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RESEARCH MEMORANDUM

for the

Bureau of Aeronautics, Department of the Navy

DITCHING TESTS OF A $\frac{1}{8}$-SCALE MODEL OF THE CHANCE VOUGHT XF6U-1 AIRPLANE - TED No. NACA DE319

By

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NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS

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SUMMARY

Tests were made with a $\frac{1}{8}$-scale dynamically similar model of the Chance Vought XF6U-1 airplane to study its behavior when ditched. The model was ditched in calm water at the Langley tank no. 2 monorail.

Various landing attitudes, speeds, and conditions of damage were simulated. The behavior of the model was determined from visual observations, by recording time histories of the accelerations, and by taking motion pictures of the ditchings.

From the results of the tests it was concluded that the airplane should be ditched at the near-stall, tail-down attitude (12°). The flaps should be fully extended to obtain the lowest possible landing speed. The wing-tip tanks should be jettisoned. The underside of the fuselage will be critically damaged in a ditching and the airplane will dive violently after a run of about three fuselage lengths. Maximum longitudinal decelerations up to about 7g and maximum vertical accelerations up to about 5g will be encountered.

INTRODUCTION

Model tests were conducted in calm water at the Langley tank no. 2 monorail to determine the probable ditching performance of the Chance Vought XF6U-1 airplane and to determine the best way to land it on water. This airplane was also of interest as a typical jet-powered fighter incorporating wing-inlet ducts. A three-view drawing of the airplane is given in figure 1.

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The rather unconventional shape of the aft portion of the underside of the fuselage necessitated extensive investigation of its effect on the hydrodynamic behavior of the airplane. This was accomplished by testing the model with this portion undamaged, removed, and replaced with a scale-strength bottom and scale-strength engine-mounting system.

The tests were requested by the Bureau of Aeronautics, Department of the Navy. Design information on the airplane was furnished by Chance Vought Aircraft, United Aircraft Corporation.

APPARATUS AND PROCEDURE

Description of Model

A $\frac{1}{8}$-scale dynamic model of the XF6U-1, shown in figure 2, was furnished by the contractor according to NACA specifications. It was constructed of balsa wood and spruce and was ballasted internally to obtain scale weight and moments of inertia. The model had a wing span of 4.11 feet without wing-tip tanks and 4.49 feet with the tanks and an over-all length of 4.32 feet.

The flaps were hinged and held in the down position by a strand of thread of the required strength. When a load of 1.9 psi (full scale) was applied to the flaps the thread would break and the flaps would rotate to the neutral position.

The scale-strength bottoms used in the tests were made of thin balsa bulkheads and stringers covered with water-proofed paper. A photograph of a scale-strength bottom is shown in figure 3. One scale-strength section was made to replace two removable fuselage panels. Since the two fuselage panels were of different strength (one fails at 5 psi and the other fails at 6 psi), the scale-strength bottoms were built and intermittently checked to fail at 5.5 psi (full scale).

A drawing of the scale-strength engine-mounting system is shown in figure 4. Thread of required strength was passed through the two sets of tubes and tied at each end. The alinement plates assure correct alinement of the tubes and restrict any sideways motion or wobbling of the engine. When a load above the failing load, 10,000 pounds (full scale), was applied in either a fore or aft direction, the thread failed and allowed the engine to slip off the alinement plates.

The wing-tip tanks were attached to the model with hardwood dowels and tape. They were ballasted internally to simulate the weight of a full load of fuel.

Test Methods and Equipment

The model was launched by catapulting it from the tank no. 2 monorail. The model left the launching carriage at scale speed and at the desired landing attitude, and the control surfaces were set so that the attitude did not change appreciably in flight. The behavior of the model was recorded from visual observations and by a high-speed motion-picture camera. The longitudinal and vertical accelerations were measured by a time-history accelerometer placed in the pilot's cockpit.

Test Conditions

(All values given refer to the full-scale airplane.)

Gross weight.- Tests were made with the model weight corresponding to full-scale gross weights of 9706 pounds (normal weight) and 11,521 pounds (take-off weight with tip tanks). The majority of the tests were made at the normal-weight condition without tip tanks. The tests at the heavy-weight condition were made with the tip tanks installed.

Location of center of gravity.- The center of gravity was located at 31.0 percent of the mean aerodynamic chord and 5.75 inches above the thrust line.

Landing attitude.- The model was ditched at attitudes of 4°, 8°, and 12°. The 4° attitude is the three-wheel landing attitude. The 8° attitude is an intermediate landing attitude. The 12° attitude is near the stall angle. The attitude angle was measured between the thrust line and the water surface.

Flap deflection.- Tests were made with the flaps set at 27° and fastened at scale strength.

Landing speed.- The speeds were such that the model was airborne within ±10 knots of the landing speed calculated from the power-off lift curves obtained from the Chance Vought company.

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

Conditions of simulated damage.- Structural ultimate strengths of the doors and panels on the underside of the airplane in pounds per square inch are as follows:

Nose-wheel door	8
Gun-access door	6
Catapult door	8
Fuel-pump-access door	8
Main-landing-gear door	7
Arresting-gear bumper door	8
Engine-access panel	5
Engine removable panel	6

The location of these components is shown in figure 5. Their strength and location is such that they will probably fail in a ditching.

The model was tested with the following fuselage configurations:

(a) No simulated damage.

(b) Simulated failure of the nose-wheel door, gun-access doors, catapult doors, fuel-pump-access door, main-landing-gear doors, arresting-gear bumper door, engine-access panel, and engine removable panel.

(c) Same as (b) except the engine-access panel, the engine removable panel, and engine-mounting system are scale strength. It is expected that this configuration will most nearly approximate the damage that would occur in a full-scale ditching and will be referred to as the most probable condition of damage in presenting the test results.

(d) Same as (a) but with the addition of the wing-tip tanks.

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:

d_1 violent dive – a dive in which the wings are submerged and the angle between the water surface and the thrust line is greater than 15°

d_2 slight dive – a dive in which the wings are not completely submerged and the angle between the water surface and the thrust line is less than 15°

h smooth run – a run in which there is no apparent oscillation about any axis and during which the model settles gradually in the water as the forward velocity decreases p — porpoising – an undulating motion about the transverse axis in which some part of the model is always in contact with the water

s — skipping – an undulating motion about the transverse axis in which the model clears the water completely

u — trimmed up violently – a large rotation about the transverse axis immediately after contact

Typical time histories of longitudinal and vertical accelerations are given in figures 6, 7, and 8. Figure 9 contains photographs of the ditching damage sustained by the scale-strength bottoms. Photographs showing the characteristic motions of the model as obtained in tests with the scale-strength bottom are shown in figure 10.

Effect of Attitude and Damage

The initial motion of the model when ditched with no damage simulated was a severe trimming up. At the 4° and 8° landing attitudes this trimming up was followed immediately by a skip. The model then contacted the water at a high attitude and began a porpoising motion. At the 4° landing attitude this porpoising was rather violent. The skip did not occur at the 12° landing attitude; the model trimmed up, then began a slight porpoising motion as the trim decreased.

The time histories of vertical acceleration in figure 6 illustrate the behavior of the undamaged model. The first peak in all three curves was caused by the initial contact of the model with the water. The negative values following the initial peak were recorded during the period in which the model trimmed up. The second peak, occurring at about 1 to $1\frac{1}{2}$ seconds in curves (b) and (c), was caused by the contact of the model with the water after the skip. The series of smaller peaks occurred during the porpoising motions that followed. Figure 7 gives the typical longitudinal decelerations produced in ditching the undamaged model.

When failure of the nose-wheel door, gun-access doors, catapult doors, fuel-pump-access door, main-landing-gear doors, arresting-gear bumper door, engine-access panel and engine removable panel was simulated, the model dived violently after a run of about five fuselage lengths. This dive occurred at all three attitudes.

The configuration of the underside of the aft portion of the fuselage caused the difference in behavior at the two conditions. When this portion was undamaged, the model trimmed up and generally skipped; but when this portion was removed, the model dived violently. For this reason, the model was tested with scale-strength engine-access panel and engine removable panel and with the engine mounted at scale strength. At this condition the model continued to dive violently, the decelerations in the dive being less severe at the 12° attitude than at the other attitudes. (See fig. 8.)

The amount of damage to the scale-strength bottoms occurring at the three attitudes is shown in figure 9. The smallest amount of damage occurred at the 12° landing attitude. The damage at 8° was only slightly more than at 12°, but at the 4° attitude the bottom was completely torn away and the scale-strength engine was knocked out. The sequence photographs in figure 10 show that the dive at 4° was not so deep as at the higher landing attitudes. However, the lower speed, the lower decelerations, and the smaller amount of damage make 12° the preferable landing attitude for ditching.

Effect of Flaps

The flaps always failed and had no noticeable hydrodynamic effect on the ditching characteristics of the model. The lower airspeeds obtained with the use of flaps would be advantageous in a ditching.

Effect of Jet-Intake Ducts

Wing-inlet ducts would normally seem to be undesirable should need for a ditching arise. However, in the case of the XF6U-1, the wing inlets are of little consequence. When the model was tested at the undamaged condition, it trimmed up and the ducts did not enter the water until the forward motion of the model had practically stopped. In the damaged condition the diving motion produced by the damaged aft end appeared to have enough force to make any diving moment, produced by the ducts scooping water, practically negligible.

Effect of Wing-Tip Tanks

The results of the tests with wing-tip tanks installed show higher longitudinal decelerations than were obtained without the use of tanks. Since the motions of the model were not greatly affected by the tanks, this higher deceleration was due to the increase in weight and the corresponding increase in landing speed. Therefore, the wing-tip tanks should be jettisoned.

In the model tests, spray from both tanks converged upon the rear of the fuselage, seriously damaging the horizontal tail surface. Since this portion of the model was much stronger correspondingly than the full-scale airplane, this damage would likely occur in a full-scale ditching. The tanks were attached much stronger than scale strength and were sometimes torn away in the test ditchings.

CONCLUSIONS

From the results of the tests with a $\frac{1}{8}$-scale model of the Chance Vought XF6U-1 airplane the following conclusions were drawn:

(1) The airplane should be ditched at the near-stall, tail-down attitude (12°). The flaps should be fully extended to obtain the lowest possible landing speed. The wing-tip tanks should be jettisoned.

(2) The underside of the fuselage will be critically damaged in a ditching and the airplane will dive violently after a run of about three fuselage lengths. Maximum longitudinal decelerations up to about 7g and maximum vertical accelerations up to about 5g will be encountered.

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TABLE I.– SUMMARY OF RESULTS OF DITCHING TESTS IN CALM WATER

OF A $\frac{1}{8}$–SCALE MODEL OF THE CHANCE–VOUGHT XF6U–1 AIRPLANE

(All values full–scale; landing flaps 27°)

Landing attitudes, (deg)		12					8					4		
Configurations	Gross weight (lb)	Landing speed (knots)	Maximum accelerations (g)		Length of run (a)	Motions of model (b)	Landing speed (knots)	Maximum accelerations (g)		Length of run (a)	Motions of model (b)	Landing speed (knots)	Maximum accelerati (g)	
			Longi–tudinal	Vertical				Longi–tudinal	Vertical				Longi–tudinal	Ver
No damage	9,706	97.3	1.8	5.0	12	up	106.9	1.0	6.8	16	usp	124.3	2.0	7
Simulated failure of nose–wheel door, gun–access doors, catapult doors, fuel–pump access doors, main–landing–gear doors, arresting–gear door, engine–access panel and engine removable panel	9,706	97.3	8.0		5	d_1	106.9	8.0		5.5	d_1	124.3	9.0	
Same as above except the engine–access panel, engine removable panel, and engine–mounting system are scale strength	9,706	97.3	7.0		3	d_1	106.9	10.0		4.5	d_1	124.3	9.0	
No damage, wing–tip tanks installed	11,521	105.2	2.3		10	ush	116.4	6.0		14	ush			

[a]Length of run in fuselage lengths.

[b]Motions of the model are denoted by the following symbols:

- d_1 dived violently.
- d_2 dived slightly.
- h ran smoothly.
- p porpoised.
- s skipped.
- u trimmed up violently.

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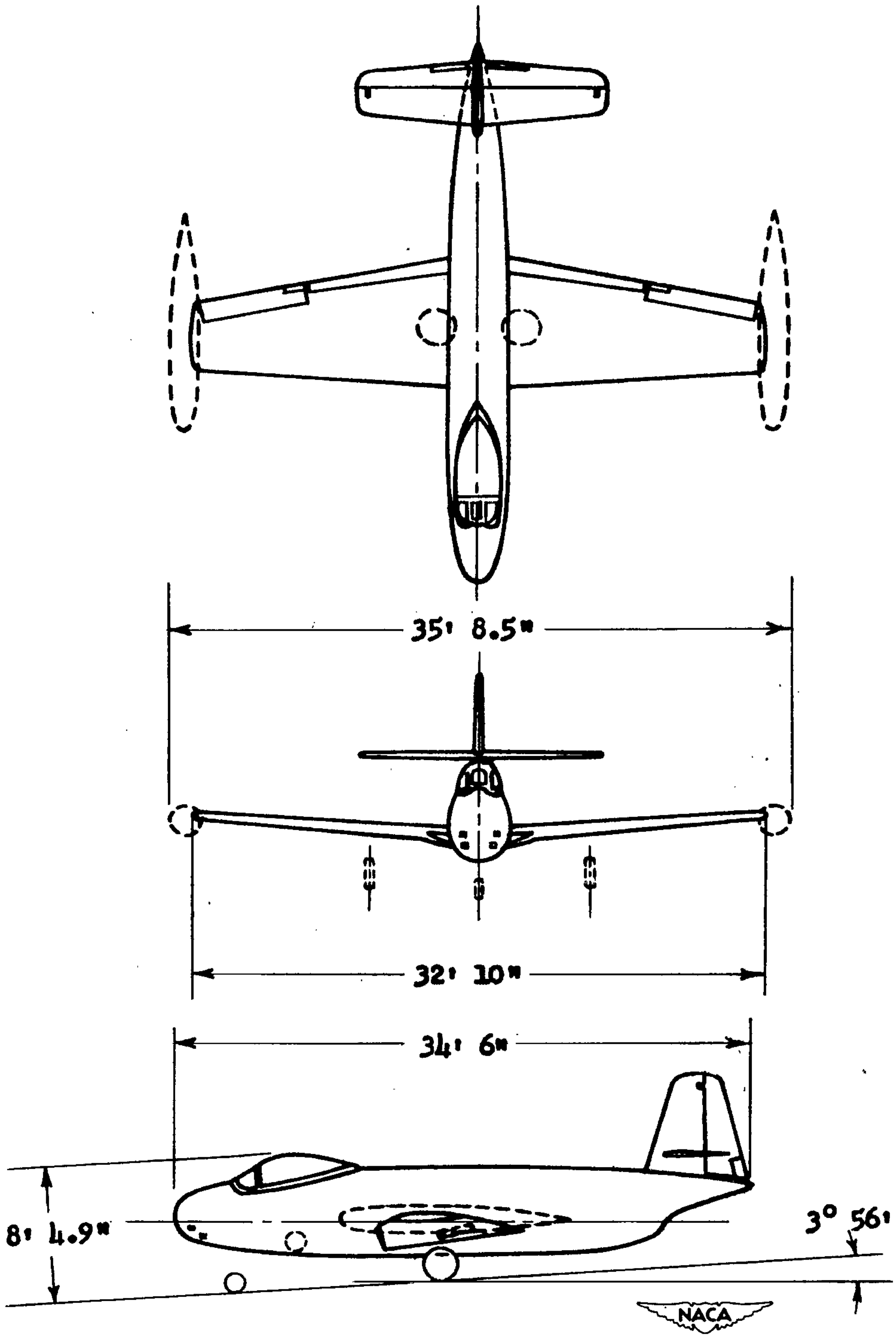

Figure 1.- Three-view drawing of the Chance Vought XF6U-1 airplane.

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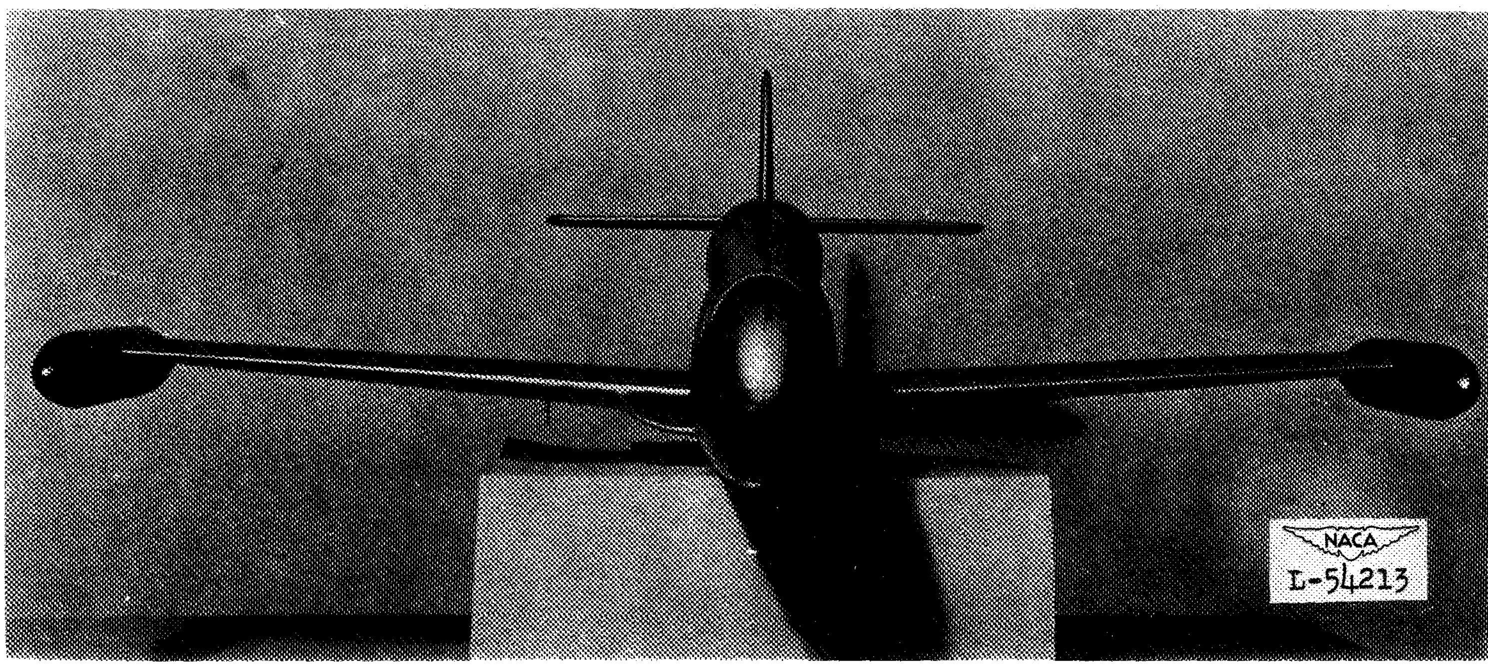
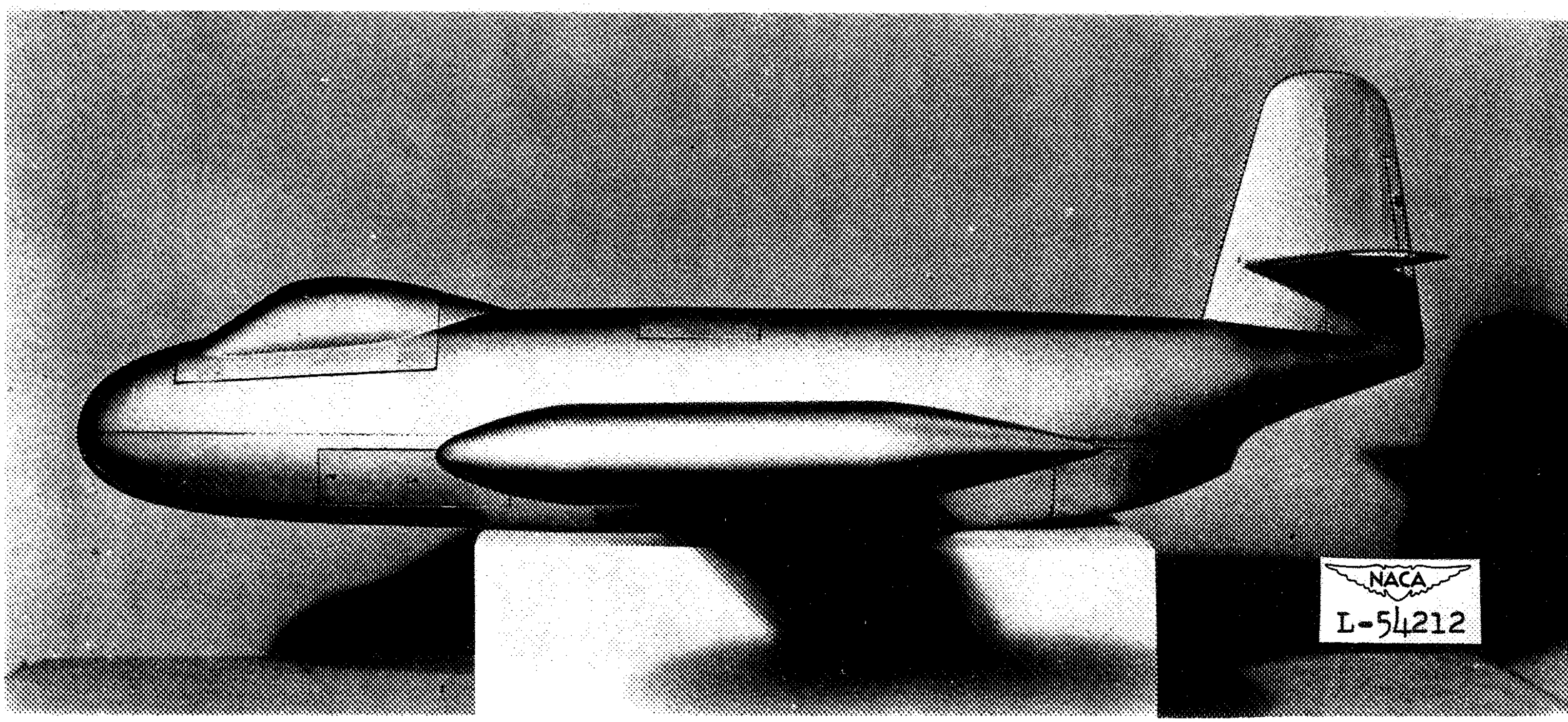


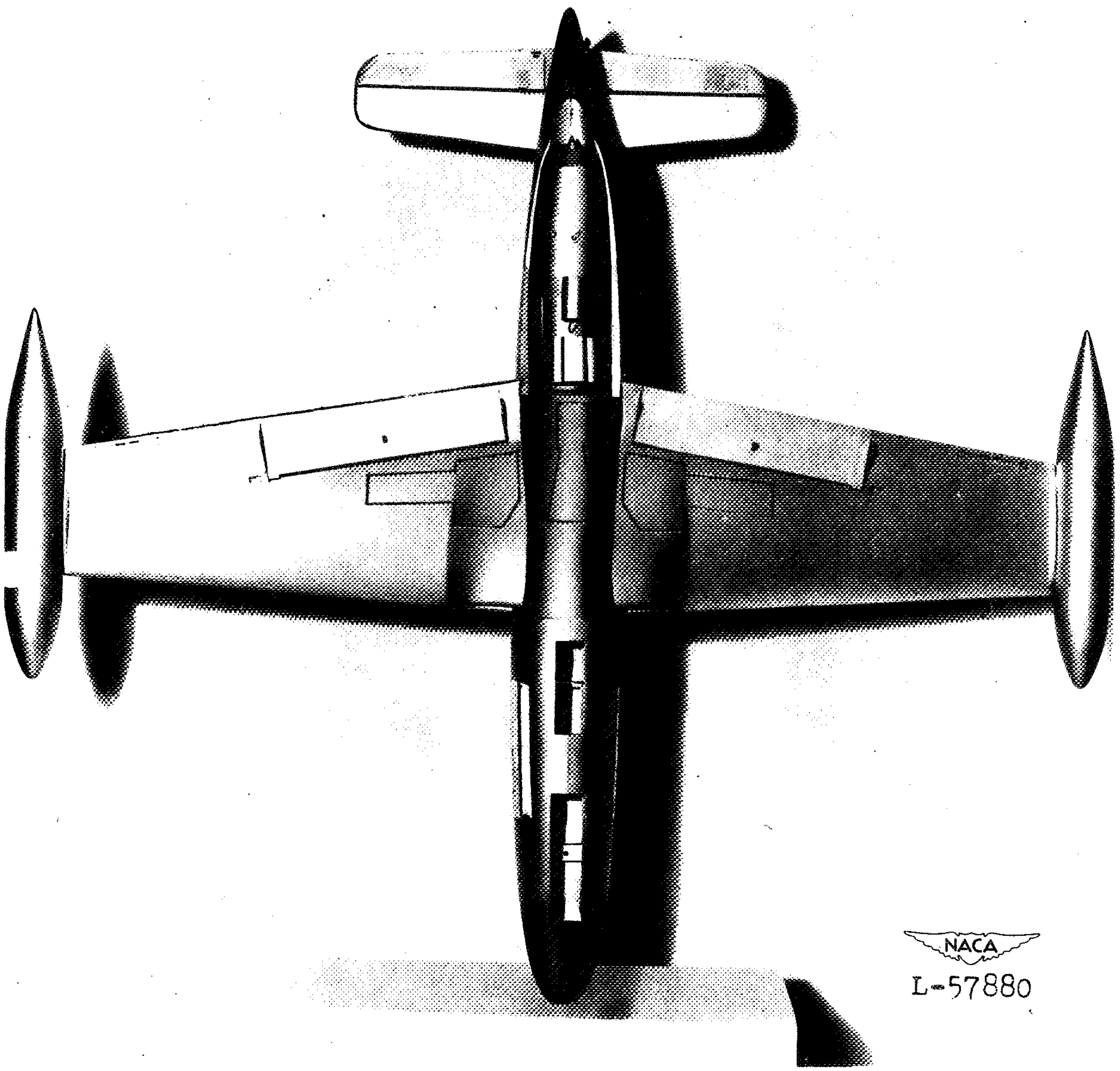
(a) Front view.

Figure 2.- Chance Vought XF6U-1 airplane, 1/8-scale dynamic model.



(b) Side view.

Figure 2.- Continued.



(c) Bottom view.

Figure 2.- Concluded.

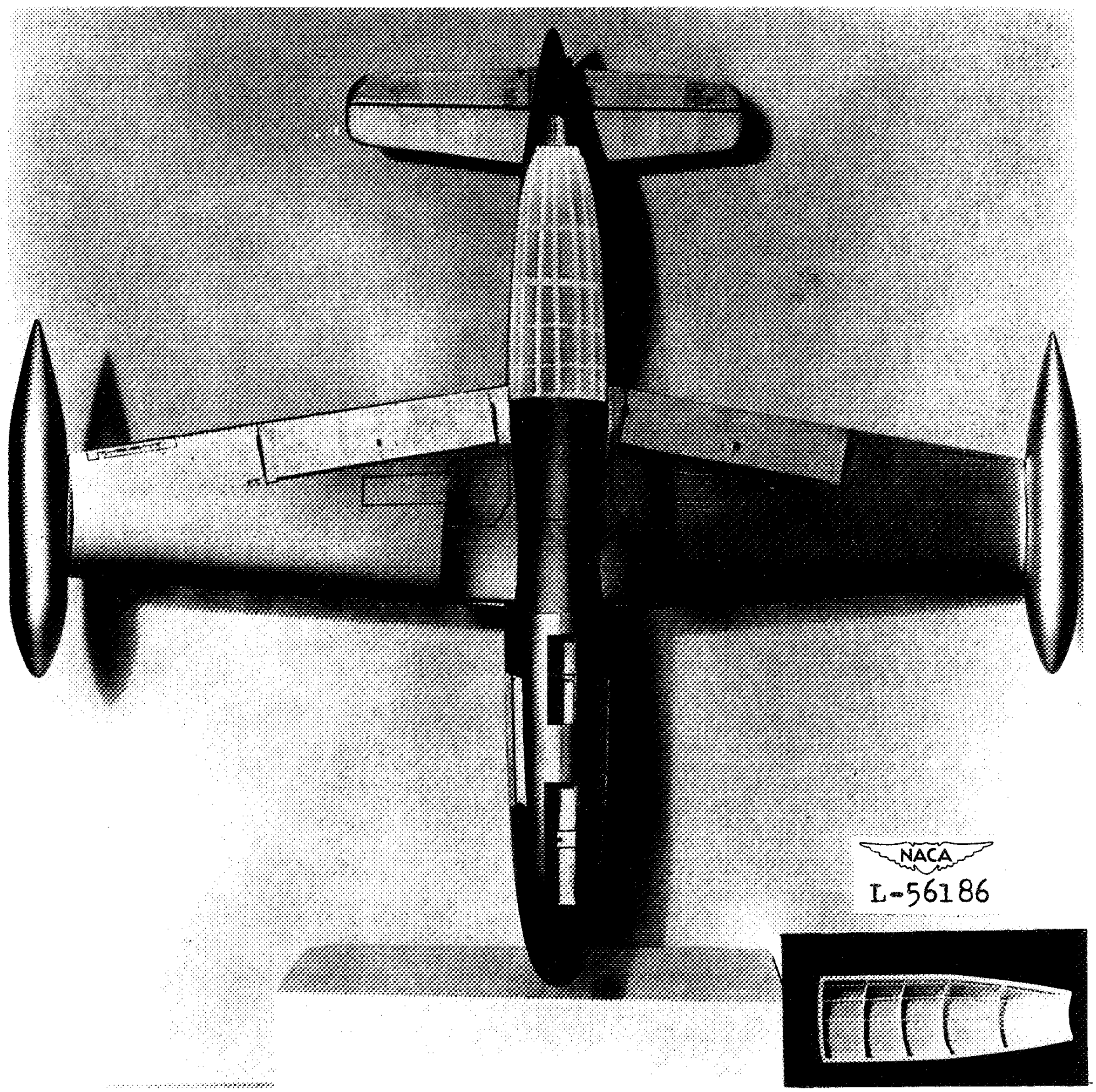


Figure 3.- Installation of the scale-strength bottom. Insert shows the structure of the scale-strength bottom.

[redacted]

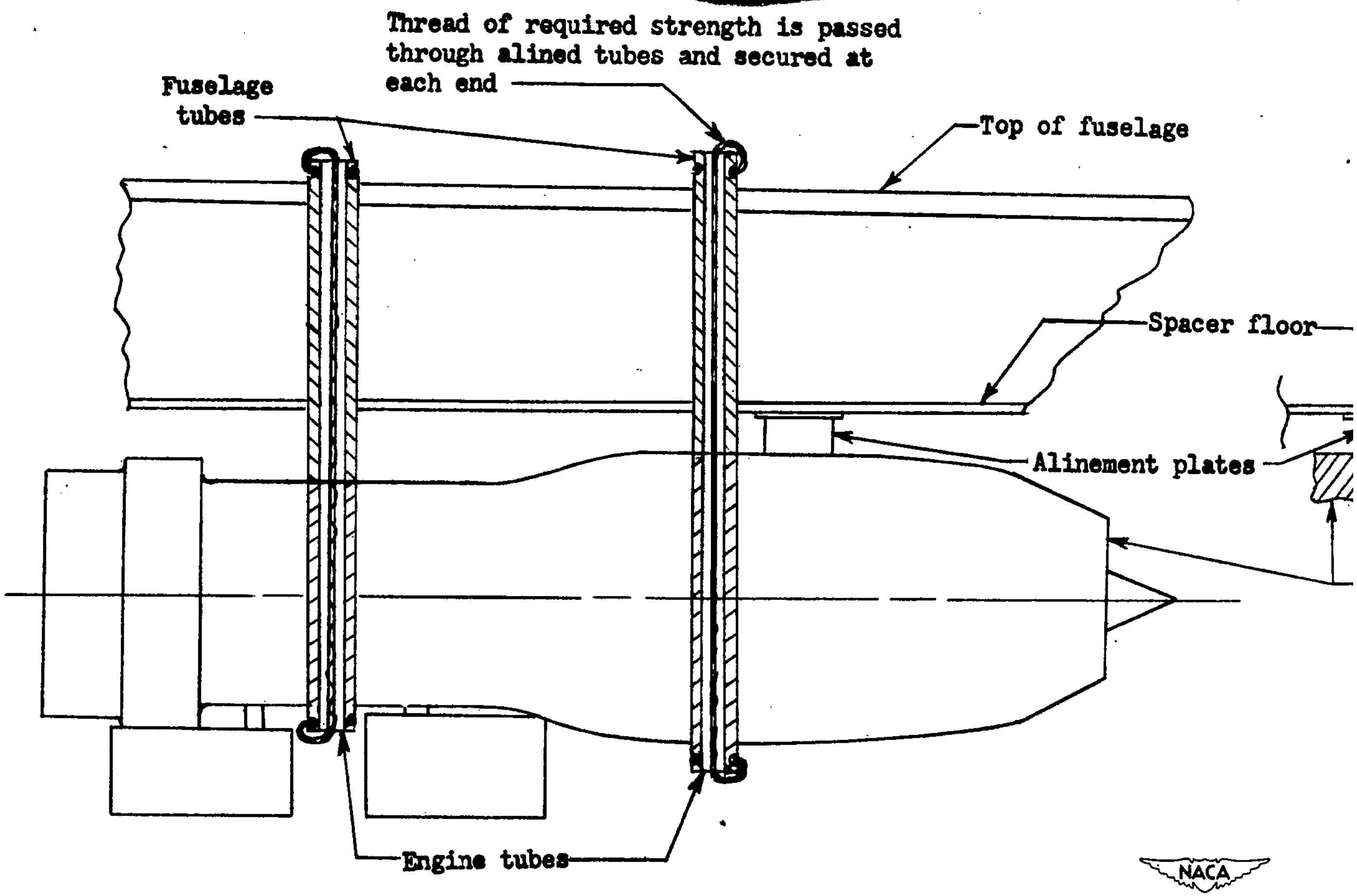


Figure 4.- Scale-strength engine-mounting system.

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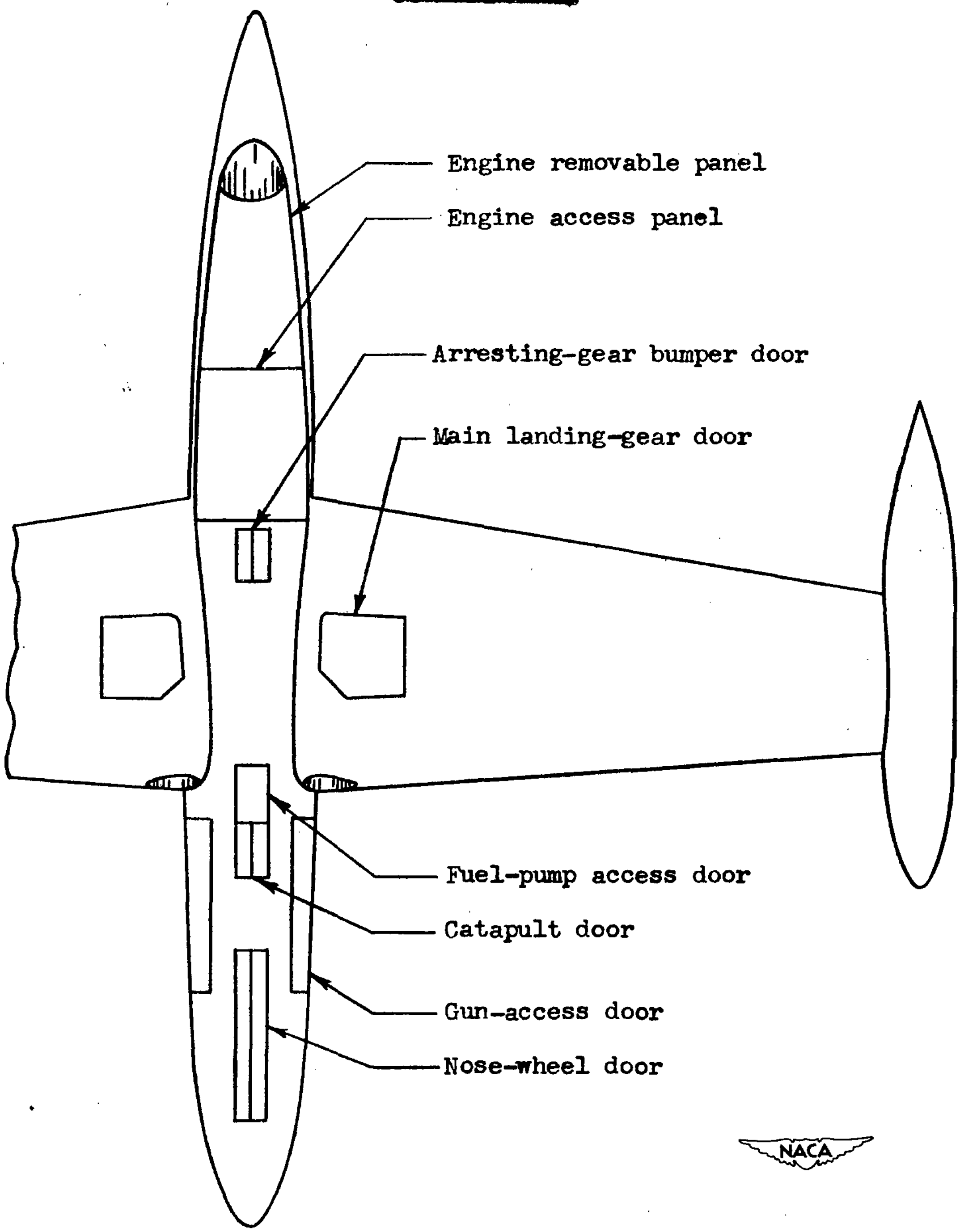

Figure 5.- Components removed to simulate their failure.

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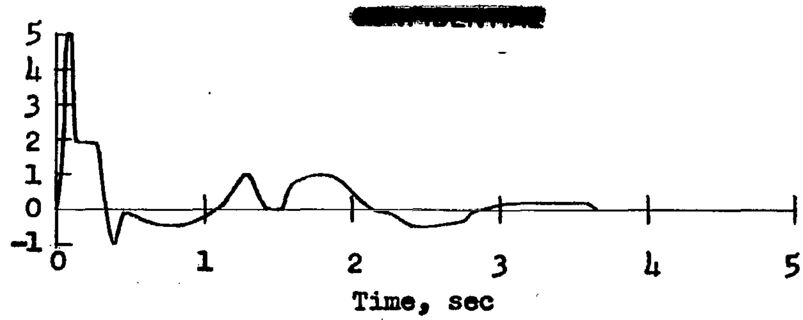
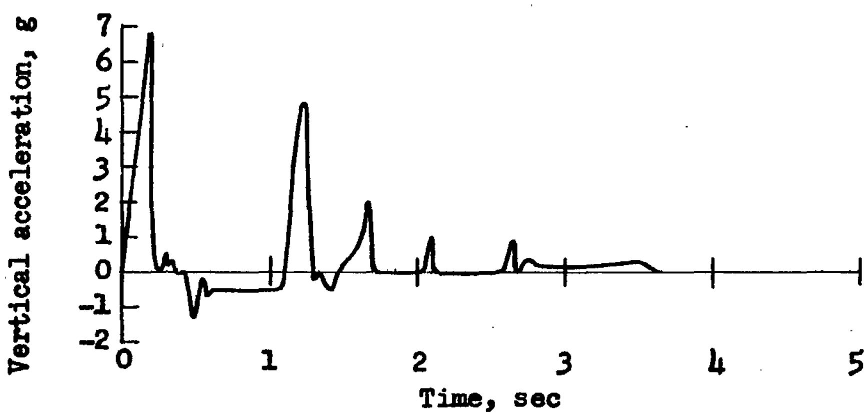
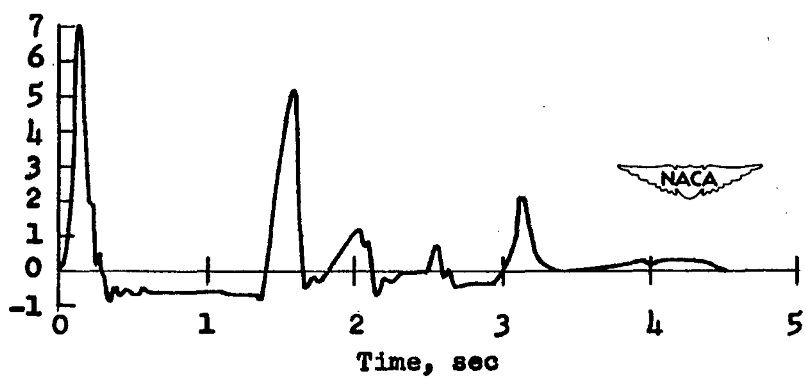


(a) Landing attitude, 12°; landing speed, 97.3 knots.



(b) Landing attitude, 8°; landing speed, 106.9 knots.



(c) Landing attitude, 4°; landing speed, 124.3 knots.

Figure 6.- Typical time histories of vertical accelerations of ditching tests of the undamaged model. (All values full scale.)

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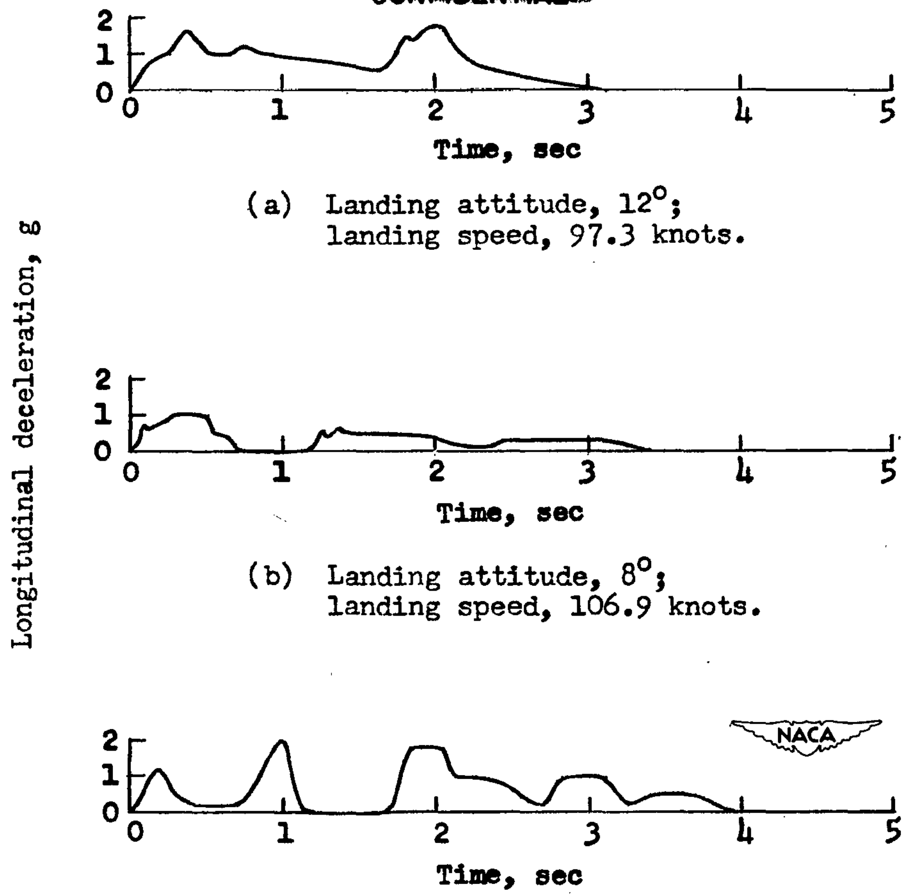

(a) Landing attitude, 12°; landing speed, 97.3 knots.

(b) Landing attitude, 8°; landing speed, 106.9 knots.

(c) Landing attitude, 4°; landing speed, 124.3 knots.

Figure 7.- Typical time histories of longitudinal decelerations for ditching tests of the undamaged model. (All values are full scale.)

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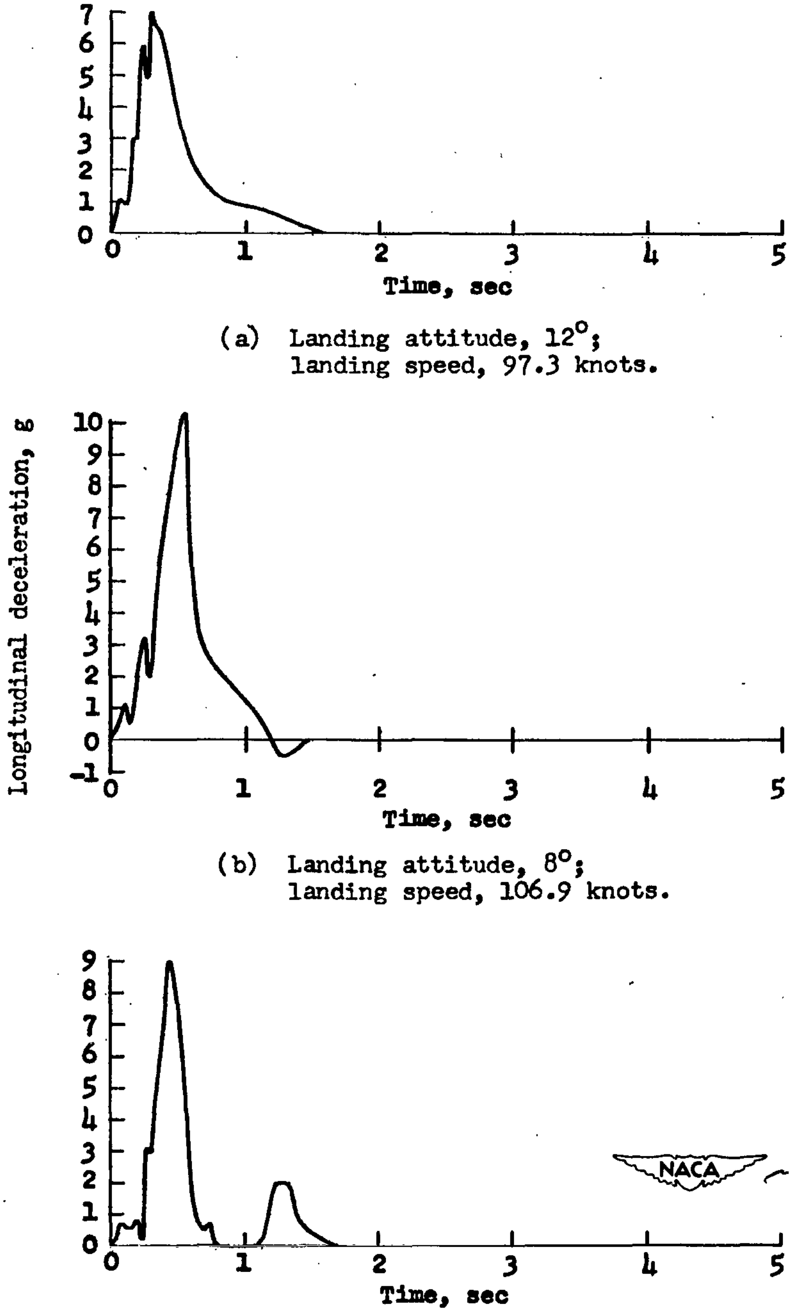

(a) Landing attitude, 12°; landing speed, 97.3 knots.

(b) Landing attitude, 8°; landing speed, 106.9 knots.

(c) Landing attitude, 4°; landing speed, 124.3 knots.

Figure 8.- Typical time histories of longitudinal deceleration for ditching tests at the most probable condition of damage. (All values are full scale.)

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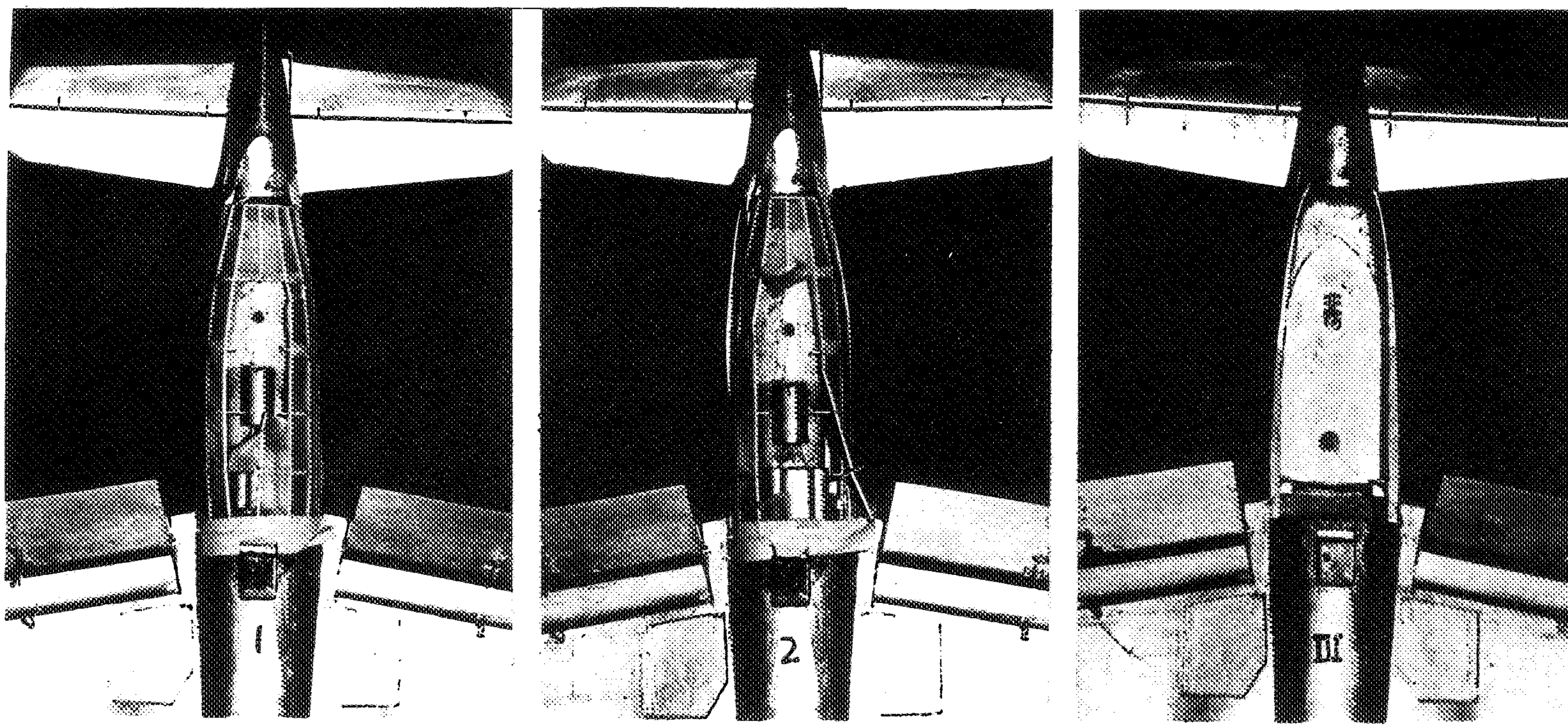

(a) Landing attitude, 12°; landing speed, 97.3 knots.

(b) Landing attitude, 8°; landing speed, 106.9 knots.

(c) Landing attitude, 4°; landing speed, 124.3 knots.

Figure 9.- Photographs showing the typical damage to the scale-strength bottoms in a ditching.

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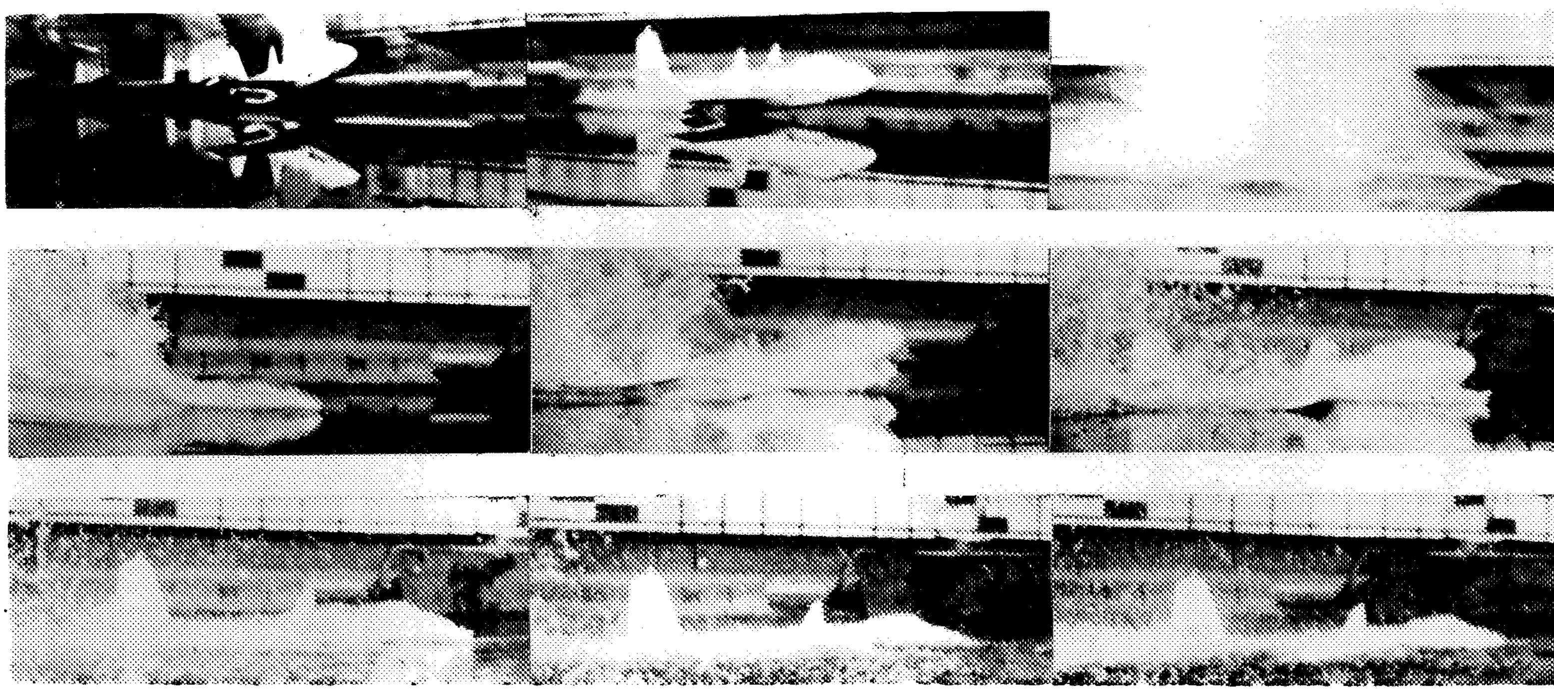

(a) Landing attitude, 12°; landing speed 97.3 knots.

Figure 10.- Sequence photographs at 0.53-second intervals of model ditchings at the most probable condition of damage. (All values full scale.)

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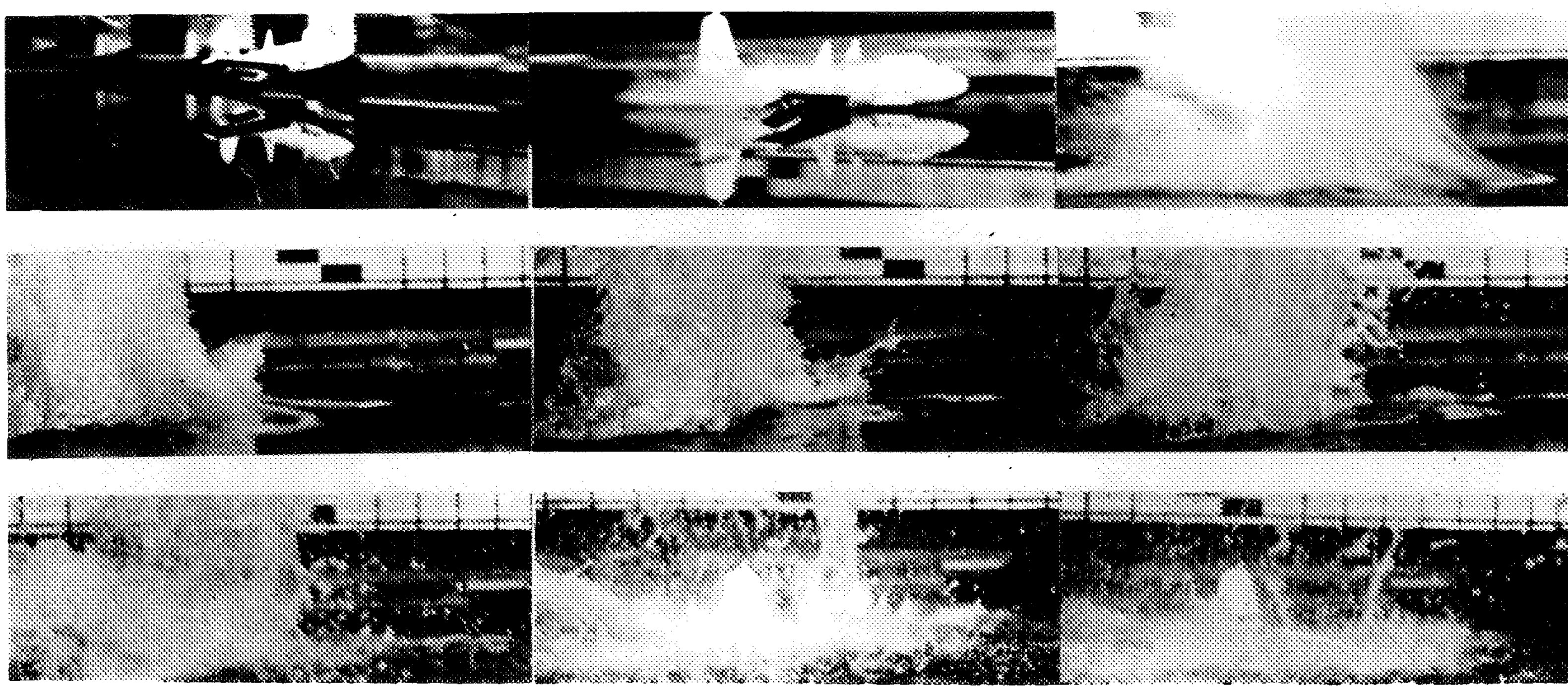

(b) Landing attitude, 8°; landing speed 106.9 knots.

Figure 10.- Continued.

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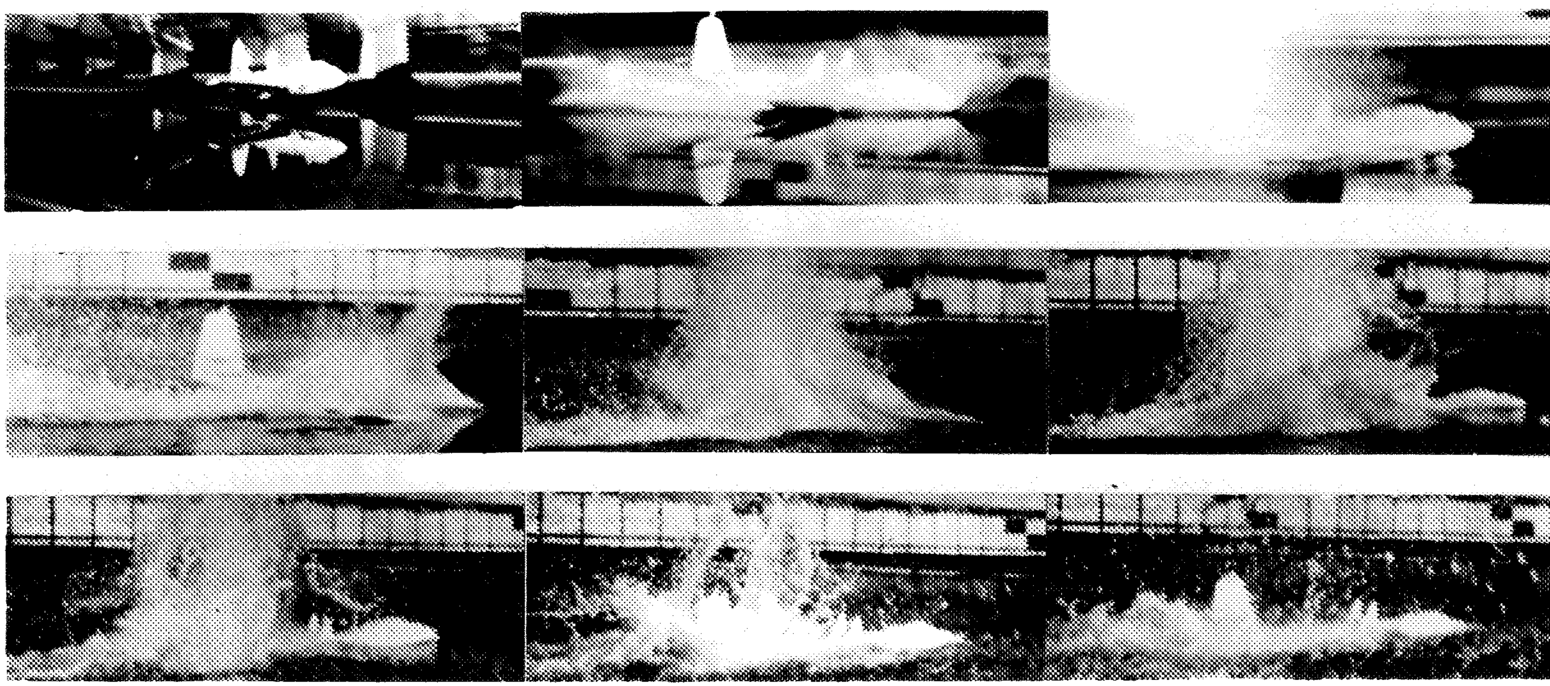

(c) Landing attitude, 4°; landing speed 124.3 knots.

Figure 10.- Concluded.

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