNo. 89360) manufactured by Curtiss-Wright Corp., Columbus, Ohio plant came off the production line 0900 this date.

Sept. 11, 1945

Partial termination of contract. From 2530 to 1137 SB2C-5 airplanes.

Oct. 29, 1945

Further reduction of contract. From 1137 to 970 SB2C-5 airplanes.

Last SB2C-5 BuNo. 89465 delivered and accepted by BAR, Columbus.

The SB2C-1C, -2, -3 and -5 were identical to the SB2C-1, -3 and -4 airplanes respectively. The SB2C-1C, -2, and -3 were identical to the SBF-1, -3 and -4 airplanes respectively. The SBF which corresponded to the Model SB2C-5 airplane, Canadian Car & Foundry Co. built 775 SBF-1, 26 SBF-1B (delivered to the United Kingdom), 415 SBF-5, 275 SBF-4 and 85 SBF-5 airplanes, for a total of 825 airplanes. The contract for SBF airplanes was terminated 14 August, 1943. Fairchild of Canada built 50 SBF-1, 150 SBF-3, and 100 SBF-4 airplanes, for a total of 300 airplanes.
To implement the production of dive bombers of the SB2C design, production facilities were obtained from the Canadian Government through their agency, The War Supplies, Ltd. Contracts were awarded to Canadian Car & Foundry Co. for the construction of 1000 airplanes designated SBW's. The main assembly of the airplanes was made at the Ft. William, Ontario plant, with many of the sub-assemblies machined and fabricated in other facilities of the Canadian Car & Foundry Co. throughout the Dominion. A similar contract was awarded to Fairchild of Canada for the construction of 300 airplanes designated SBF's.

Complete engineering data was furnished by the Curtiss-Wright Corp. Major component parts were interchangeable between the SB2C, SBW and SBF airplanes. Many of the detail parts were procured from a common vendor for all three airplanes.

The SB2C-1C, -3, -4 and -5 were identical to the SBW-1, -3, -4 and -5 airplanes, respectively. The SB2C-1C, -3 and -4 were identical to the SBF-1, -3 and -4 airplanes respectively, there being no model SBF which corresponded to the Model SB2C-5 airplane. Canadian Car & Foundry Co. built 39 SBW-1, 26 SBW-1B (delivered to the United Kingdom), 415 SBW-3, 270 SBW-4 and 85 SBW-5 airplanes, for a total of 835 airplanes. The contract for SBW airplanes was terminated 14 August, 1945. Fairchild of Canada built 50 SBF-1, 150 SBF-3, and 100 SBF-4 airplanes, for a total of 300 airplanes.
XSB2C-2 Airplanes

A conference was held on 16 January, 1941, to discuss the design of a seaplane version of the model SB2C and SB2A airplanes for use by the U.S. Marine Corps.

It was decided, if practicable, to maintain the SB2C in its present form for carrier use with the same strength requirements and in all other details possible in order to minimize the engineering required by the contractor.

The contractor submitted a proposal which was accepted by the Bureau of Aeronautics. The fifth production model SB2C-1 BuNo. 00005 was assigned to the contractor for conversion to the prototype airplane. Upon completion of this prototype the airplane was flown as a landplane to NAS, Anacostia, where the twin floats were installed. Production Inspection Trials were successfully completed.

During the interval of prototype construction, 294 airplanes were allocated to be built as SB2C-2 airplanes. The airplanes were to be delivered with installation provisions for conversion to seaplanes. Due to early production difficulties with the SB2C-1 airplanes, the time required for trials of the XSB2C-2 airplane and changes in tactical requirements, the 294 seaplane versions were pushed further and further behind. By 1943, the main and most important requirement for the SB2C series airplane was the carrier based dive-bomber version to replace the then outmoded SBD series airplane. Therefore, the procurement for the SB2C-2 was changed, and the 294 airplanes were actually delivered as SB2C-4 airplanes.
MODEL SB2D-1 and BTD-1 AIRPLANES

General

In early 1942, the contractor was issued a Letter of Intent 180-42 for SB2D-1 airplanes, which were the production version of the XSB2D-1 airplane procured under NO-88707. This Letter of Intent was later replaced by Contract NOs-94997 dated 9 April, 1942. This contract called for a total of 358 SB2D-1 Airplanes to be built in accordance with Detail Specification SD-288-1 dated 10 November, 1941. Contract NOs-94997 was later superseded together with all its amendments by a new contract, NOa(s)-743, dated 31 August, 1943. Contract NOa(s)-743 increased the total number of SB2D-1 airplanes to 623 which were to be delivered in accordance with the following schedule:

1 in November, 1943 32 in July, 1944
1 December 54 August
2 January, 1944 71 September
2 February 89 October
3 March 106 November
3 April 117 December
7 May 118 January, 1945
14 June 2 February

The guarantees given in the contract were:

1. Weight empty - 12,710#
2. Vmax at A.C.A. with military power = 361 mph
3. T.O. in 25 kts. wind = 375 ft. (at about 15,000 lbs.)

These guarantees were based on the Wright R-3350-14 engine (two speed) delivering:

1. 2300 BHP for takeoff
2. 2250 BHP military power
3. 2100 BHP normal rated power

These SB2D-1 airplanes were to be very similar to the prototype models, the XSB2D-1 airplanes. The history of the SB2D-1 airplane program was much the same as that of the experimental airplanes. The comments that were made about delivery and overweight (see XSB2D-1 airplane) apply here also. Some of the important changes that were made during the design stage were:

1. Change in the fixed forward firing guns to 2-20 mm M-2 guns with 200 rds/gun in May, 1942.
2. Change to 3-bladed Hamilton Standard propeller in June, 1942, because of the difficulty in procuring the 4 bladed propeller called for in the detail specification.
(3) Deletion of heat anti-icing provisions. This was done in order to both save weight and accelerate the program, by relieving the engineering load.

The progress was such that it became evident in the fall of 1942 that the first SB2D-1 airplanes would not be delivered until the summer of 1943. Trouble with engine deliveries further set back the manufacturing of the SB2D-1 airplanes.

In the fall of 1943, flight tests on the XSB2D-1 airplanes gave much doubt as to the suitability of this two-seater design for carrier operations. It was therefore decided that the model SB2D-1 airplane would be converted to a single-seater so that its gross weight and resultant take-off would meet carrier requirements. The contractor was advised of this decision in a telephone conversation September 7, 1943. In the same conversation the contractor was advised that all efforts were being made to have the engine deliveries expedited; however, it would be necessary to have some of the single-seater airplanes equipped with the single-speed R-3350-14 engine, and others with the single-speed R-3350-8 engine. The main trouble with the engine was the development of a satisfactory two-speed clutch. It was hoped that this clutch would be available by March, 1944, and that all engines could then be replaced by the latest version. The single-seater airplane was redesignated the model BTD-1 airplane.

During early September, 1943, the following personnel went to the West Coast for the purpose of discussing the conversion and inspecting a mock-up of the single-seater:

Captain L.C. Stevens  Experiments & Developments
Comdr. J.N. Murphy  VSB Design
Lt.Comdr. D.W. Shumway  Military Requirements
Lt. Comdr. J.A. Thomas  VSB Design
Mr. W.Z. Frisbie  Design Coordination

Discussions were held with members of the GINA, Western District, and INA, El Segundo, offices and Douglas engineers. It was decided that since the rear-seat and associated equipment were to be deleted, it would be possible to have an airplane which could carry enough internal fuel and have enough performance to be operational. A second fuel tank of 120 gallons capacity was added aft of the existing fuselage tank. This brought the center of gravity position back to where it belonged and increased the internal capacity to 460-470 gallons of fuel.

The mock-up consisted of the first production fuselage and center section modified to show in part the changes which would be made in the single-seater conversion. The main changes in the conversion of the SB2D-1 into the BTD-1 airplane were:
(1) Elimination of gunner's enclosure, seat, turrets, sighting station, armor plate, oxygen, and other equipment special to the rear seat.
(2) Elimination of landing light, two man life raft, provisions for propeller and windshield spray anti-icing, and other items of equipment.
(3) Fairing of the gunner's cockpit, and extension of the fin forward.
(4) Simplification of radio installation.

Discussion as to schedule revealed that deliveries of BTD-1 airplanes would be very slow until summer of 1944. This would make it possible to have sufficient R-3350-14 engines available to meet the schedule, provided some of the XP4Y engines were diverted. Of the 623 model SB2D-1 airplanes that had been on contract N0a(s)-743, 622 were to be modified to single-seater airplanes, and one which had been used for the test installation of an Emerson turret was to remain a two seater. (This turret, although giving less angle of fire than the old turrets, was much lighter).

The first model BTD-1 airplane, BuNo. 04959, with a single-speed R-3350-14 engine, made its first flight on 15 December, 1943. The second BTD-1, BuNo. 04960, made its first flight March, 1944. Other first flights were: 04962 during March, 1944; 04963 during April, 1944; 04966 and 04967 during June, 1944; 04969 during February, 1945; 04971 during March, 1945; 09048 during April, 1945.

Because the initial SB2D-1 airplanes were similar to the prototype XSB2D-1 airplanes the contractor was allowed to delay manufacture of the static test structures until the 13th SB2D-1 had been built. Tests started in the spring of 1943 and continued through 1944. A typical example of the policy which was followed during the design of the SB2D-1, that of getting an overstrength and in consequence overweight airplane, is given by the test of the positive low angle of attack condition (PLAA) which was made in September, 1943: a failing load test was run with the result that the wing did not wrinkle up to ultimate load and did not fail until it had reached 13.9 load factors.

Flight Tests - General

As BTD-1 airplanes came out of the factory and made their first flights, they were used for flight testing of aerodynamic configurations, power plant operation, dive brake configuration. Five major problems were encountered during these flight tests, namely: dive brakes, ailerons, rudder, elevators, and carbon monoxide. The status report of VSB Design Projects for 1 April, 1944, states that during the past 10 months of flight testing four of the above five problems were believed to have been satisfactorily corrected and said "the following summarizes the results to date:"

(1) Ailerons: Original trouble was lack of stability in roll under carrier approach conditions with control forces excessive. The
new-design over-balanced aileron (flat sided) with hinge line at 81% and with a balance-tab ratio of .4 is now believed to be satisfactory. Control forces are now only slightly high, and a slight lateral instability at low speeds is not expected to be noticeable when these control forces are finally sufficiently reduced. This aileron has been released for all production airplanes.

(2) Rudder - Original trouble was lack of effectiveness in carrier wave-off condition. A new design with normal thin-section long-chord rudder has been tested satisfactorily, and has been released for all airplanes.

(3) Elevators - Original trouble was ineffectiveness in carrier landing condition. The latest tests, using a slotted elevator with a narrow chord slat (third revision), has shown adequate effectiveness in landing with the C.G. at either 24% or 22% MAC. The slot causes only a slight nibbling as it enters the slip stream and is not considered unacceptable by the test pilot. Control forces are in the acceptable range. It is believed that the control available in this elevator, based on flight tests, is satisfactory for holding the nosewheel off the ground during landing with the C.G. as far forward as 21% MAC. The farthest forward C.G. position in the combat airplane is expected to be 22% with all fuel expended.

(4) Dive-brakes - The original wing dive brakes caused buffeting of the ailerons, landing flaps and tail surfaces. Progress was being made on this item when the Bureau requested, in September 1943, that the dive speed be reduced to 270 kts. IAS in a 70° dive. Fuselage dive brakes supplementing the wing brakes are now released for production and will be incorporated in all but four special test airplanes, either as a production line or modification change item.

(5) Carbon Monoxide Concentrations - CO concentrations in the cockpit have exceeded the spec. limit of .01%. Leakage of exhaust gases via nose wheel well, bomb bay and engine accessory compartment are indicated. The program to eliminate CO is being expedited on the second XB2D-1 airplane, the cockpit of which has been divided to simulate conditions on the production airplane. The worst conditions noted so far have been in the carrier approach condition with the cockpit enclosure open. A change in the exhaust stack configuration has thus been indicated. Recent tests have been carried out which show an approach to satisfactory CO condition by using quarter collector exhaust stacks in lieu of individual jet stacks. In one flight all concentrations were measured below the limit of .01%. A loss of speed of 14 mph is indicated, using these 4 collectors.

(6) Propeller - Recent flight tests have indicated that material
Improvement in performance, especially in take-off distance (-37 ft. in 25 kts. wind), is to be gained by use of a Curtiss electric 4-bladed propeller. Steps are being taken to procure this propeller for all airplanes.

(7) Present and continuing failure of the Wright Aero. Corp. to supply R-3350-14 engines in accordance with their own "cold-blooded" estimates, does not yet materially hurt the BTD-1 program. Present BuAer estimates of engine deliveries (15 per month thru the summer) will be adequate to meet the Douglas proposed delivery schedule which apparently cannot be bettered by application of W-9 or any other schedule. Douglas maintains their delay behind the W-9 schedule is due to lack of accumulation of complete sets of fabricated parts owing to tool shortages, and not to any lack of productive capacity. Although engineering releases were 100% completed on Dec. 7, 1943, these releases entailed tooling changes which are responsible for the delay. The W-9 schedule is based on Douglas delivery estimates as of June, 1943, for the SB2D-1 airplane. In September 1943, the SB2D-1 was changed to a single-seat airplane, thereby in effect voiding the previous delivery estimates.

In May, 1944, the schedule called for 4 airplanes to be delivered for Navy Trials by early July, 1944 and for deliveries for operational use in the latter part of July, 1944. It was thought that the BT D-1 airplane would constitute a material improvement over the SB2C airplane, and that, with another year of development and execution of a perfected weight reduction program (which was expected to remove approximately 1000 lbs. from the gross weight of the airplane) it would more than justify its conception. The weight reduction and improvement program were to include:

1. The incorporation of an extended wing tip 18" long on each side, without change in the aileron. This was to give more wing area with resultant shorter take-off.
2. Minor weight savings in equipment and provisions for equipment.
3. Elimination of the bomb-bay and provision for the external mounting of bombs and torpedoes. This was to amount to a weight reduction of about 300 lbs.
4. Replacement of the two fuselage tanks by one single tank, saving weight in tank material. These changes were to be effective at different points in the BT D-1 production line.

During May, 1944, the program for the BT D-1 airplanes was as follows:

1. #1 BT D-1 (04959) - Resident prototype. Used for take-off tests with various propellers and extended wing tips.
2. #2 BT D-1 (04960) - Power Plant Demonstration airplane - was to receive the first R-3350-14 engine with a high-speed blower.
(3) #3 BTD-1 (04963) - First delivery article.
(4) #4 BTD-1 (04965) - Second delivery airplane.
(5) #5 BTD-1 (04966) - Tests of control surfaces, armament, and equipment.
(6) #6 BTD-1 (04967) - Dive brake test airplane. To be the first BTD-1 with fuselage dive-brakes.
(7) #7 BTD-1 (04968) - Tests of radio equipment, cockpit heater, and ventilation.
(8) #8 BTD-1 (04969) - Dive demonstration airplane.
(9) #9 BTD-1 (04970) - Production acceptance tests.

Airplanes BuNos. 04961, 04962 and 04964 were used respectively for the Emerson Turret project, installation of the Westinghouse 19A unit, and installation of the Westinghouse 19B unit (See Special Studies).

Model BTD-1 airplane, BuNo. 04963, was delivered to NAS, Patuxent River, on 10 May, 1944, for preliminary trials for the purpose of arriving at an estimate of the future satisfactory performance of the model. The principal defects reported by Flight Test were:

1. Longitudinal stability unsatisfactory in carrier approach condition.
2. Lateral stability neutral to slightly negative in carrier approach condition.
3. Insufficient rudder control in same condition as (2) above.
4. Elevator forces too large in a pull-out.
5. Take-off tests showed a distance of 590 ft. in 25 kts. wind, at a gross weight of 18,000 lbs., using 2300 HP and the Curtiss four bladed 13' 2" propeller.

It had been hoped that the take-off distance could be reduced to 450 feet with weight reductions, increased take-off rating of the engine, and optimum propeller. However, the preliminary tests at NAS, Patuxent definitely revealed that the airplane was not acceptable for carrier use because of its long take-off and unsatisfactory stability in the carrier approach and wave-off conditions.

In a conference presided over by Rear Admiral L.B. Richardson, Ass't Chief, BuAer, in the Board Room on 5 June, 1944, it was concluded that the BTD-1 airplane, because of its deficiencies, represented insufficient advance beyond the SB2C type to be its successor; for this reason it was decided that production of the BTD-1 airplane should be stopped. It was during June, 1944, that it was also decided that the Douglas Co. should proceed with a complete redesign known as the XBT2D-1 airplane (see XBT2D-1 airplane). In July, 1944, Contract Noa(s)743 was therefore cut back to 50 airplanes: one SB2D airplane (BuNo.04961), two XBT2D-2 airplanes (BuNos. 04962 and 04964) and forty-seven BTD-1 airplanes. These BTD-1 airplanes were to be used for various tests and utility purposes. By the same directive which increased the number of model XBT2D-1 airplanes to 25, the number of airplanes was further cut back to 28 (1 SB2D-1, 2 XBT2D-2's and
25 BTD-1's). Before delivery the contractor was requested to
demilitarize the airplanes in order to reduce the weight by some
2500 lbs. (This demilitarization took place on 9 airplanes, 15
being delivered by the contractor in the combat configuration).

After a summary demonstration to prove the basic strength of
the model, all airplanes were delivered, the last ones during the
summer of 1945.

The BTD-1 airplanes are now at various activities: NAMC,
Philadelphia, Technical Training Command, NPG, Dahlgren, NATC,
Patuxent River ... being used for miscellaneous tests or for utility
work.

Special Studies

(1) Jet Propulsion Study. On March 16, 1943, a conference was
held between officers of BuAer and engineers of the Douglas Company
for the purpose of discussing the application of jet propulsion to
the SB2D-1 airplane. The contractor made some studies for the
installation of a jet propulsion unit by Westinghouse, internally
mounted in the SB2D-1 airplane. The unit was aft of the pilot, in
place of the gunner and all rear seat accessories and armament.
The air intake scoop was located just aft of the pilot's enclosure
and the exhaust duct aft and below the fuselage. The airplane was
therefore a single-seater with the main power plant (R-3350-14
engine) and a booster unit (Westinghouse 19" J.P. Motor): it was
known as the XBTD-2 airplane. The two airplanes used for this
installation were BuNos. 04962 (incorporating the Westinghouse 19A
unit) and 04064 (incorporating the Westinghouse 19B unit).

In May 1944 the contractor was requested to conduct functional
flight tests only. BuNo. 04962 was to be delivered to NACA for
wind tunnel tests and BuNo. 04964 was to be delivered to NAS, Patuxent
River, for general evaluation.

Delay in repairs to the 19A unit which had been shipped back
to Westinghouse after failure at Douglas and delay in shipment of
the 19B unit caused this program to lose much of its earlier use-
fulness, and kept the airplanes grounded. It was therefore decided,
in order to save money and manpower (which was then needed on the
XBT2D-1 program), that the two airplanes should be stricken. This
was done about February, 1945 for XBT2D-2, BuNo. 04962, and August,
1945 for XBT2D-2, BuNo. 04964.

(2) Emerson Turret Project. When the airplanes under contract
Noa(s) 94997 grew overweight, it was decided that one SB2D-1 airplane,
BuNo. 04961, would be used for the development of the installation
of an Emerson Turret. This turret was lighter although the arc
of fire was less. With subsequent conversion of the SB2D-1 airplane

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to the single-seater, this study lost its interest and in May, 1944, the contractor was requested to cancel the Emerson Turret project. The airplane, BuNo. 04961, was later used in connection with the experimental development of an external bomb arrangement.

As early as in March 1944, the Bureau of Aeronautics was discussing the contractor's proposal to send him a release for 348 model BT25-1 airplanes to assure a smooth changeover in the manufacture of experimental to production airplanes. On 4 April, 1945, a Procurement Directive, WO1-2874-45, Serial 55555, for 348 BT25-1 airplanes was released and the contractor received a Letter of Intent for Contract NO(a)3-5555, AER-PR-2-RMB, NO(a)3-3276 dated 18 April, 1945.

The airplane was to be very similar to the prototype airplane, with a few changes, among them improved electronics.

The detailed specification for the BT25-1, SD-372-1, dated 27 April, 1945, was approved by all concerned in May, 1945.

Here again the contractor proceeded to expedite the program. By 31 July, 1945, the status was as follows: (1) 90 BT-1 engines released to Tool Planning, (2) 140 release from Tool Planning to Tool Design and Fabrication, (3) 2,325 tools ordered to date, (4) 1,832 tools in fabrication, and 2,272 tools completed, out of an estimated 10,500 tools required for production.

After the surrender of Japan, the quantity of BT25-1 airplanes was reduced from 348 to 277, while the serial numbers to Serial 6-28366, dated 26 September, 1945, further put the program back to 277 BT25-1 airplanes. On 1 November this quantity was still in effect.

The outlook of the program and the war and had the obvious result of closing down the production program, especially with the return to the European area. The Letter of Intent for Contract NO(a)3-5555 called for delivery dates of follow:

March 1946  4 airplanes
April 1946  10 airplanes
May 1946  16 airplanes
June 1946  25 airplanes and 5 per month thereafter

Although the contractor had originally set target completion date of 4 to 5 weeks ahead of this schedule, it was doubtful that he could meet them.

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Declassified under NND 913043
Since the Victory over Japan, the production BTM-1 contract has been cut back from 750 airplanes to 99 airplanes. The first production plane is due to be completed in March, 1946.

This contract called for a total of 394 BTM-1 airplanes to be built in accordance with the specifications 52-232-1 dated 26 November, 1941. Contract 520-1-4297 was later superseded together with all its amendments by a new contract, AGA(s)-743, dated 5 August, 1943. Contract AGA(s)-743 increased the total number of BTM-1 airplanes to 99 which were to be delivered in accordance with the following schedule:

<table>
<thead>
<tr>
<th>Month</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>December, 1943</td>
<td>32</td>
</tr>
<tr>
<td>January, 1944</td>
<td>52</td>
</tr>
<tr>
<td>February, 1944</td>
<td>71</td>
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<tr>
<td>March, 1944</td>
<td>97</td>
</tr>
<tr>
<td>April, 1944</td>
<td>104</td>
</tr>
<tr>
<td>May, 1944</td>
<td>117</td>
</tr>
<tr>
<td>June, 1944</td>
<td>118</td>
</tr>
<tr>
<td>July, 1944</td>
<td>10</td>
</tr>
</tbody>
</table>

The guarantees given in the contract were:

1. Weight empty: 13,710 lbs.
2. Vmax at A.O.A.: with military power = 361 mph
3. T.O. in 25 knots, wind = 325 ft. (at about 15,000 lbs.)

These guarantees were based on the Wright R-1820-14 engine (two each) delivering:

1. 2300 BHP for takeoff
2. 2200 BHP military power
3. 2200 BHP normal rated power

These BTM-1 airplanes were to be very similar to the previous models, the B25D-1 airplanes. The history of the B25D-1 airplane program was such that all of the experimental airplanes were made about delivery and overweight (e.g., B25D-1 airplanes) apply here also. Some of the important changes that were made during the design stage were:

1. Change in the fixed forward-firing guns to 2-20 mm .30 guns with 200 rds./min in May, 1942.
2. Change to 10-bladed Hamilton Standard propeller in June, 1943, because of the difficulty in producing the 9-bladed propeller called for in the detail specifications.
B. Production Airplanes

5 - MODEL BT2D-1 AIRPLANE

General

As stated previously, in March 1945, the Bureau of Aeronautics was discussing the contractor's proposal to send him a release for 548 model BT2D-1 airplanes to assure a smooth changeover in the manufacture of experimental to production airplanes. On 4 April, 1945, a Procurement Directive, EN11-2674-45 Serial 55556, for 548 BT2D-1 airplanes was released and the contractor received a Letter of Intent for Contract NOa(s)-6539, Aer-PR-2-EMR, NOa(s)-6539 dated 18 April, 1945.

The airplane was to be very similar to the prototype airplanes, with a few changes, among them improved electronics.

The detail specification for the BT2D-1, SD-379-1, dated 19 April, 1945, was approved by all concerned in May, 1945.

Here again the contractor proceeded to expedite the program. By 31 July, 1945, its status was as follows: (1) 99.8% engineering released to Tool Planning, (2) 55.7% release from Tool Planning to Tool Design and Fabrication, (3) 9332 tools ordered to date, 6760 tools in fabrication, and 2572 tools completed, out of an estimated 19,500 tools required for production.

After the surrender of Japan, the quantity of BT2D-1 airplanes was reduced from 548 to 377. Confidential Directive EN11-2428-46, Serial C-26866, dated 26 September, 1945, further cut the program back to 277 BT2D-1 airplanes. On 1 November this quantity was still in effect.

The cutback of the program and the war's end had the obvious result of slowing down the production program, especially with the return to the 40-hour week. The Letter of Intent for Contract NOa(s)-6539 called for delivery dates as follows:

<table>
<thead>
<tr>
<th>Month</th>
<th>1946</th>
<th>Planes</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td></td>
<td>6 airplanes</td>
</tr>
<tr>
<td>April</td>
<td></td>
<td>10 airplanes</td>
</tr>
<tr>
<td>May</td>
<td></td>
<td>16 airplanes</td>
</tr>
<tr>
<td>June</td>
<td></td>
<td>25 airplanes and 25 per month thereafter</td>
</tr>
</tbody>
</table>

Although the contractor had originally set target completion date of 4 to 6 weeks ahead of this schedule, it was doubtful that he would meet them.