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RESEARCH MEMORANDUM

for the

Civil Aeronautics Administration

DITCHING TESTS OF A $\frac{1}{18}$-SCALE MODEL OF THE LOCKHEED CONSTELLATION AIRPLANE WITH SPEEDPAK ATTACHED

By Lloyd J. Fisher and William C. Thompson

Langley Aeronautical Laboratory
Langley Air Force Base, Va.

NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS

WASHINGTON
AUG 9 1949

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SUMMARY

Tests of a $\frac{1}{18}$-scale dynamically similar model of the Lockheed Constellation airplane with Speedpak attached were made in Langley tank no. 2 to investigate the ditching characteristics and to determine the proper ditching technique of the airplane as influenced by the Speedpak. The Speedpak was attached to the model with scale-strength connections. Two models of the Speedpak were used. One was of rigid construction and the other was constructed so that scale-strength bottoms could be fitted on the lower portion.

The behavior of the model was determined from visual observations, longitudinal deceleration records, and motion pictures of the ditchings. Data are presented in tabular form, time-history deceleration curves, and photographs.

It was concluded that the airplane with the Speedpak attached should be ditched at a medium nose-high landing attitude with the landing flaps full down. The airplane will probably make a smooth run and settle in fairly deep near the end of the run. The Speedpak bottom will be damaged considerably. However, the bottom of the airplane fuselage will probably be damaged relatively little in reasonably smooth water because of the protection afforded by the Speedpak. Maximum longitudinal deceleration in a calm-water ditching will be about $1\frac{1}{2}g$. The airplane will tend to make a better ditching with the Speedpak attached than without it.

INTRODUCTION

Results of previous model ditching tests of the Lockheed Constellation airplane are reported in reference 1. Further model tests have been made to determine the probable ditching characteristics and the proper ditching technique for the airplane with the Speedpak attached. This paper presents the results of these tests.

Design information was furnished by the Lockheed Aircraft Corporation. A three-view drawing of the airplane with the Speedpak attached is shown in figure 1. The tests were made in calm water at the Langley tank no. 2 monorail.

APPARATUS AND PROCEDURE

Description of Model

The $\frac{1}{18}$-scale airplane model (with scale-strength landing flaps) used in the tests of reference 1 was also used in the present tests. Two models of the Speedpak were tested; they were 22.51 inches long, 4.92 inches wide, and had a gross weight of 1.71 pounds. Internal ballast was used in the Speedpak models to obtain scale weight. One of the Speedpak models was a rigid model of hollowed out construction with a minimum wall thickness of 0.6 inch. A photograph of the rigid Speedpak is shown attached to the airplane model in figure 2. The other Speedpak model was constructed so that a scale-strength bottom could be fitted on the lower portion. The scale-strength Speedpak bottom was constructed of cardboard bulkheads and balsa stringers and was covered with aluminum foil. The strength of the bottom of the Speedpak was estimated by the manufacturer as 5 pounds per square inch (full scale). The bottom of the scale-strength Speedpak was designed to fail under a model load corresponding to this. Photographs of the scale-strength Speedpak are shown in figures 3 and 4. Each Speedpak was attached to the airplane model at scale strength with thread of known strength. The required strength was determined by calculating the ultimate strength of the minimum cross-section area of the full-scale Speedpak connections. It was found that the forward connections would fail under a load of 66,000 pounds and the aft connections would fail under a load of 30,000 pounds (full scale). A detail drawing of the method of scale-strength attachment is shown in figure 5.

Test Methods and Equipment

The model was ditched by catapulting it into the air so that it was free to glide onto the water. The model was launched at scale speed and the desired landing attitude, and the control surfaces were set so that this attitude did not change appreciably while the model was in the air. The behavior was determined by means of visual observation, motion-picture records, and longitudinal-deceleration records.

Test Conditions

(All values are full scale)

Weight.- A gross weight corresponding to a full-scale value of 93,000 pounds was used in the tests. The airplane weight was 83,000 pounds and the Speedpak weight was 10,000 pounds.

Center of gravity.- The fore and aft location of the center of gravity of the airplane without the Speedpak was at 25 percent of the mean aerodynamic chord; the vertical location was 23 inches above the thrust line of the inboard engines. The Speedpak was ballasted so that it did not change the fore and aft location of the center of gravity, but its additional 10,000 pounds weight caused the vertical position to be lower by an amount approximating that obtained in actual use.

Landing attitude.- The landing attitude is the angle between the fuselage reference line and the smooth-water surface. Three landing attitudes were investigated: 12° (near stall), 9° (intermediate), and 4° (three-wheel static).

Flaps.- Tests were made with landing flaps up and full down.

Landing speed.- The landing speeds are listed in table I. These speeds were computed from lift curves furnished by the manufacturer.

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

Model configurations.- Both the scale-strength and the rigid Speedpak were tested. The rest of the airplane model (except landing-flap attachments) was made without regard to scale strength and remained undamaged during the tests.

RESULTS AND DISCUSSION

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

b ran deeply – the model moved through the water partially submerged exhibiting a tendency to dive although the attitude did not change appreciably.

d dived slightly – the nose of the model was submerged in the water, and the angle between the water surface and the fuselage reference line was approximately 20°. The wing of the model was partially submerged.

h ran smoothly – there was no apparent oscillation about any axis and the model gradually settled into the water as the forward velocity decreased.

s skipped – an undulating motion about the transverse axis in which the model cleared the water completely.

u trimmed up – the attitude of the model increased immediately after contact with the water.

Photographs showing characteristic behavior are given in figure 6. Typical time histories of longitudinal decelerations at various attitudes are given in figure 7. Photographs showing damage to the scale-strength Speedpak bottom at 9° and 12° landing attitudes are shown in figure 8.

Effect of Landing Flaps

When the flaps were full down, the inboard flaps (approx. one-half of the total flap area) always failed on landing. The flaps-down condition had no apparent detrimental effect on the ditching behavior of the model. The flaps-up condition resulted in a higher landing speed and a more violent behavior of the model. Full-down flaps should be used in a ditching because of the lower landing speed, and more stable and generally smoother runs thus obtained.

Effect of Damage and Attitude

When the model was tested with the rigid Speedpak attached, its ditching behavior was characterized by a trimming-up motion shortly after contact with the water. At the 4° attitude with flaps down and

9° attitude with flaps up, the trimming-up motion was so violent that it caused the model to skip. Under these conditions, both the fore and aft scale-strength connections to the Speedpak failed immediately after trimming up. At the 9° attitude with flaps down and the 12° attitude with flaps up or down the model trimmed up shortly after contact with the water, the aft scale-strength connection to the Speedpak failed but the forward connection did not fail (the strength of the forward connection was twice that of the aft connection), and then the model settled down to a moderate attitude. The latter half of the run was smooth and sometimes fairly deep.

When the model was tested with a scale-strength bottom attached to the Speedpak, the flexible Speedpak bottom absorbed enough of the landing forces so that neither of the scale-strength connections from the Speedpak to the model failed. At the 4° attitude, the model made a smooth run and dived slightly at the end of the run. Damage to the Speedpak bottom was considerably more at this attitude than at either of the higher attitudes. At the 9° and 12° attitudes, the model made smooth runs and settled in rather deeply near the end of the run. A comparison of figures 6(a) and 6(b) shows the behaviors of the model to be very similar at these two attitudes. Typical damage to the scale-strength Speedpak bottom at 9° and 12° landing attitudes is shown in figure 8. The resulting damage was about equal at both attitudes. The maximum longitudinal deceleration at the 9° attitude was about $1\frac{1}{2}$g and at the 12° attitude was about 2g. These values are shown in figures 7(a) and 7(b).

The 4° landing attitude is undesirable because of the excessive damage which occurs. There is very little difference in the damage and behavior of the model at the 9° and 12° landing attitudes; but since the decelerations are lower at 9°, it is recommended that a medium nose-high landing attitude be used in a ditching. This is the same as was recommended in reference 1 for landing without the Speedpak.

Effect of Speedpak

The model tests of reference 1 show that the under surface of the fuselage was damaged principally in the area between the leading edge and trailing edge of the wing. This portion of the fuselage is covered by the Speedpak; and since the Speedpak absorbs a considerable amount of the impact of a ditching, the bottom of the airplane will probably be damaged relatively little in reasonably smooth water.

The decelerations obtained when the model was ditched with the Speedpak attached were about $1\frac{1}{2}$g as compared to about 4g when the model

was ditched without the Speedpak; the length of landing run was also longer and the behavior was generally more favorable. (See reference 1.) The airplane will, therefore, tend to make a better ditching with the Speedpak attached than without it.

CONCLUSIONS

From the results of model tests the following conclusions were drawn:

1. The Lockheed Constellation airplane with Speedpak attached should be ditched at a medium nose-high landing attitude. The landing flaps should be full down. This technique is the same as that which was to be used without the Speedpak.

2. The airplane will generally make a smooth run and will settle in fairly deep near the end. This type of run is more favorable than that without the Speedpak.

3. The Speedpak bottom will be damaged considerably. The bottom of the airplane fuselage will probably be damaged relatively little in reasonably smooth water because of the protection afforded by the Speedpak.

4. The maximum longitudinal deceleration in a calm-water ditching will be about $1\frac{1}{2}$g with the Speedpak attached, as compared with about 4g without the Speedpak.

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jsf

REFERENCE

1. Fisher, Lloyd J., and Morris, Garland J.: Ditching Tests of a $\frac{1}{18}$-Scale Model of the Lockheed Constellation Airplane. NACA RM SL8K18, CAA, 1948.

TABLE I

SUMMARY OF RESULTS OF DITCHING TESTS IN CALM WATER OF A $\frac{1}{18}$-SCALE DYNAMIC MODEL

OF THE LOCKHEED CONSTELLATION AIRPLANE WITH SPEEDPAK ATTACHED

[Gross weight, 93,000 lb; all values, full scale]

Landing attitude, deg		4		9					12				
Landing speed, mph		110		147		98			124		90		
Configuration	Behavior[1] / Flap setting	Run	Mo	Run	Mo	Max	Run	Mo	Run	Mo	Max	Run	Mo
Rigid Speedpak	Up			830	s b				470	u h			
	Down	380	s d				390	u b				320	u h
Scale-strength Speedpak bottom	Down	670	h d			$1\frac{1}{2}$	490	h b			2	270	h b

[1]Behavior

Max maximum longitudinal decelerations, given in multiples of the acceleration of gravity

Run length of landing run given in feet

Mo motions of the model, denoted by the following symbols

- b ran deeply
- d dived slightly
- h ran smoothly
- s skipped
- u trimmed up

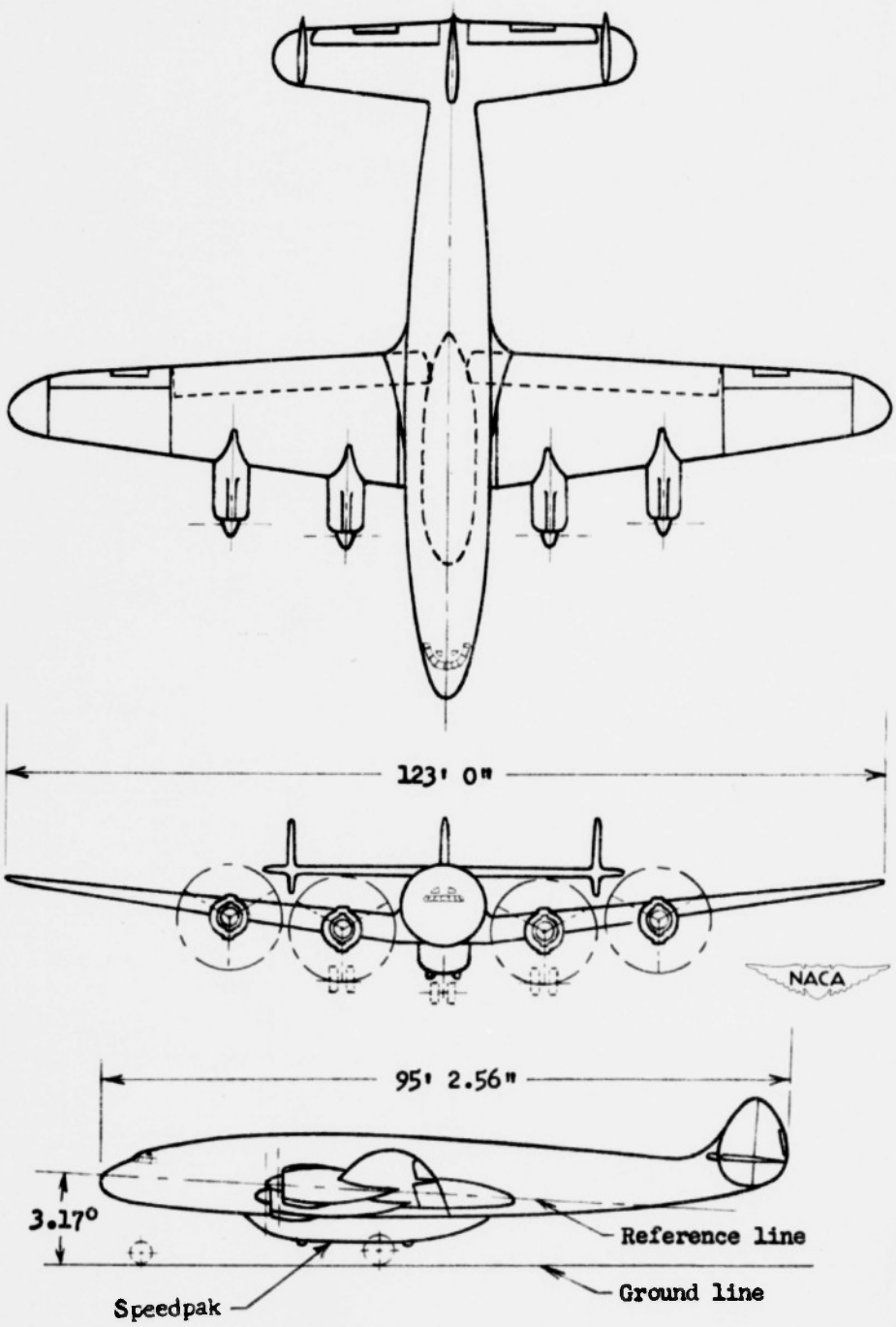


Figure 1.– Three-view drawing of the Lockheed Constellation with Speedpak attached.

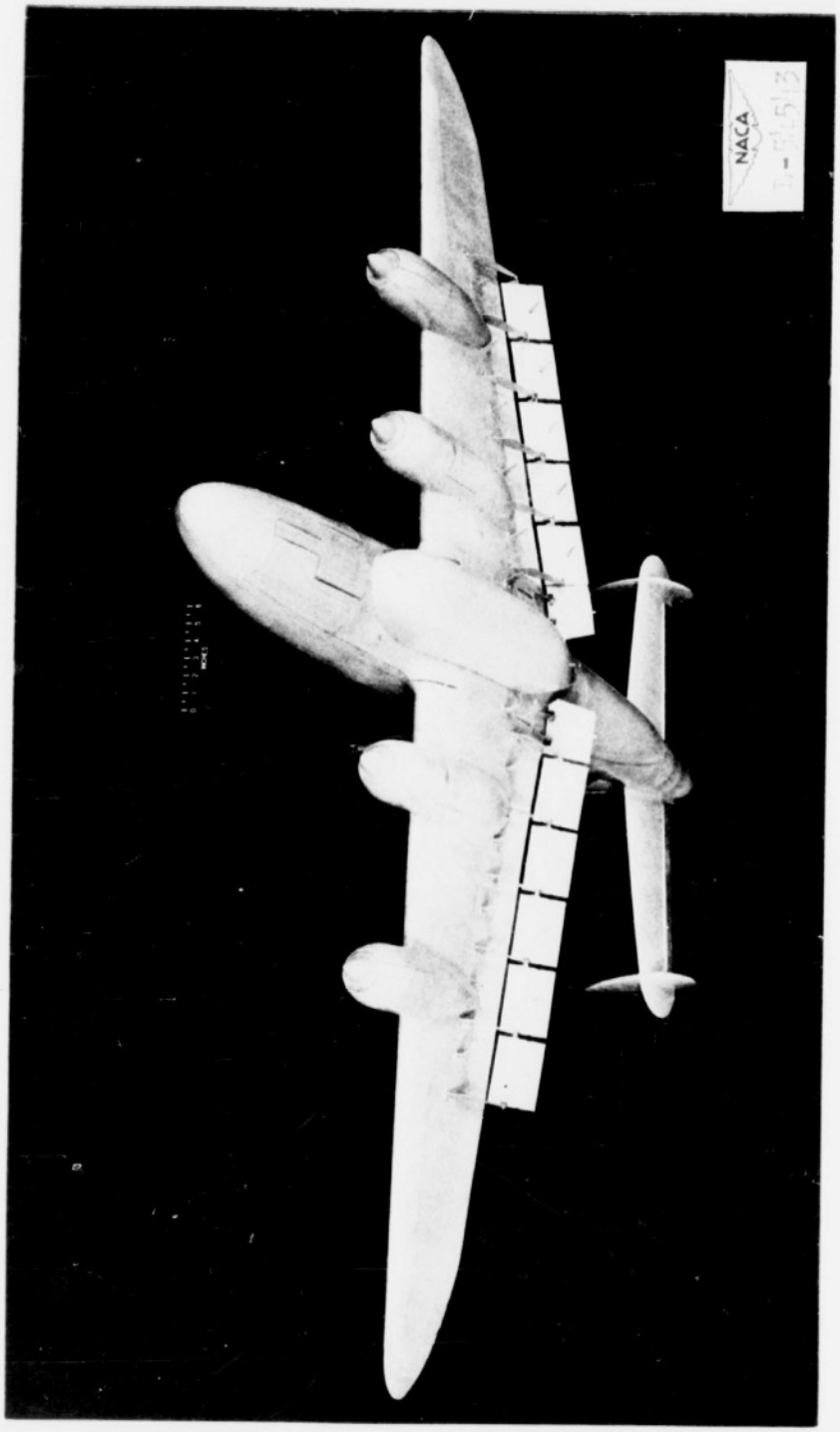


Figure 2.- Model with rigid Speedpak attached.

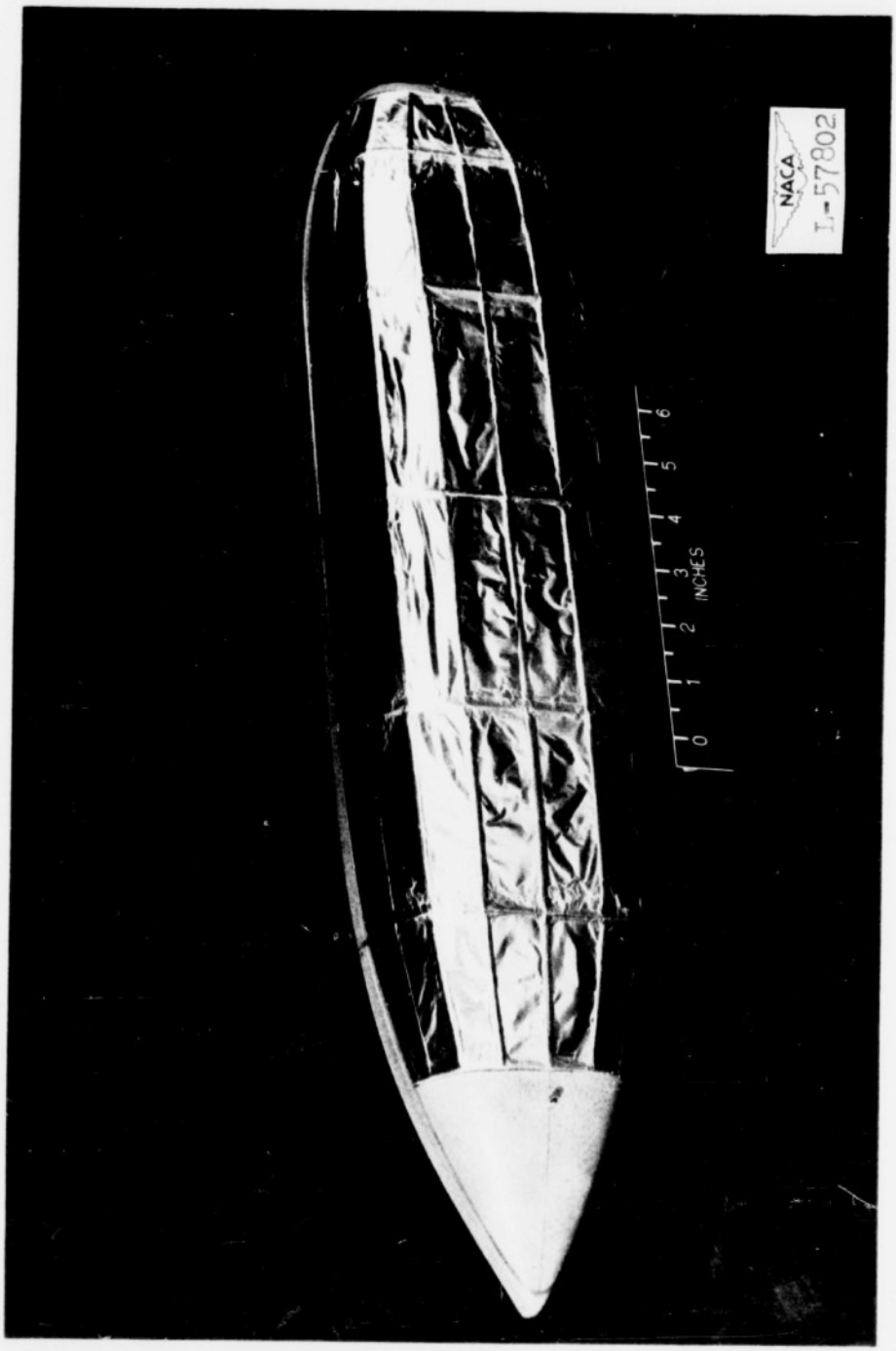


Figure 3.- Bottom view of Speedpak with scale-strength bottom attached.

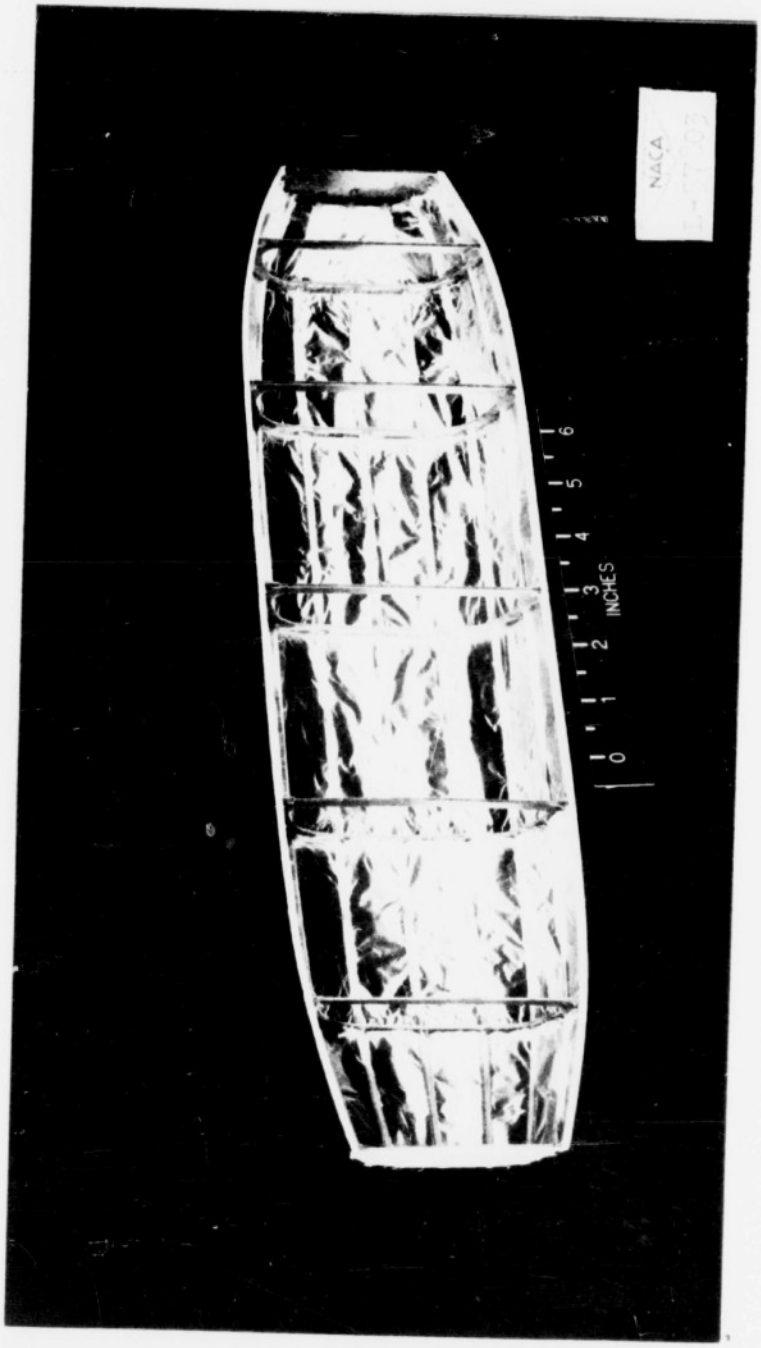


Figure 4.- Inside view of scale-strength Speedpak bottom.

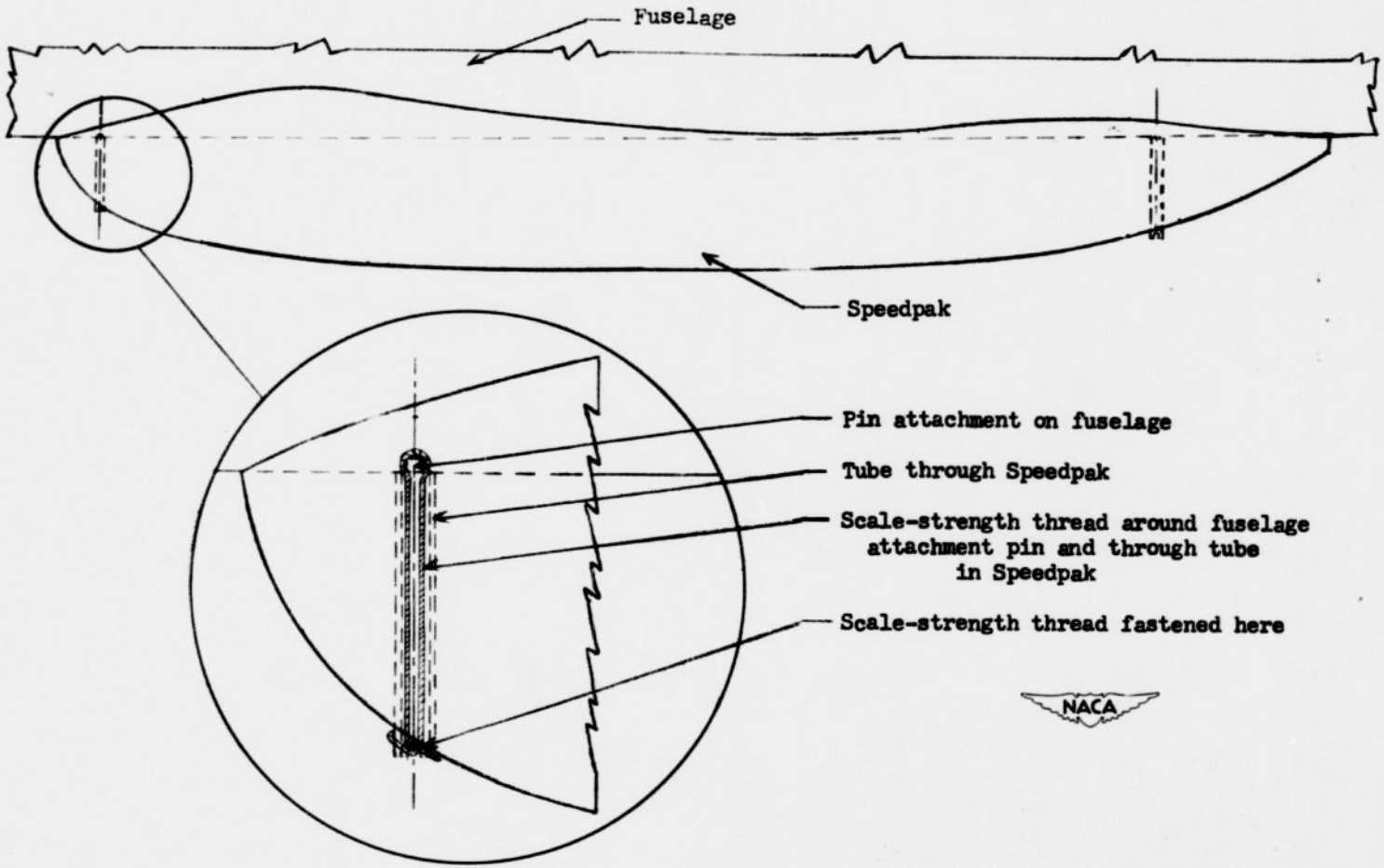
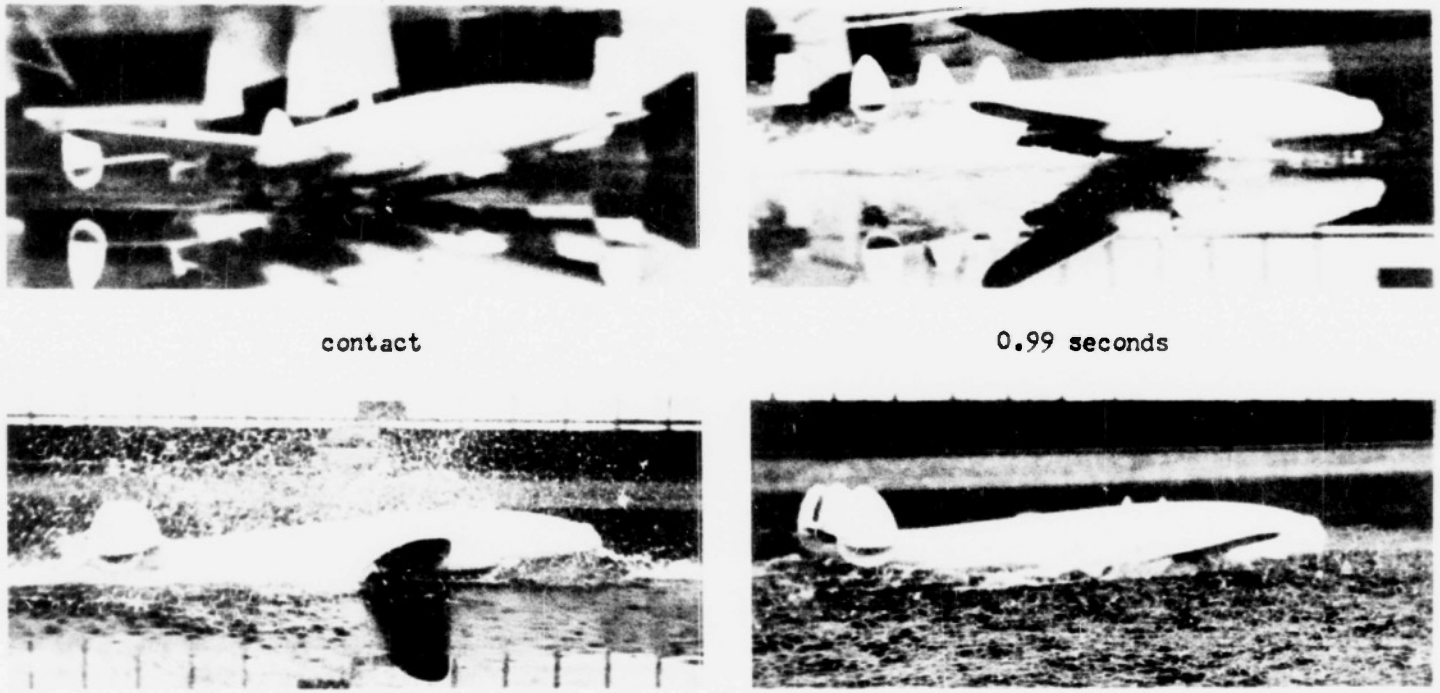


Figure 5.- Details of scale-strength attachment of Speedpak to model.



(a) Landing attitude 9°.

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Figure 6.- Sequence photographs at indicated time of model ditchings with scale-strength Speedpak bottom attached. Flaps are full down. All values are full scale.

contact

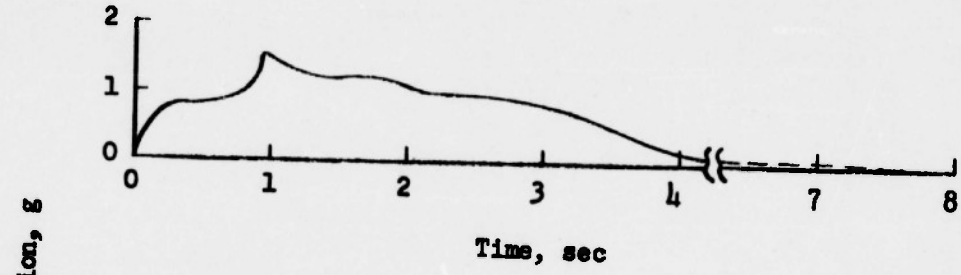
0.74 seconds

2.72 seconds

5.68 seconds

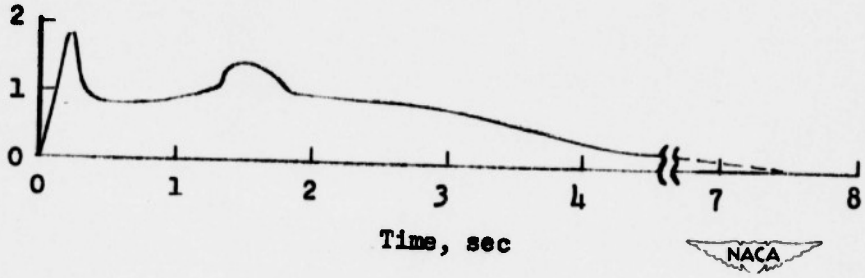
(b) Landing attitude 12°. L-60596

Figure 6.- Concluded.



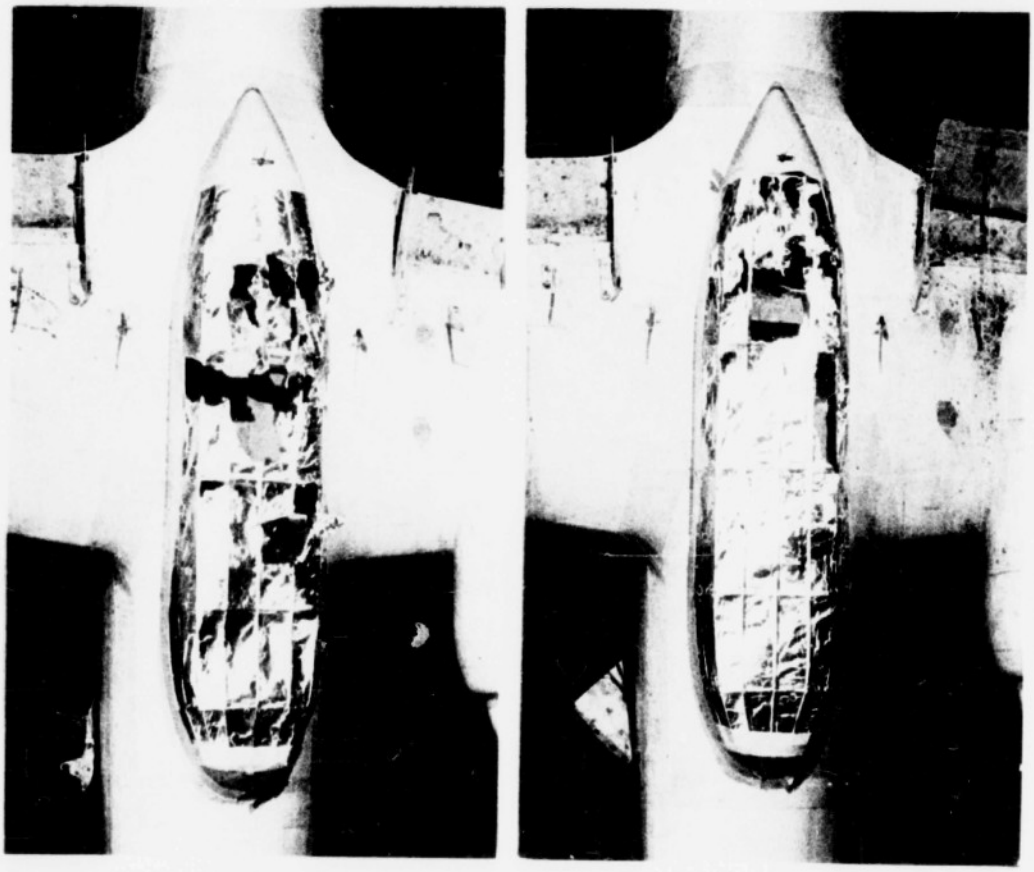
(a) 9° landing attitude; landing speed, 98.4 mph.

Longitudinal deceleration, g



(b) 12° landing attitude; landing speed, 90 mph.

Figure 7.– Longitudinal decelerations with scale-strength Speedpak bottom installed and flaps full down. All values are full scale.



(a) Landing attitude 9°.

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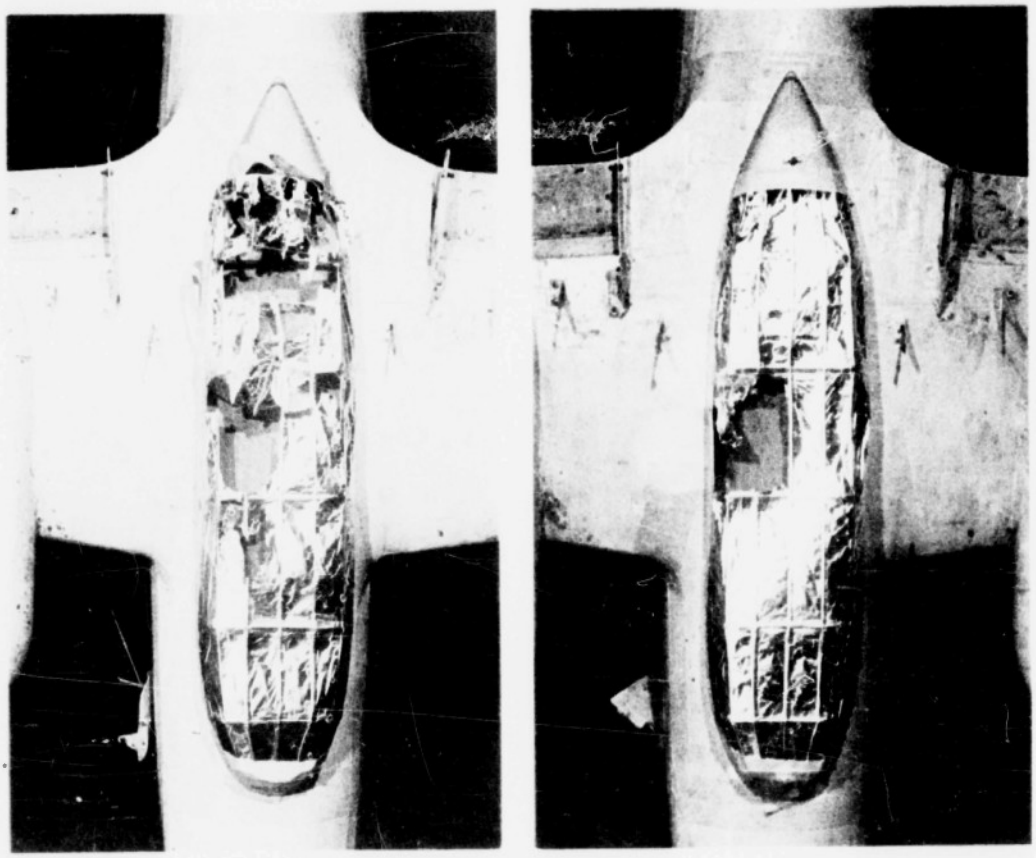
Figure 8.- Typical damage sustained by scale-strength bottom on Speedpak.



(b) Landing attitude 12°. L-60598

Figure 8.- Concluded.

Ditching Characteristics 2.9

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By Lloyd J. Fisher and William C. Thompson

NACA RM SL9H05a
August 1949

(Abstract on Reverse Side)

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