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RESEARCH MEMORANDUM

for the

Bureau of Aeronautics, Department of the Navy

DITCHING INVESTIGATION OF A $\frac{1}{11}$-SCALE MODEL OF THE CHANCE VOUGHT F7U-3 AIRPLANE

TED NO. NACA DE 360

By Lloyd J. Fisher and John O. Windham

Langley Aeronautical Laboratory
Langley Field, Va.

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

WASHINGTON

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SUMMARY

An investigation was made of a $\frac{1}{11}$ - scale dynamically similar model of the Chance Vought F7U-3 airplane to study its behavior when ditched. The model was landed in calm water at the Langley tank no. 2 monorail. Various landing attitudes, speeds, and configurations were investigated.

The behavior of the model was determined from visual observations, acceleration records, and motion-picture records of the ditchings. Data are presented in tabular form, sequence photographs, time-history acceleration curves, and plots of attitude change against time after contact.

From the results of the investigation, it was concluded that the airplane should be ditched at the lowest speed and highest attitude consistent with adequate control. The aft part of the fuselage and the main landing-gear doors will probably be damaged. In a calm-water ditching under these conditions the airplane will probably skip slightly and then porpoise for the remainder of the run. Maximum longitudinal decelerations will be about $3\frac{1}{2}$g and maximum normal accelerations will be about 7g in a landing run of about 500 feet.

INTRODUCTION

An investigation of a dynamic model of the Chance Vought F7U-3 airplane was made to determine the best way to land the airplane on water. The investigation was requested by the Bureau of Aeronautics, Department of the Navy. This airplane was of interest because of its unusual fuselage configuration. The airplane is a flying-wing type with two vertical stabilizers which extend below the wing and house the main landing gear. The stall angle and three-wheel landing attitudes are unusually high as compared with those of conventional airplanes and were of particular interest in this investigation.

The ditchings of the model were made in calm water at the Langley tank no. 2 monorail. In rough-water ditchings made parallel to waves or swells, the same general type of performance should be obtained. In rough-water ditchings made perpendicular to waves, more damage and violence of motion may occur, depending on the choice of the ditching site and the portions of the waves contacted.

APPARATUS AND PROCEDURE

Description of Model

A three-view drawing of the F7U-3 airplane is given in figure 1. A $\frac{1}{11}$-scale dynamic model of the F7U-3 airplane, shown in figure 2, was furnished by the Bureau of Aeronautics. It was constructed principally of balsa wood with spruce at areas of concentrated stress. Internal ballast was used to obtain scale weight and moments of inertia. The model had a wing span of 3.61 feet and an over-all length of 3.98 feet. The ailavators were installed so that they could be held rigidly in various positions.

From the behavior of the undamaged model it was estimated that the rear portion of the fuselage bottom and the bottoms of the two vertical stabilizers would absorb the initial impact and suffer the greatest damage; therefore, the rear portion of the fuselage was made so that it could be removed and replaced by a simulated crumpled bottom and the main landing-gear doors located in the bottoms of the two vertical stabilizers were made removable to simulate their failure. The nose landing-gear doors were also made removable to simulate their failure if the model nosed down. (See fig. 3.) The crumpled bottom was constructed of balsa wood and dented to conform with damage estimates based on the strength of the various fuselage panels replaced by the bottom. The manufacturer estimated the full-scale strength of the bottom of the airplane to be about 5 pounds per square inch.

Test Methods and Equipment

The model was attached to a launching carriage on the Langley tank no. 2 monorail at the desired attitude with the control surfaces set to hold this attitude in flight. The model was then catapulted into the air and the preset control surfaces kept the model at approximately the desired attitude during the glide from release to landing.

The results of the investigation were obtained from visual observations, motion-picture records, and time-history acceleration records. The accelerations were measured with a two-component accelerometer placed in the pilot's cockpit. Both normal and longitudinal components of acceleration, measured with respect to the axis of the airplane, were recorded. The natural frequency of the accelerometer was 73 cycles per second and it was damped to about 65 percent of critical damping. The accuracy with which the instrument could be read was estimated to be about $\pm\frac{1}{4}$g.

Test Conditions

All values given refer to the full-scale airplane.

Gross weight.- The design gross weight of 22,800 pounds was simulated in the tests.

Moments of inertia.- The moments of inertia used in the investigation were as follows:

I_x (roll), slug-ft^2	25,000
I_y (pitch), slug-ft^2	44,000
I_z (yaw), slug-ft^2	64,500

Location of the center of gravity.- The center of gravity was located at 11.7 percent mean aerodynamic chord and 1.27 inches above the wing chord line.

Landing attitude.- Ditchings were made at three attitudes: 28° (near lift-curve stall), 23° (near maximum tail down, static), and 18° (intermediate between three-wheel and maximum tail down, static). The attitude was measured between the fuselage reference line and the smooth water surface.

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

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

Fuselage conditions.- The model was tested in the following conditions:

(a) No damage simulated

(b) Simulated crumpled bottom installed

(c) Simulated crumpled bottom installed and main landing-gear doors removed

(d) Simulated crumpled bottom installed and main and nose landing-gear doors removed

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:

n trimmed down - a negative rotation about the lateral axis immediately after contact with the water

p porpoised - an undulating motion about the lateral axis with some part always in contact with the water

s skipped - an undulating motion about the lateral axis, intermittently completely clearing the water

u trimmed up - a positive rotation about the lateral axis after contact with the water

Sequence photographs of model ditchings are shown in figure 4. Figures 5 and 6 present time histories of attitude, longitudinal deceleration, and normal acceleration for the 28° and 23° landing attitudes in the undamaged condition and with crumpled bottom installed and main landing-gear doors removed.

Effect of Damage

The F7U-3 airplane lands at a very high attitude, and consequently, the aft fuselage and lower part of the vertical stabilizers made first contact with the water (fig. 4). At the 28° and 23° landing attitudes the undamaged model trimmed down appreciably immediately after contact (see attitude curves in fig. 5) and then trimmed up and made one long skip followed by porpoising. At the 18° landing attitude (table I) the undamaged model trimmed up immediately after contact and made an extremely long and violent skip. The total lengths of landing runs for the undamaged model varied from 720 feet to 940 feet. Maximum longitudinal decelerations of $1\frac{1}{2}$g to 2g and maximum normal accelerations of 5g to 7g were recorded for the 28° and 23° attitudes (table I and fig. 5).

There was little difference in behavior between the undamaged model and the model with the crumpled bottom installed. However, with the crumpled bottom installed and the main landing-gear doors removed, the runs were shorter (total length about 500 feet to 600 feet), the trimming-up tendency and skipping motion were lessened (table I and figs. 4(b) and 6), and the accelerations were higher (about $3\frac{1}{2}$g maximum longitudinal and 7g maximum normal, as seen in fig. 6). Because of the way the aft fuselage and vertical stabilizers contact the water, it is very likely that both will be damaged; therefore, the above condition appears to be the most probable condition of damage that will occur in an actual ditching. Since the nose landing-gear doors did not enter the water until the low-speed part of the run, removal of these doors had little effect on behavior other than to reduce slightly the length of the landing run. The inlet ducts located at the wing roots exhibited a tendency to dig in at the low attitudes with damage simulated.

Effect of Landing Attitude and Speed

In general, the effect of landing attitude on behavior depended on the speeds associated with the attitude. The lower attitudes, especially 18°, with the accompanying higher speeds caused the motions to be more violent and undesirable than those of the higher attitudes and lower speeds. Consequently, a ditching should be made at the lowest speed and highest attitude consistent with adequate control.

CONCLUSIONS

From the results of the investigation of a $\frac{1}{11}$-scale dynamically similar model of the Chance Vought F7U-3 airplane, the following conclusions were reached:

1. The airplane should be ditched at the lowest speed and highest attitude consistent with adequate control.

2. The airplane will probably trim down, skip slightly, and then porpoise for the remainder of the run.

3. The aft part of the fuselage and the main landing-gear doors will probably be damaged.

4. When ditched as recommended and in calm water the maximum longitudinal deceleration will be about $3\frac{1}{2}g$, the maximum normal acceleration will be about 7g, and the landing run will be about 500 feet.

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TABLE I

SUMMARY OF RESULTS OF DITCHING INVESTIGATION IN CALM WATER OF A

$\frac{1}{11}$-SCALE MODEL OF THE CHANCE VOUGHT F7U-3 AIRPLANE

[All values are full scale; gross weight 22,800 lb]

Landing attitude, deg	Ailavator setting, deg	Slat position	Landing speed, knots	Motions[1]	Length of run, ft	Maximum longitudinal decelerations, g	Maximum normal accelerations, g
No damage							
28	-40	extended	106	n, u, s_{100}, p	720	$1\frac{1}{2}$	5
23	-30	retracted	117	n, u, s_{130}, p	870	2	7
18	-20	retracted	131	u, s_{390}	940	---	---
Crumpled bottom installed							
28	-40	extended	106	n, u, s_{80}, p	705	---	---
23	-30	retracted	117	n, u, s_{120}, p	825	---	---
Crumpled bottom installed and main landing-gear doors removed							
28	-40	extended	106	n, p	500	$3\frac{1}{2}$	7
23	-30	retracted	117	n, u, s_{60}, p	540	$3\frac{1}{2}$	$6\frac{1}{2}$
18	-20	retracted	131	u, s_{190}	600	---	---
Crumpled bottom installed and main and nose landing-gear doors removed							
28	-40	extended	106	n, p	470	---	---
23	-30	retracted	117	n, u, s_{60}, p	510	---	---

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

- n trimmed down
- p porpoised
- s skipped (subscript denotes length of skip in feet)
- u trimmed up

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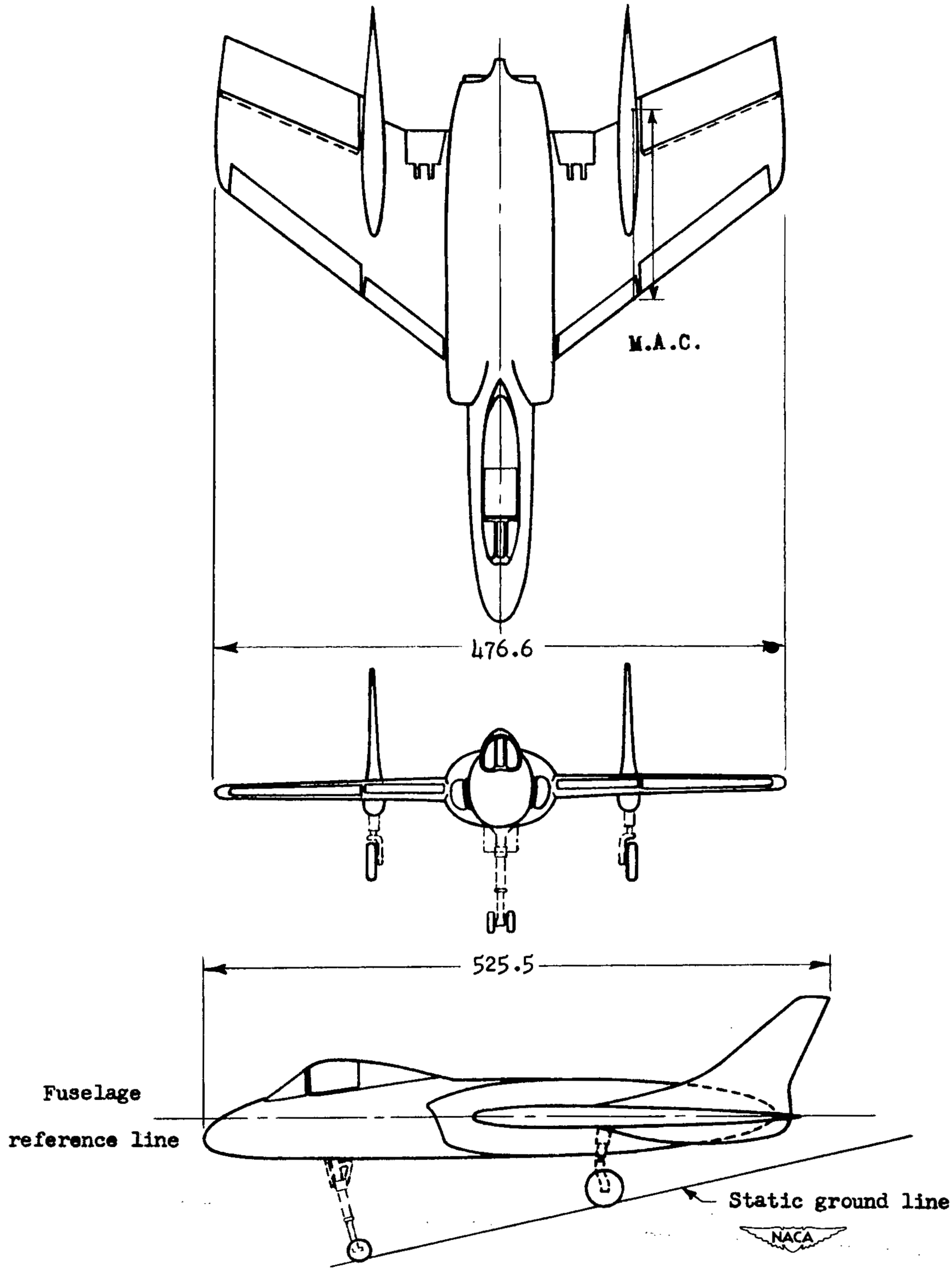
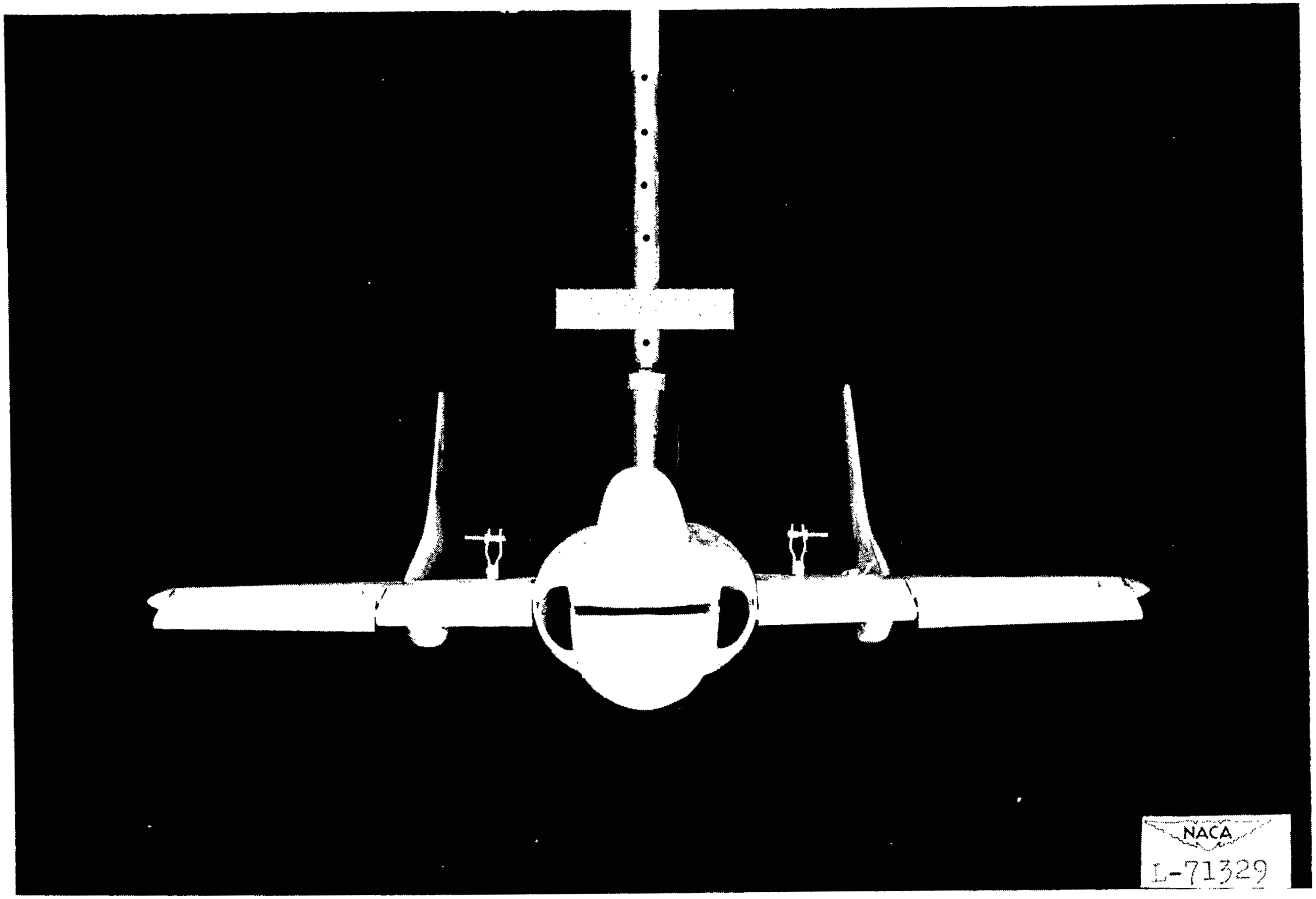


Figure 1.- Three-view drawing of the Chance Vought F7U-3 airplane.
(Dimensions are in inches, full size.)

[redacted]



(a) Front view.

Figure 2.- Model of Chance Vought F7U-3 airplane.

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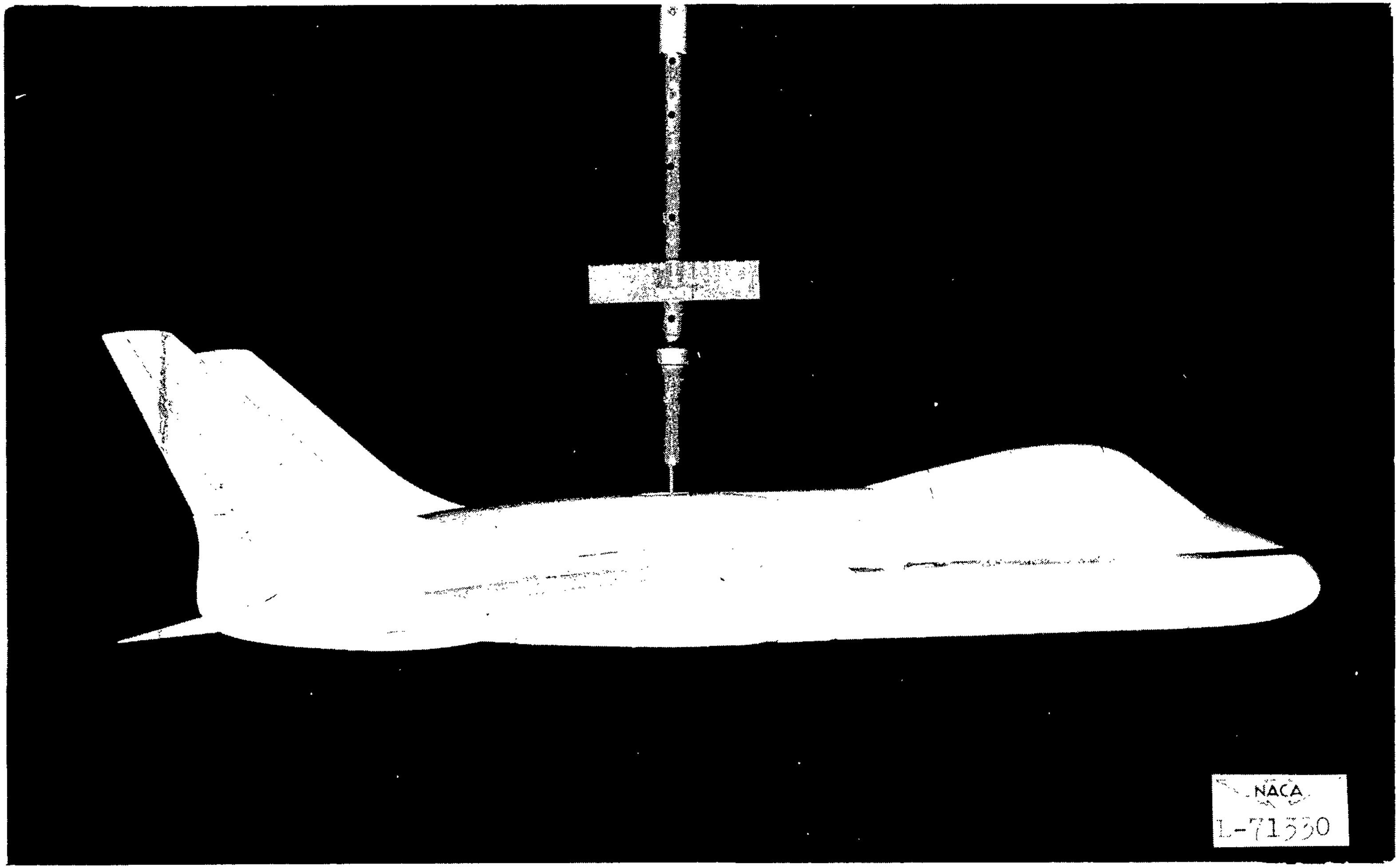
[redacted]



(b) Side view.

Figure 2.- Continued.

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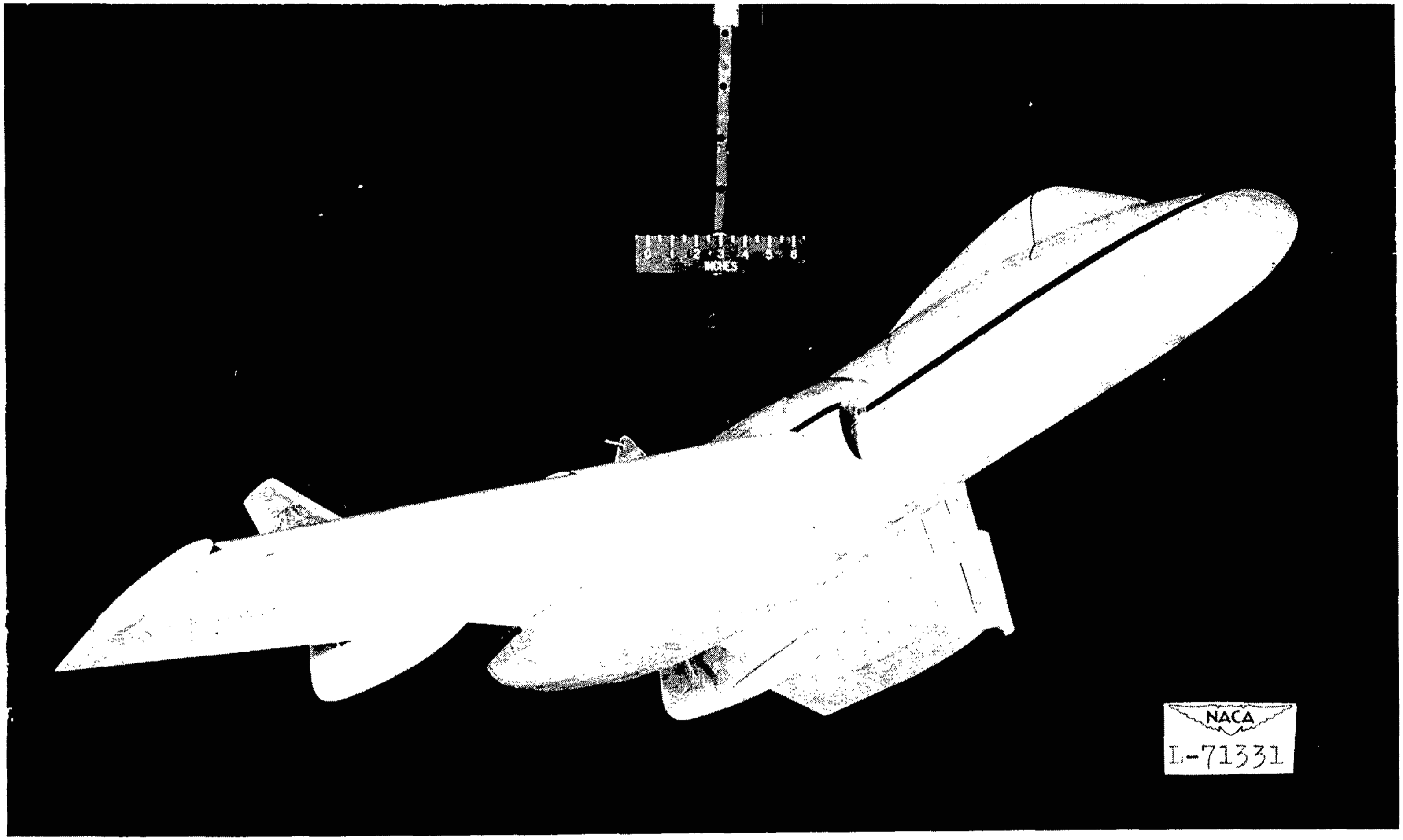

(c) Three-quarter bottom view.

Figure 2.- Concluded.

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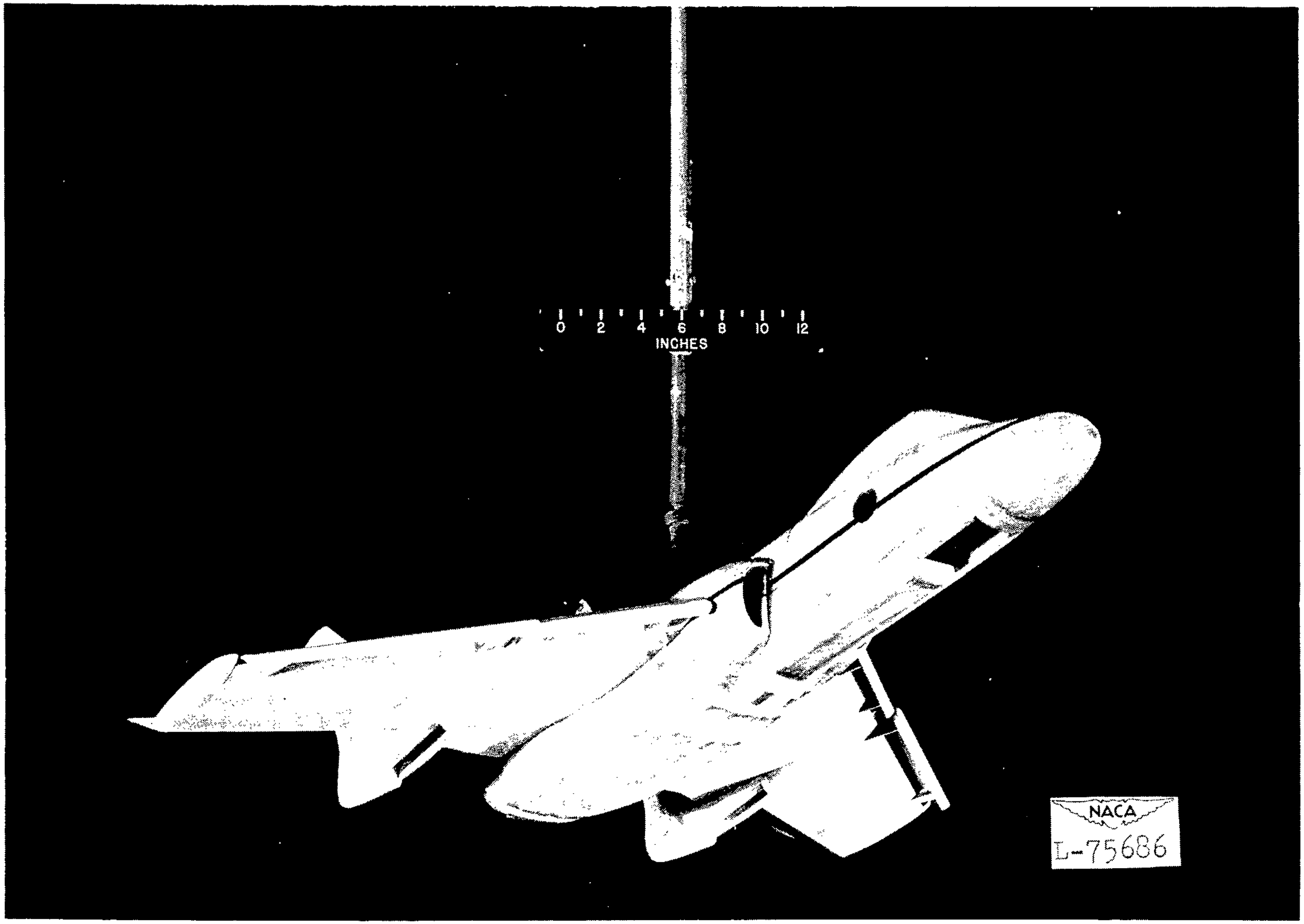

Figure 3.- Model with crumpled bottom installed and landing-gear doors removed.

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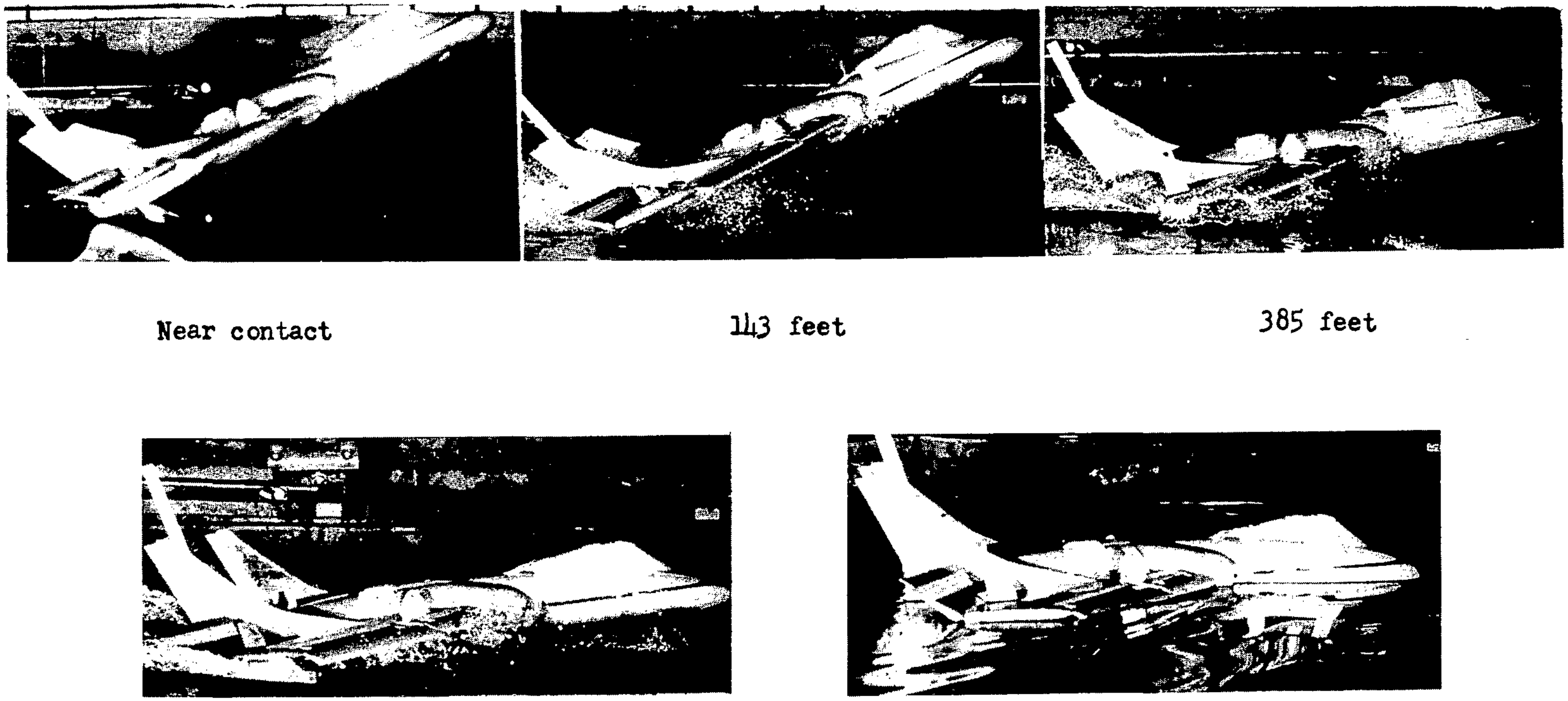

(a) No simulated damage.

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Figure 4.- Sequence photographs of model ditching at the 28° landing attitude; speed, 106 knots. Distances after contact are indicated. (All values are full scale.)

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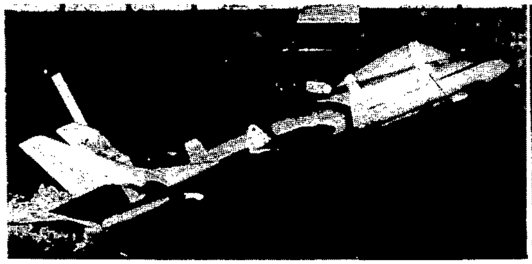
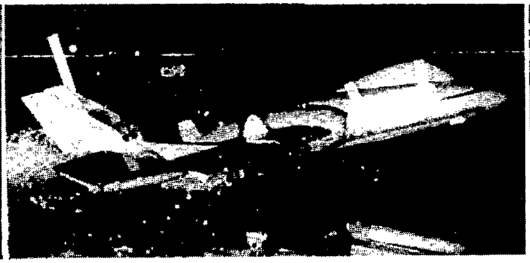
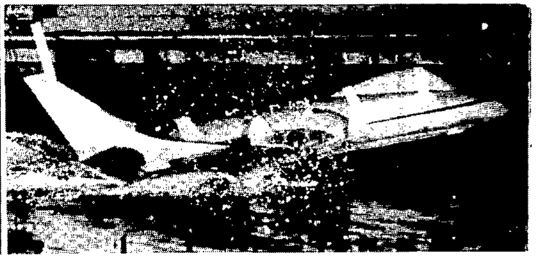


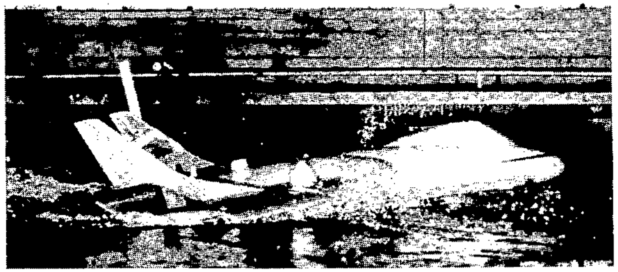
Near contact



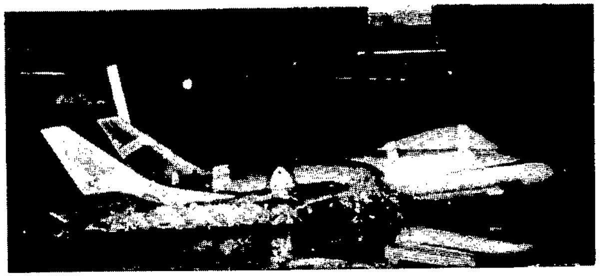
154 feet



289 feet



363 feet



451 feet

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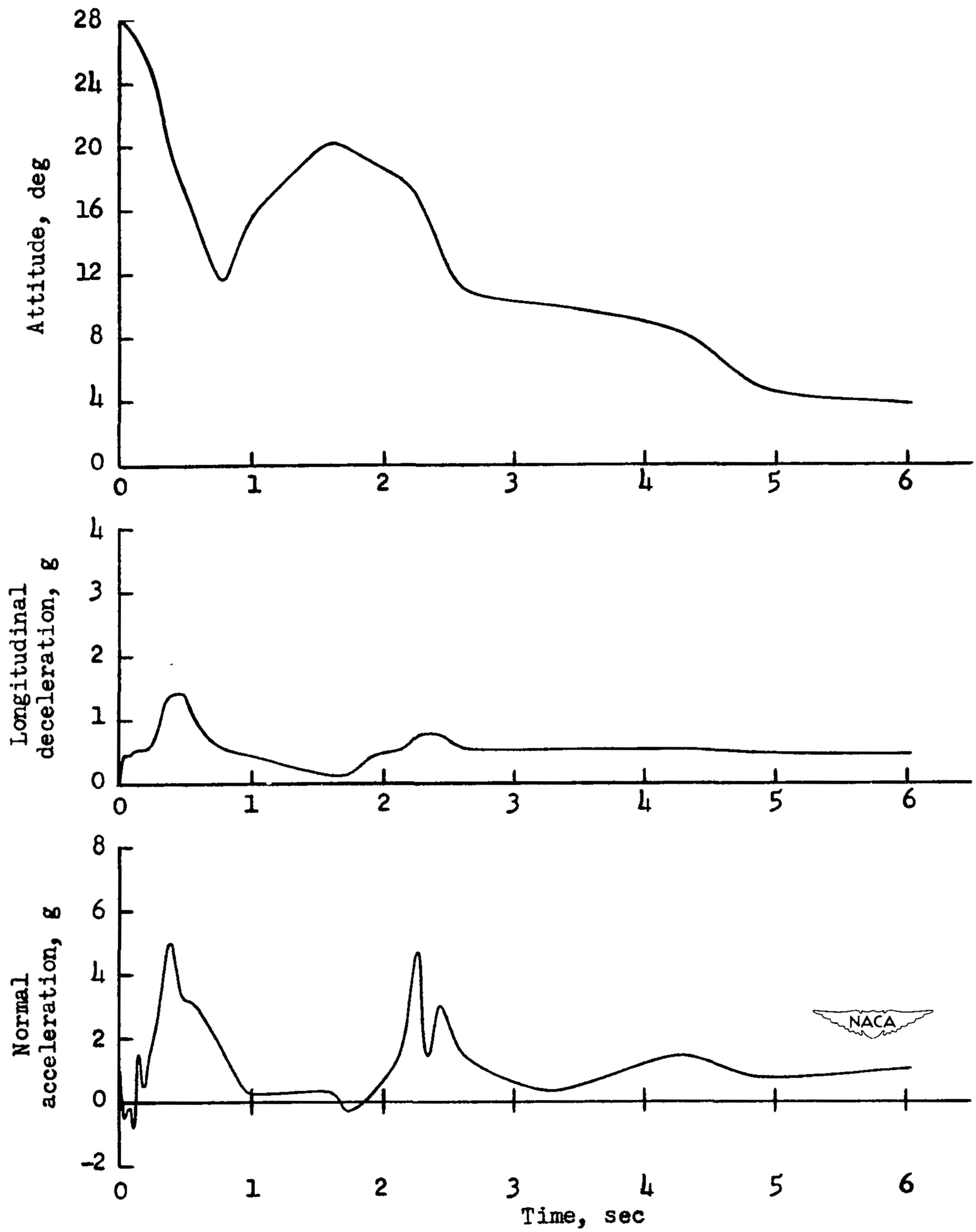
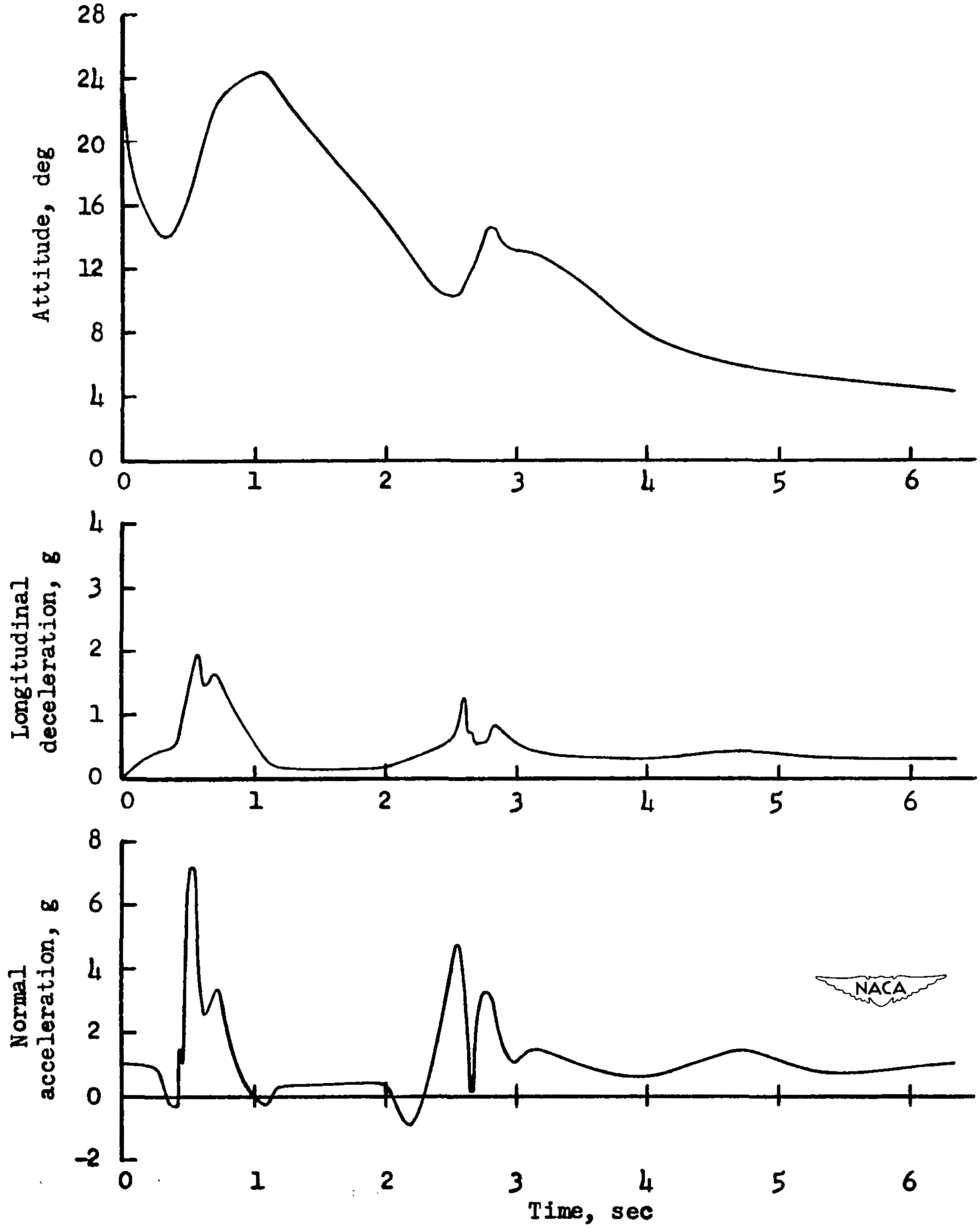
(b) Crumpled bottom installed and main landing-gear doors removed.

Figure 4.- Concluded.



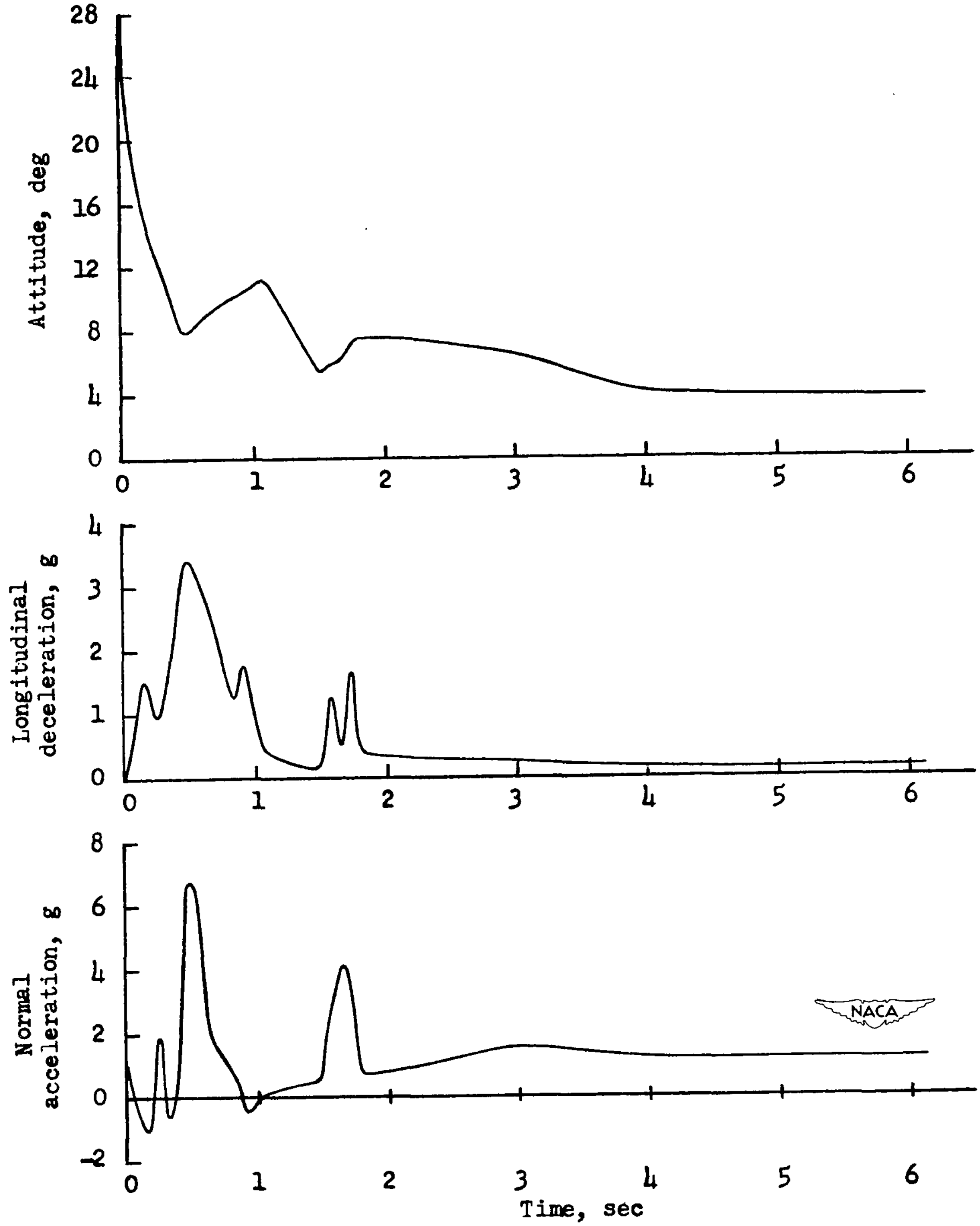
(a) Landing attitude, 28°; speed, 106 knots.

Figure 5.- Attitude, longitudinal deceleration, and normal acceleration curves. Undamaged condition. (All values are full scale.)



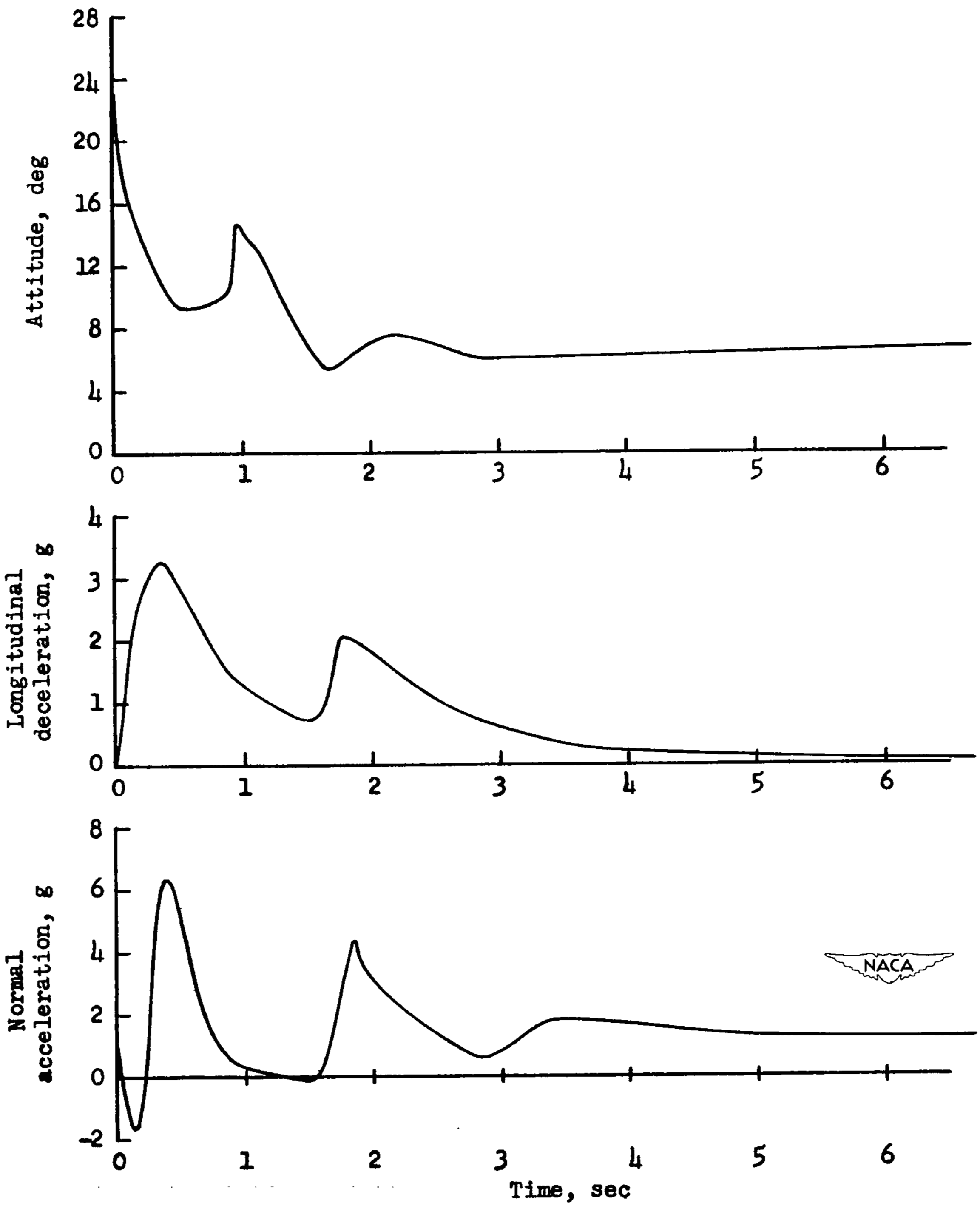
(b) Landing attitude, 23°; speed, 117 knots.

Figure 5.- Concluded.



(a) Landing attitude, 28°; speed, 106 knots.

Figure 6.- Attitude, longitudinal deceleration, and normal acceleration curves. Crumpled bottom installed and main landing-gear doors removed. (All values are full scale.)



(b) Landing attitude, 23°; speed, 117 knots.

Figure 6.- Concluded.

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