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RESEARCH MEMORANDUM

for the

Air Materiel Command, U. S. Air Force

SUPPLEMENTARY DITCHING INVESTIGATION OF A $\frac{1}{18}$-SCALE MODEL OF THE NORTH AMERICAN B-45 AIRPLANE

By Lloyd J. Fisher and William C. Thompson

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NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS

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SUMMARY

A supplementary investigation of a $\frac{1}{18}$-scale dynamically similar model of the North American B-45 airplane was made in calm water to observe the ditching behavior and to determine the effect of further conditions of simulated damage. The behavior of the model was determined from motion-picture records, time-history deceleration records, and visual observations.

It was concluded that, during a ditching, the nose-wheel doors, bomb-bay doors, under surface of the aft fuselage and lower part of the bomb-bay aft bulkhead will be torn away. When such damage occurs, the diving found in the previous tests will not occur and the airplane will porpoise during the first third of the landing run and then run smoothly. Because of the extensive damage which occurs, the fuselage aft of the pilots' compartment will fill with water very rapidly and is, therefore, an undesirable ditching station. No change in the previously recommended ditching attitude and flap setting (6° attitude, flaps down) is indicated by these supplementary tests.

INTRODUCTION

A model ditching investigation of the North American B-45 airplane is reported in reference 1. Undesirable ditching behavior was obtained in that investigation primarily because of the failure of the bomb-bay doors. The doors were made approximately scale strength and when they failed diving was produced.

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In seeking methods to alleviate the diving it was found that when a part of the fuselage just aft of the bomb bay was removed from the model it did not dive. Strength data obtained from North American Aviation, Inc. since the publication of reference 1 indicated that the bulkhead and fuselage bottom just aft of the bomb bay might fail in a ditching. A supplementary model investigation was therefore made in calm water at the Langley tank no. 2 monorail with the area in question approximately scale strength. A three-view drawing of the B-45 airplane is shown in figure 1.

APPARATUS AND PROCEDURE

Description of Model

The $\frac{1}{18}$-scale dynamic model of the B-45 airplane described in reference 1 was used in the present investigation. As in the previous tests, the bomb-bay doors and nose-wheel doors were removed and replaced by approximately scale-strength sections. To investigate the effect of further damage, part of the under surface of the fuselage between fuselage stations 475 and 600 was removed and replaced by an approximately scale-strength section. (See fig. 2.) The full-scale ultimate strength of this section was estimated by the manufacturer as 2.8 pounds per square inch. Part of the bomb-bay aft bulkhead (station 475) below water line -24.12 (see fig. 2) also was attached so that it would fail at approximately scale strength. The manufacturer estimated the bulkhead to have a full-scale ultimate strength of 2.1 pounds per square inch.

Test Methods and Equipment

The model was ditched by catapulting into the air to permit a free glide onto the water. The model left the launching carriage at scale speed and the desired landing attitude. The control surfaces were set so the attitude did not change appreciably in flight. The behavior was recorded by a motion-picture camera, from visual observations, and by a single-component time-history accelerometer installed in the pilots' compartment. The accelerometer had a natural frequency of 20 cycles per second and was damped to about 65 percent of critical. The reading accuracy of the instrument was $\pm\frac{1}{2}g$.

Test Conditions

(All values are full scale.)

Weight.- The design gross weight of 82,600 pounds was simulated in the investigation.

Moments of inertia.- The moments of inertia corresponded approximately to the following values:

Roll, slug-feet^2	540,000
Pitch, slug-feet^2	310,000
Yaw, slug-feet^2	830,000

Center of gravity.- The center of gravity was located at 28.8 percent of the mean aerodynamic chord and 18.5 inches above the thrust line of the engines.

Landing attitude.- An attitude of 6° (near lift-curve stall) was used in the investigation and was measured between the fuselage reference line and the smooth-water surface.

Flaps.- All tests were made with the landing flaps in the down position attached at scale strength.

Landing speed.- The landing speed as computed from design lift curves is 137 miles per hour. The model was air-borne when launched and within ±10 miles per hour of this speed.

Landing gear.- All tests simulate ditchings with the landing gear retracted.

Model configuration.- The model was tested with the nose-wheel doors, bomb-bay doors, part of the aft under surface of the fuselage, and bomb-bay aft bulkhead approximately scale strength (see fig. 2).

RESULTS AND DISCUSSION

A summary of the results of the investigation is presented in table I. The notations used in the table are defined as follows:

Porpoised - oscillated about the transverse axis with some part of of the model remaining in contact with the water at all times.

Ran smoothly - made no apparent oscillation about any axis and the model gradually settled into the water as the forward velocity decreased.

In the present investigation, the model porpoised during the first third of the landing run and then ran smoothly, gradually settling into the water as the forward velocity decreased. The maximum longitudinal deceleration was about 3g (see fig. 3) and the total length of landing run was about 600 feet (full scale). Sequence photographs of a typical run are shown in figure 4. Usually, the scale-strength covering was torn from the nose-wheel doors, bomb-bay doors, and aft fuselage section and the scale-strength section of the bomb-bay aft bulkhead was torn away. (See fig. 5.) It is possible that further damage might occur in a ditching, but unless the fuselage breaks in two (which seems unlikely), the behavior is not expected to be substantially different. When damaged, the fuselage aft of the pilots' compartment filled with water very rapidly making it undesirable as a ditching station.

The present behavior is in sharp contrast to that obtained in reference 1 where the model dived violently when the bomb-bay doors failed but the aft fuselage and bomb-bay aft bulkhead did not fail. The present tests do not indicate any change in the recommended ditching attitude and flap setting given in reference 1 (6° attitude, flaps down).

CONCLUSIONS

The supplementary ditching investigation made with a $\frac{1}{18}$-scale model of the North American B-45 airplane having additional fuselage area at scale strength indicates the following conclusions:

1. During the ditching, the nose-wheel doors, bomb-bay doors, under surface of the aft fuselage, and lower part of the bomb-bay aft bulkhead will be torn away.

2. When such damage occurs, the diving found in the previous tests will not occur and the airplane will porpoise during the first third of the landing run and then run amoothly.

3. Because of the extensive damage which occurs, the fuselage aft of the pilots' compartment will fill with water very rapidly making it undesirable as a ditching station.

4. No change in the previously recommended ditching attitude and flap setting (6° attitude, flaps down) is indicated by these supplementary tests.

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REFERENCE

1. Fisher, Lloyd J., and Thompson, William C.: Ditching Investigation of a $\frac{1}{18}$-Scale Model of the North American B-45 Airplane. NACA RM SL9L22a, U. S. Air Force, 1949.

TABLE I

SUMMARY OF RESULTS OF SUPPLEMENTARY DITCHING INVESTIGATION IN CALM WATER OF A $\frac{1}{18}$-SCALE DYNAMIC MODEL OF THE NORTH AMERICAN B-45 AIRPLANE

[Gross weight, 82,600 lb; landing flaps, full down; all values, full scale]

Model configuration	Landing attitude (deg)	Landing speed (mph)	Maximum longitudinal deceleration (g)	Length of landing run (ft)	Motions of the model
Approximately scale-strength nose-wheel doors, bomb-bay doors aft fuselage under surface, and bomb-bay aft bulkhead	6	137	3	600	Porpoised then ran smoothly

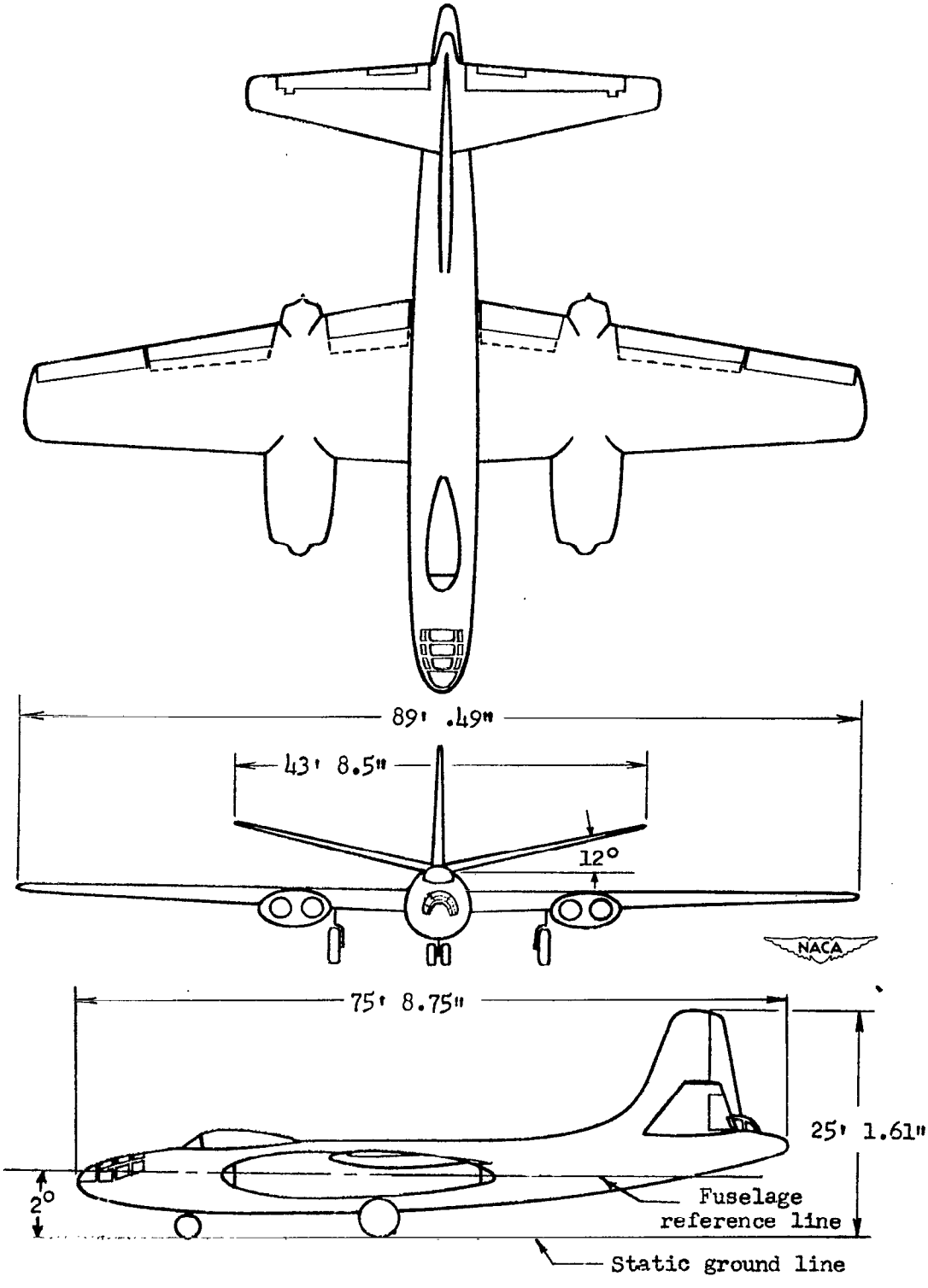


Figure 1.- Three-view drawing of the North American B-45 airplane.

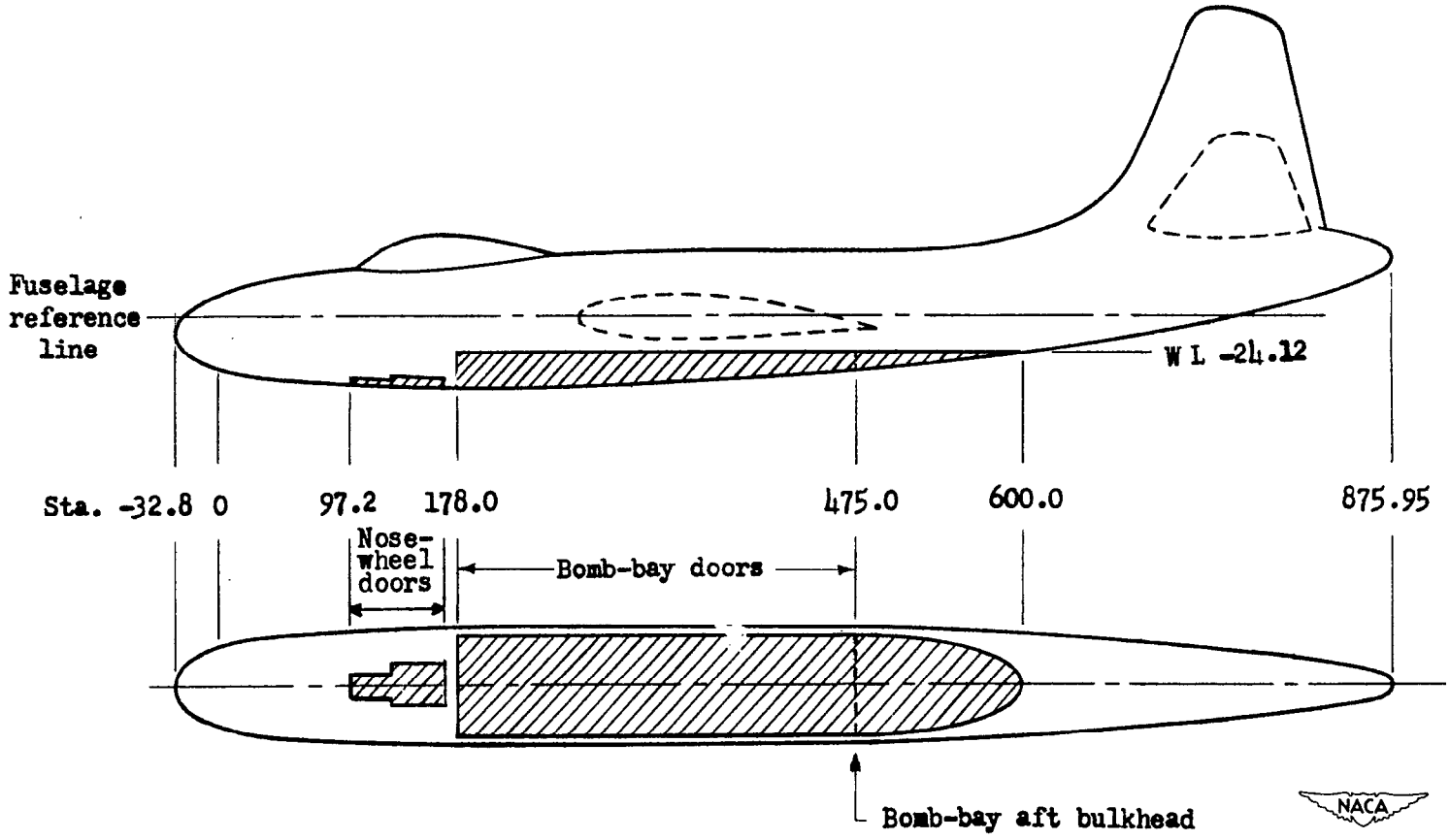


Figure 2.- Model fuselage showing scale-strength sections. Dimensions are in inches; all values are full scale.

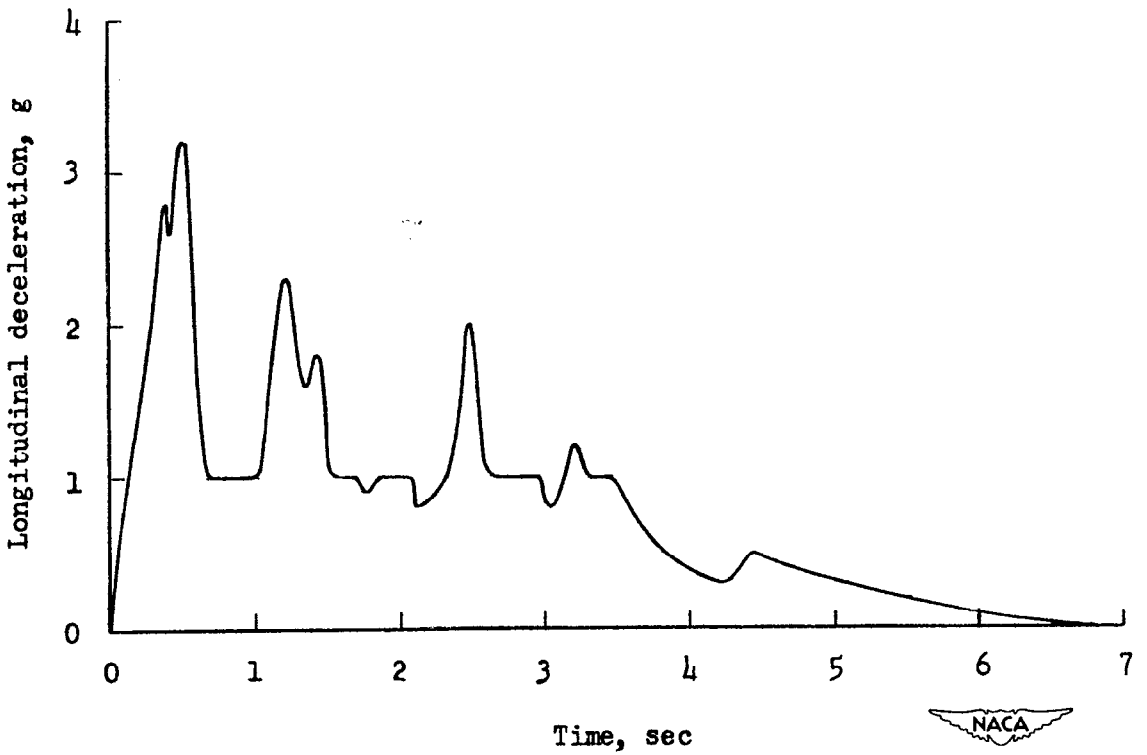
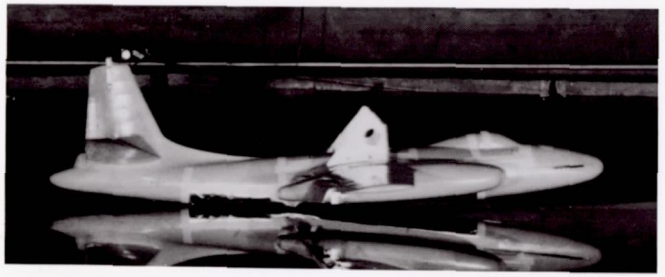
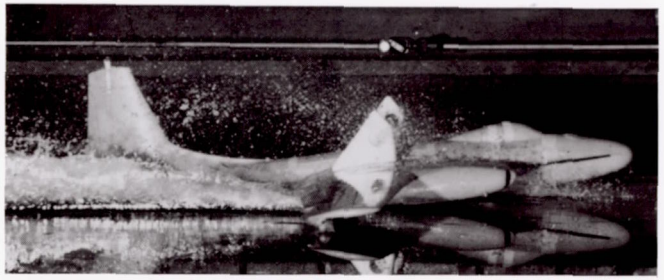


Figure 3.- Longitudinal deceleration for typical ditching with scale-strength nose-wheel doors, bomb-bay doors, aft fuselage section, and bomb-bay aft bulkhead. Landing attitude, 6°; landing speed, 137 miles per hour. All values are full scale.



Near contact

320 feet



460 feet

600 feet

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Figure 4.- Sequence photographs of model ditching with scale-strength nose-wheel doors, bomb-bay doors, aft fuselage section and bomb-bay aft bulkhead. Landing attitude, 6°; landing speed, 137 miles per hour. All values are full scale.

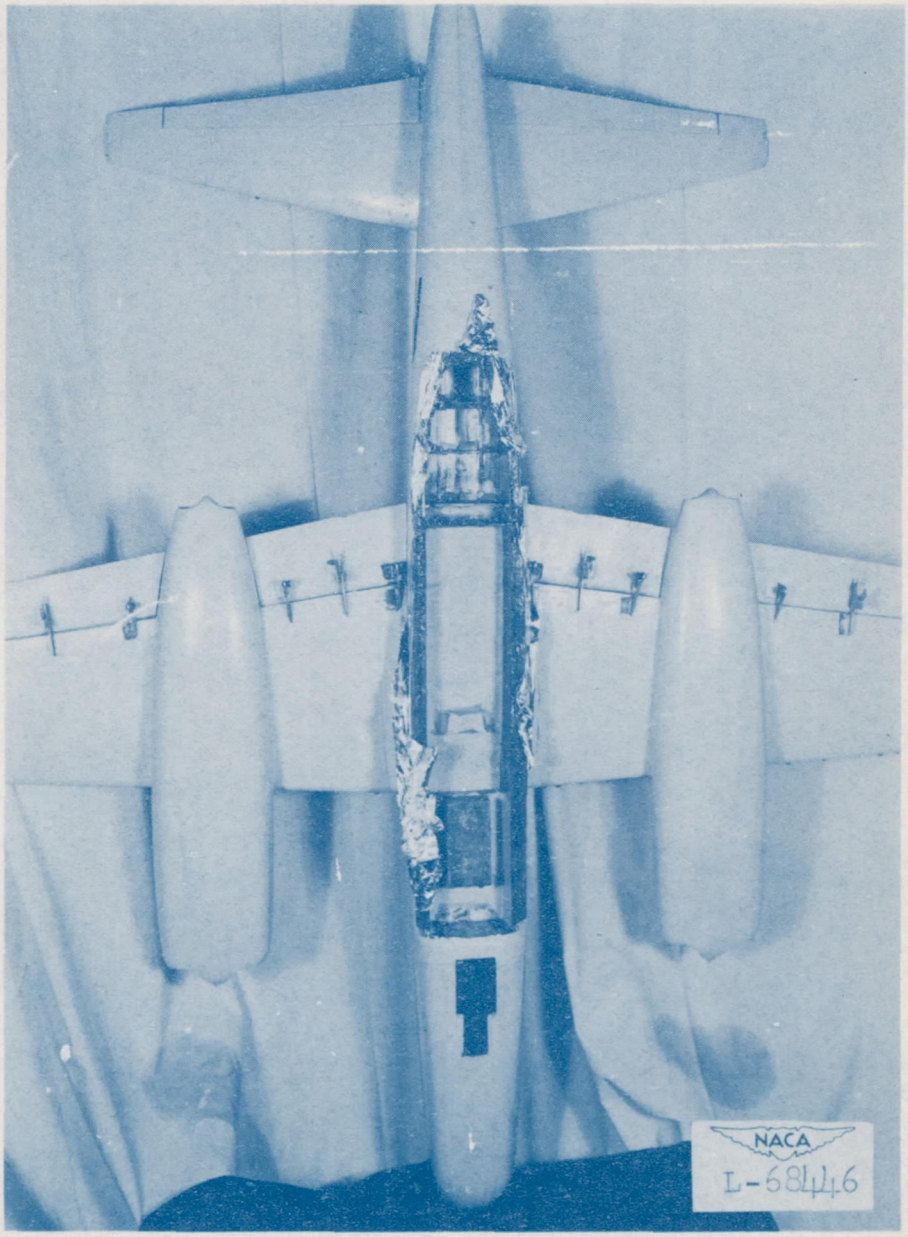

Figure 5.- Typical damage which occurred to the scale-strength sections.