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# RESEARCH MEMORANDUM

for the

Air Materiel Command, U. S. Air Force

DITCHING INVESTIGATION OF A  $\frac{1}{14}$  - SCALE MODEL

OF THE NORTHROP C-125 AIRPLANE

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Authority J. W. Crowley Date 12/14/53  
Dir., Aeron. Research  
NACA

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## RESEARCH MEMORANDUM

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DITCHING INVESTIGATION OF A  $\frac{1}{14}$  - SCALE MODEL

OF THE NORTHROP C-125 AIRPLANE

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## SUMMARY

An investigation of a  $\frac{1}{14}$  - scale dynamically similar model of the Northrop C-125 airplane was made to determine the ditching characteristics and proper ditching technique for the airplane. Various conditions of damage, landing attitude, flap setting, and speed were investigated. The behavior of the model was determined from visual observations, motion-picture records, and time-history deceleration records. The results of the investigation are presented in table form, photographs, and curves.

It was concluded that the airplane should be ditched at a nose-high landing attitude (near  $8^{\circ}$ ) with flaps full down. The fixed landing gear will cause the airplane to dive. The fuselage will be damaged and will probably flood rapidly. Longitudinal decelerations will be about  $4g$  and the length of landing run will be about two fuselage lengths. If the main landing gear could be <sup>made</sup> jettisonable or retractable the ditching characteristics would be greatly improved.

## INTRODUCTION

At the request of the Air Materiel Command, U. S. Air Force, an investigation of a model of the Northrop C-125 airplane was made to determine the probable ditching characteristics and the proper technique to be used in an emergency water landing. The tests were made in calm water at Langley tank no. 2 monorail. The effect that the fixed landing

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gear would have on ditching behavior was of particular interest in this investigation. Data on the airplane were obtained from the manufacturer. A three-view drawing of the airplane is shown in figure 1.

## APPARATUS AND PROCEDURE

### Description of Model

The  $\frac{1}{14}$ -scale model supplied by the U. S. Air Force had a wing span of 5.77 feet, a fuselage length of 4.78 feet, and a gross weight of 12.8 pounds. Photographs of the model are shown in figure 2. The model was constructed principally of balsa wood with spruce or mahogany at areas of concentrated stress. Internal ballast was used to obtain scale weight and approximate moments of inertia.

The landing flaps were installed so that they could be held in the down position at approximately scale strength (design full-scale failing load is 180 pounds per square foot for the inboard flaps and 120 pounds per square foot for the outboard flaps). A calibrated thread was fastened between a wing bracket and a corresponding flap bracket so that loads on the flaps greater than the scale design load would break the thread and the flaps would return to the up position.

The model was constructed so that sections of the under part of the fuselage could be removed and various amounts of damage could be simulated. In order to simulate a condition similar in strength to the actual airplane, where the bulkheads are relatively rigid in comparison with the skin, a section of the fuselage bottom (between stations 177 and 466) was replaced by a part of known strength. This part consisted of a framework of rigid bulkheads covered with 0.001-inch aluminum foil (fig. 3). The tested strength of this part was approximately 50 percent greater than the strength of the airplane (576 pounds per square foot, full scale, estimated by the manufacturer). This condition was used to determine the approximate extent of damage. To simulate a condition where the bulkheads remained intact while the skin failed completely, the framework of rigid bulkheads was installed without the aluminum covering. The very weak air exit door and pilot's compartment entry hatch were removed to simulate their complete failure (fig. 3).

The main landing gear was designed so it could be attached at scale strength as shown in figure 4. The breaking load for each main strut was estimated by the manufacturer to be 30,000 pounds, full scale, applied in an aft direction at the center of the wheel.

## Test Methods and Equipment

The test methods and equipment used were similar to those used in previous ditching investigations. The model was attached to the launching carriage on the Langley tank no. 2 monorail at the desired attitude with 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 deceleration records. The decelerations were measured with a single-component accelerometer located in the pilot's compartment. The natural frequency of the accelerometer was 20 cycles per second and it was damped to about 65 percent of the critical dampening. The accuracy with which the instrument could be read was estimated at about  $\pm 1/2g$ .

## Test Conditions

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

Gross weight.- The design gross weight of 35,000 pounds was simulated in the tests.

Location of center of gravity.- The center of gravity was located at 30.5 percent mean aerodynamic chord and 26 inches above the thrust line of the center engine.

Landing attitude.- Ditchings were made at three attitudes:  $0^\circ$ ,  $4^\circ$ , and  $8^\circ$  (near lift-curve stall). The attitude was measured between the thrust line of the center engine and the smooth-water surface.

Landing flaps.- Tests were made with landing flaps up and full down ( $55^\circ$ ).

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

Landing gear.- Tests were made with the main landing gear rigidly attached, attached at scale strength, and completely removed. The tail gear was either rigidly attached or completely removed.

Fuselage condition.- The model was tested in the following configurations:

- (a) Undamaged.

(b) Aluminum-covered framework of rigid bulkheads installed between stations 177 and 466, and pilot's compartment entry hatch and air exit door removed.

(c) Framework of rigid bulkheads installed between stations 177 and 466, and pilot's compartment entry hatch and air exit door 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:

Dived slightly - the nose of the model partially submerged and the angle between the water surface and the thrust line was less than  $15^{\circ}$ .

Dived violently - the nose of the model submerged up to the wing and the angle between the water surface and the thrust line was greater than  $15^{\circ}$ .

Flipped over - the model rotated about the transverse axis and stopped in an inverted position.

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

Porpoised - the model undulated about the lateral axis with some part always in contact with the water.

Ran deeply - the model settled deeply into the water with little change in attitude.

Trimmed up - the attitude of the model increased immediately after contact with the water.

Sequence photographs of ditchings at the recommended attitude are shown in figure 5. Figures 6, 7, and 8 present longitudinal deceleration curves as influenced by damage, flap setting, and landing attitude. Typical damage to the aluminum-covered bottom sections is shown in figure 9.

### Effect of Landing Gear

The fixed landing gear caused the model to dive consistently. When the landing gear was attached at scale strength, it did not fail and the behavior was the same as that with the landing gear fixed. When the

model was tested with the landing gear removed, it did not dive (fig. 5). In the undamaged condition the model trimmed up on contact with the water and made a long smooth run. When damage was simulated the runs were shorter and the model porpoised or ran deeply in the water, depending on the extent of damage. If the main landing gear could be made jettisonable or retractable, the ditching characteristics of the airplane would be greatly improved.

#### Effect of Damage

Simulated damage had very little effect on the basic motions made by the model with fixed landing gear but did cause the runs to be shorter, the decelerations to be greater, and the dives to be deeper than when no damage was simulated. (See table I and figs. 6, 7, and 8.) The aluminum-covered bottoms were severely dented and crumpled and occasionally were ruptured (fig. 9). The airplane probably would sustain more extensive damage to the fuselage bottom than that shown in figure 9 as the aluminum bottoms were over strength, but it should not receive greater damage to the skin than that simulated when the rigid bulkheads were installed without the aluminum covering. Since the behavior varied only slightly regardless of the condition of damage, the main effect of damage would be to cause the fuselage to rapidly fill with water.

With the landing gear removed, damage caused the behavior to be somewhat more severe than when no damage was simulated but even here the flooding of the fuselage would be the most important effect of damage.

#### Effect of Flaps and Speed

When the model was tested with flaps attached at scale-strength in the down position, the inboard flaps usually failed; but, whether the flaps failed or not, the effect on behavior was slight. Violent dives or flip-overs were encountered at the flaps-up condition probably because of the higher water drag of the landing gear at the high landing speeds. Since landing speeds are less and the behavior is better for the flaps-down condition, it is preferable to ditch with flaps down.

#### Effect of Landing Attitude

The behavior of the model was somewhat more severe at a low attitude than at a high attitude. There are indications that this behavior was not caused by the angle at which the model contacted the

water but rather by the high speed associated with a low-attitude landing. Consequently, ditching at a nose-high landing attitude (near  $8^\circ$ ) is preferable.

### CONCLUSIONS

From the results of the investigation of a  $\frac{1}{14}$ -scale dynamically similar model of the Northrop C-125 airplane, the following conclusions were drawn:

1. The airplane should be ditched at a nose-high landing attitude (near  $8^\circ$ ) with the flaps full down.
2. The fixed landing gear will cause the airplane to dive.
3. The fuselage will be damaged and will probably flood rapidly. When the airplane is ditched as recommended, the maximum longitudinal deceleration in calm water will be about  $4g$  and the length of landing run will be about two fuselage lengths.
4. If the main landing gear could be made jettisonable or retractable the ditching characteristics would be greatly improved.

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TABLE I

## SUMMARY OF RESULTS OF DITCHING INVESTIGATION IN CALM WATER OF

A  $\frac{1}{14}$  - SCALE MODEL OF THE NORTHROP C-125 AIRPLANE

[Gross weight, 35,000 lb; all values are full scale]

Landing attitude (deg)	Flap setting (deg)	Landing speed (knots)	Length of run (ft)	Maximum longitudinal deceleration (g)	Motions of model
Undamaged model					
0	55	64	137	$2\frac{1}{2}$	Dived violently
4	0	102	202	5	Flipped over
4	55	60	185	2	Dived slightly
8	0	87	161	4	Dived violently
8	55	56	169	2	Dived slightly
<sup>a</sup> 8	55	56	458	$\frac{1}{2}$	Trimmed up, ran smoothly
Aluminum-covered framework of rigid bulkheads installed; pilot's compartment entry hatch and air exit door removed					
0	55	64	133	4	Dived violently
4	0	102	129	6	Flipped over
4	55	60	146	2	Dived slightly
8	0	87	120	5	Flipped over
8	55	56	141	2	Dived slightly
<sup>a</sup> 8	55	56	390	1	Porpoised
Framework of rigid bulkheads installed; pilot's compartment entry hatch and air exit door removed					
0	55	64	129	3	Dived violently
4	0	102	195	6	Flipped over
4	55	60	146	3	Dived slightly
8	0	87	120	6	Flipped over
8	55	56	120	3	Dived slightly
<sup>a</sup> 8	55	56	355	$2\frac{1}{2}$	Ran deeply

<sup>a</sup>Landing gear removed.

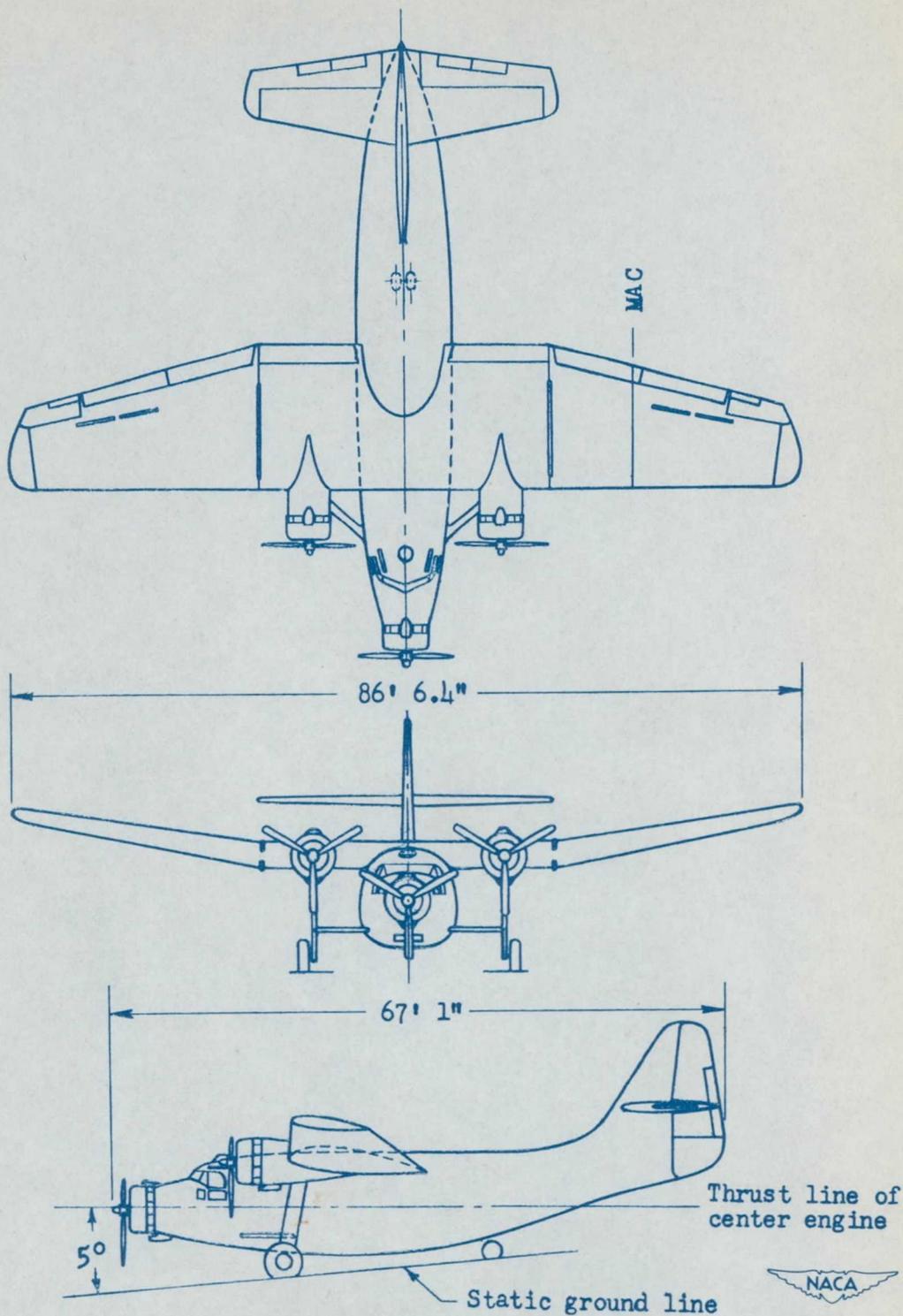
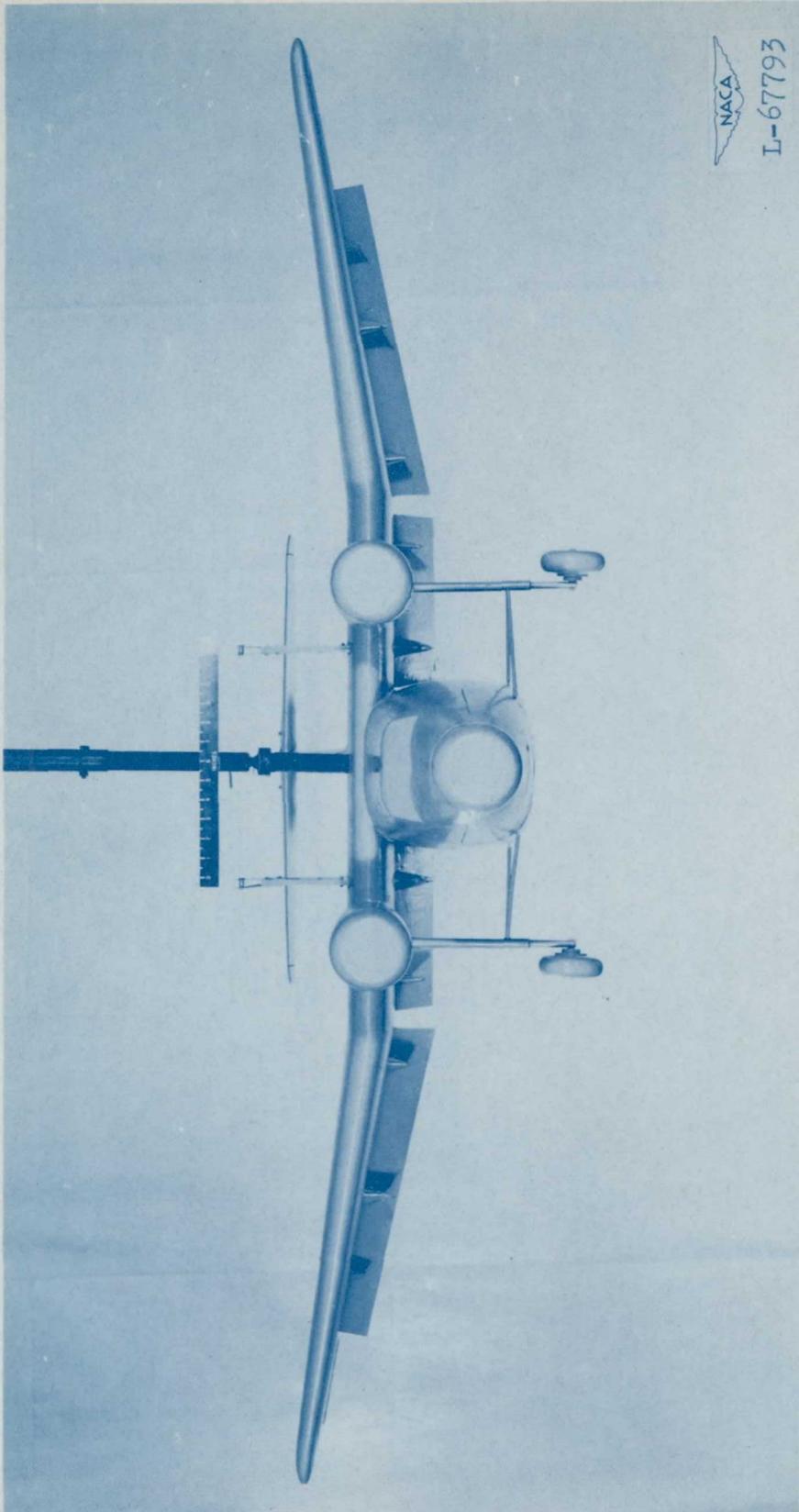
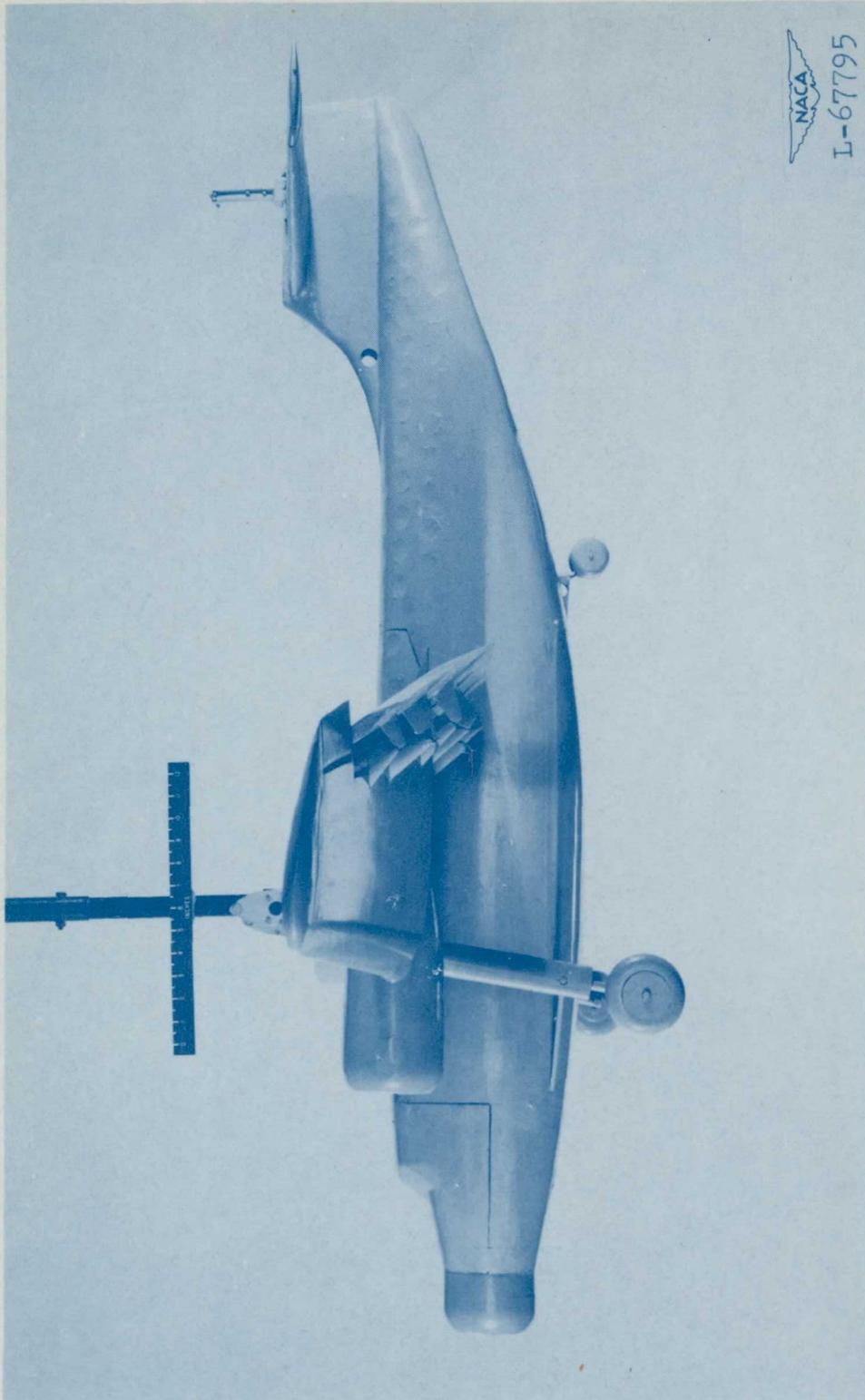


Figure 1.- Three-view drawing of the C-125 airplane.



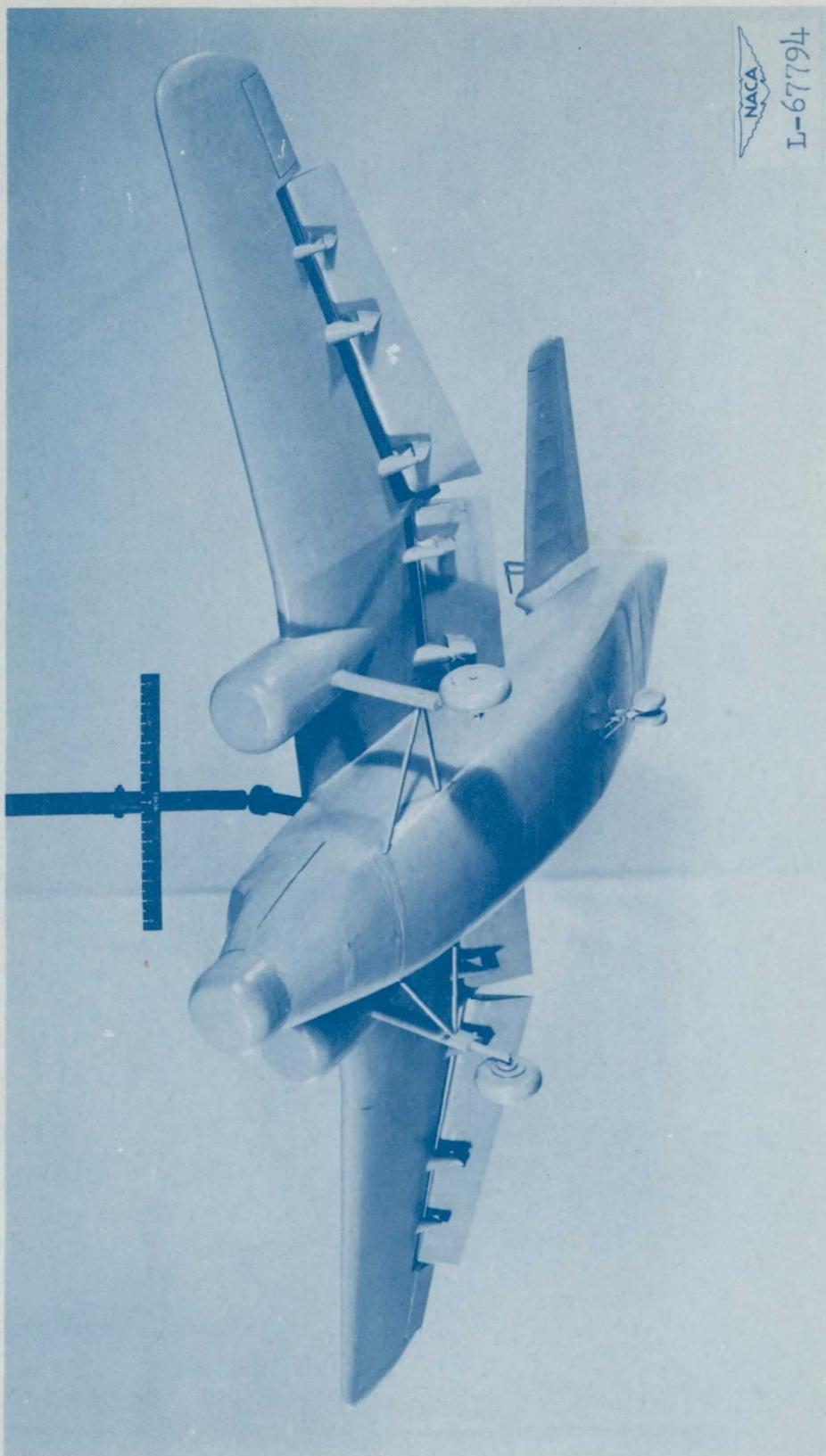
(a) Front view.

Figure 2.- Model of the C-125 airplane.



(b) Side view.

Figure 2.- Continued.



(c) Three-quarter bottom view.

Figure 2.- Concluded.

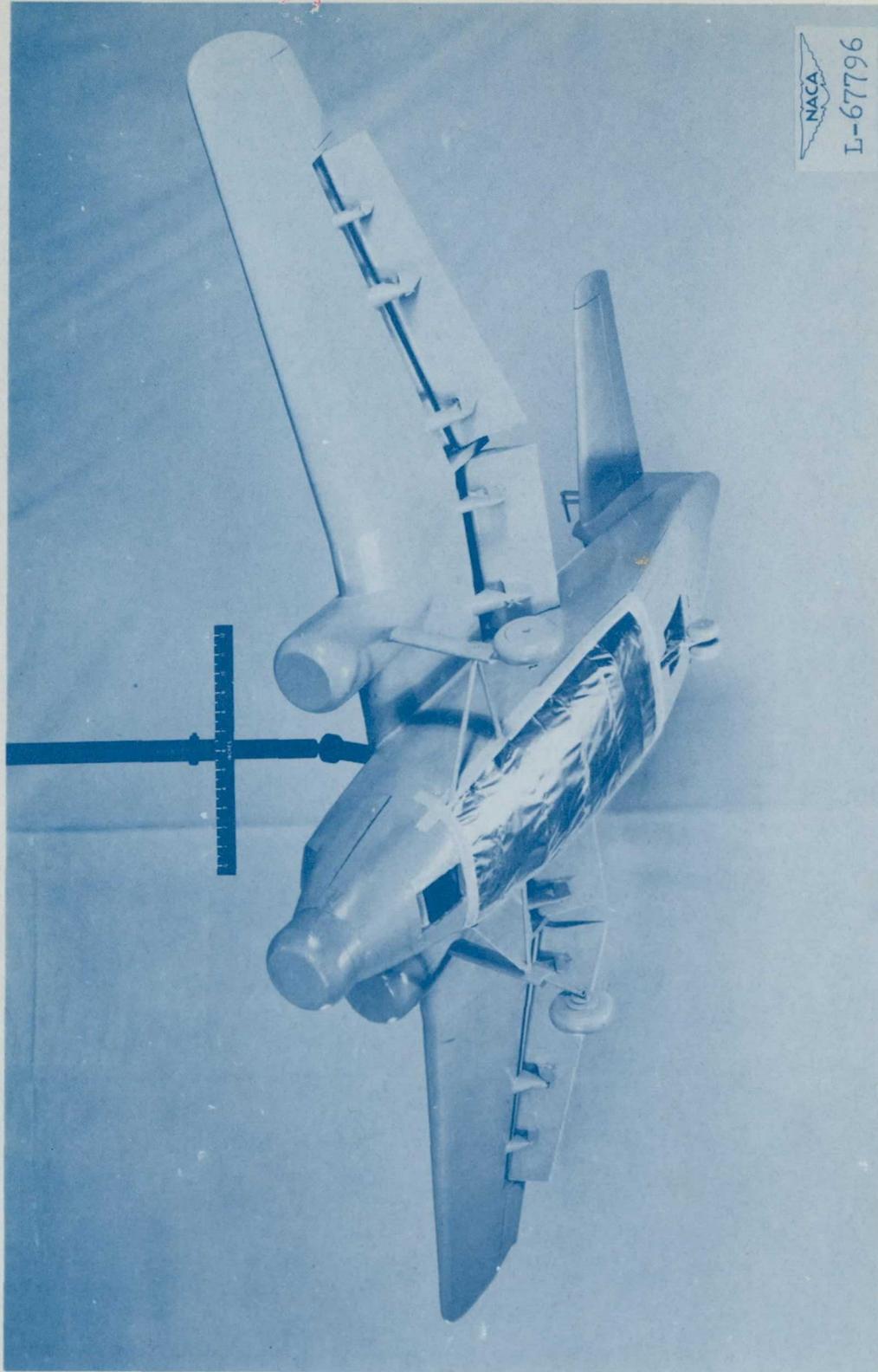


Figure 3.- Model with aluminum-covered framework of rigid bulkheads installed.

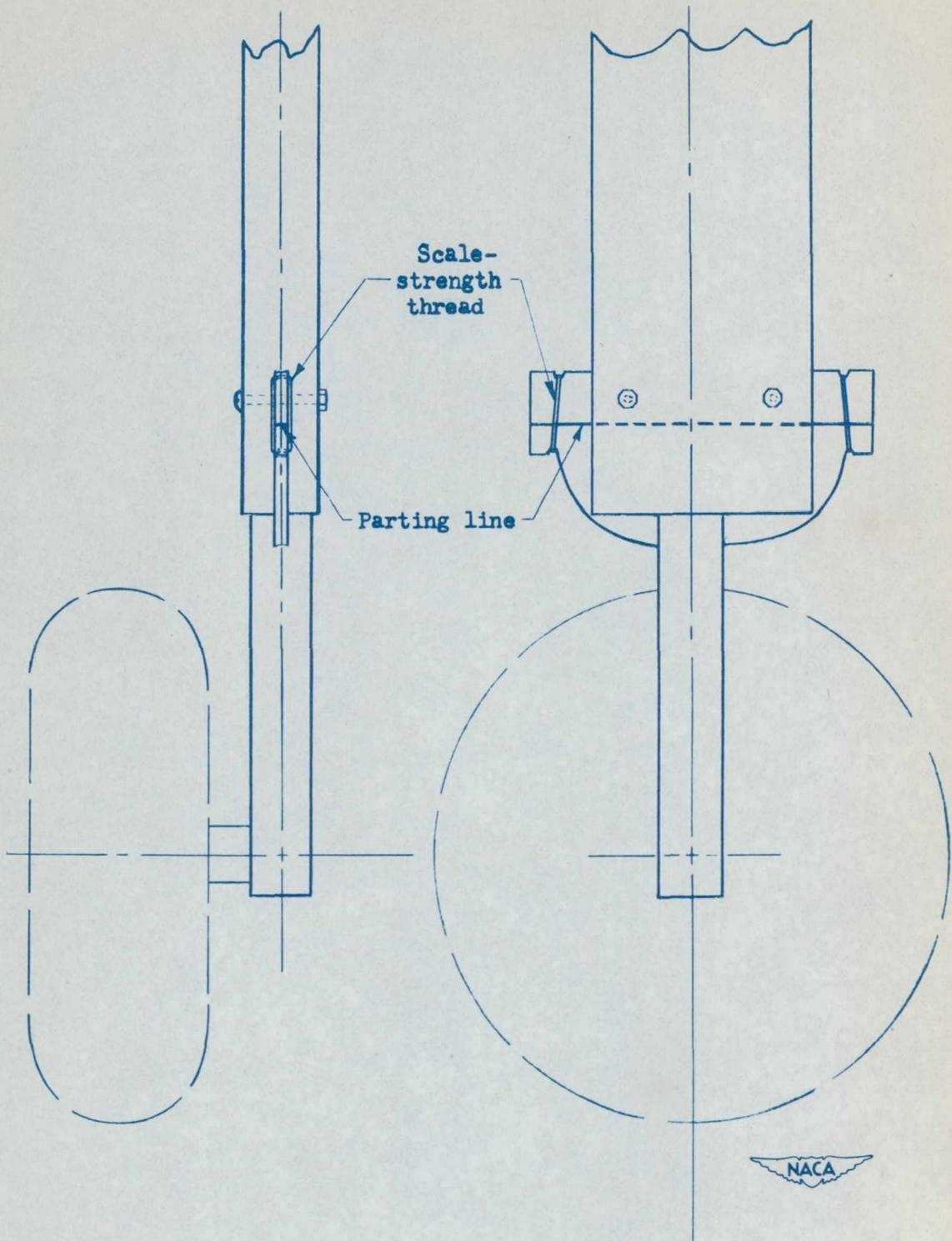
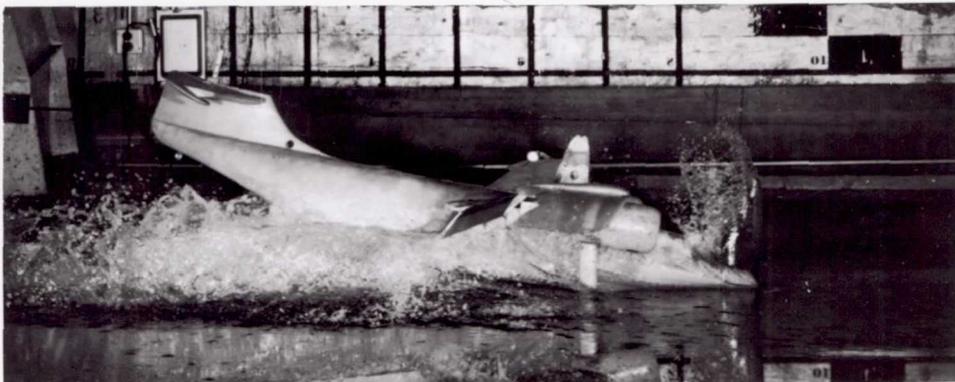


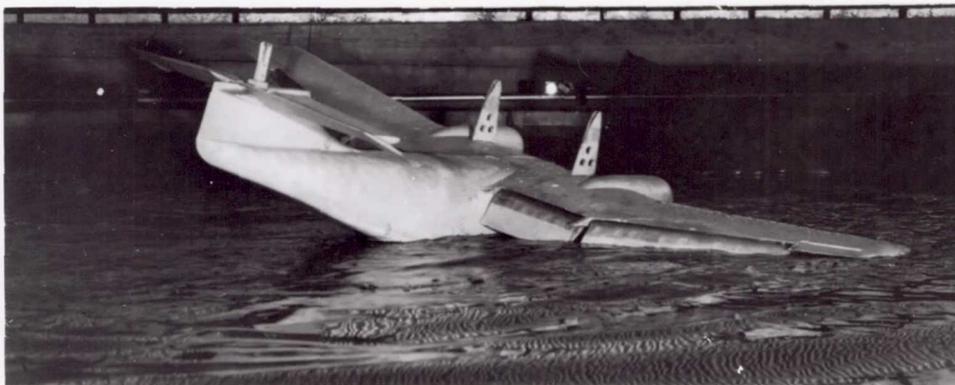
Figure 4.- Details of scale-strength attachment of main landing gear.



Near contact



85 feet



140 feet

(a) Landing gear installed.

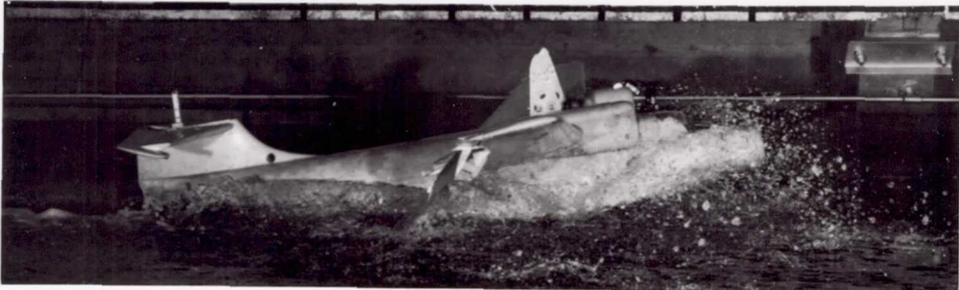


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Figure 5.- Sequence photographs of model with aluminum-covered framework of rigid bulkheads installed; pilot's compartment entry hatch and air exit door removed;  $8^{\circ}$  attitude; flaps full down. (Full-scale values are given.)



Near contact



130 feet



190 feet



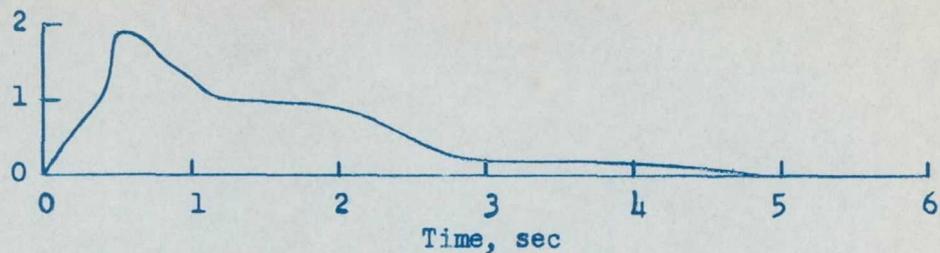
390 feet

(b) Landing gear removed.

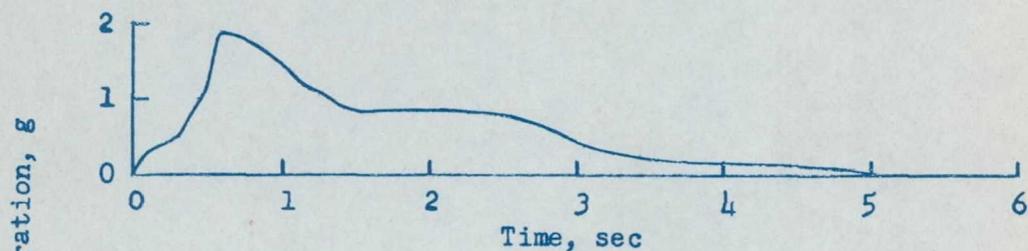
Figure 5.- Concluded.



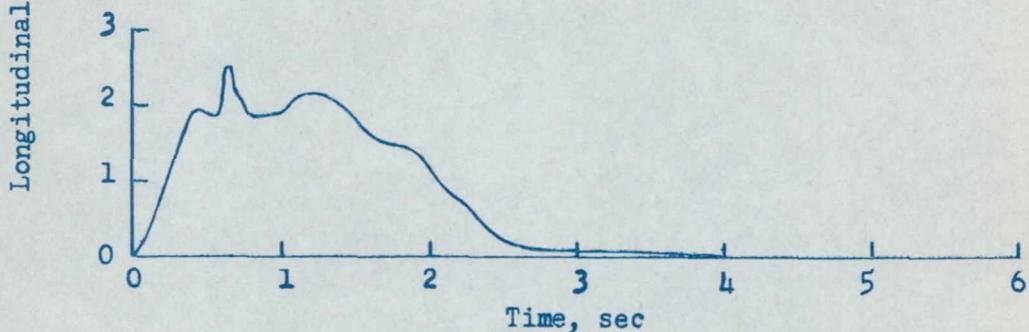
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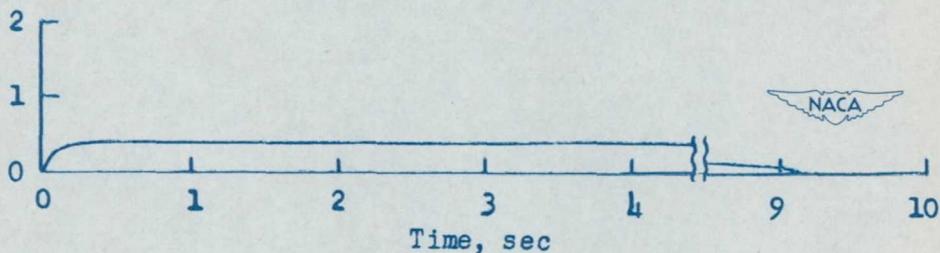
(a) 8° attitude; speed 56 knots.



(b) 4° attitude; speed 60 knots.



(c) 0° attitude; speed 64 knots.



(d) Landing gear removed; 8° attitude; speed, 56 knots.

Figure 6.- Longitudinal decelerations at various landing attitudes with no damage simulated; flaps full down. (Full-scale values given.)

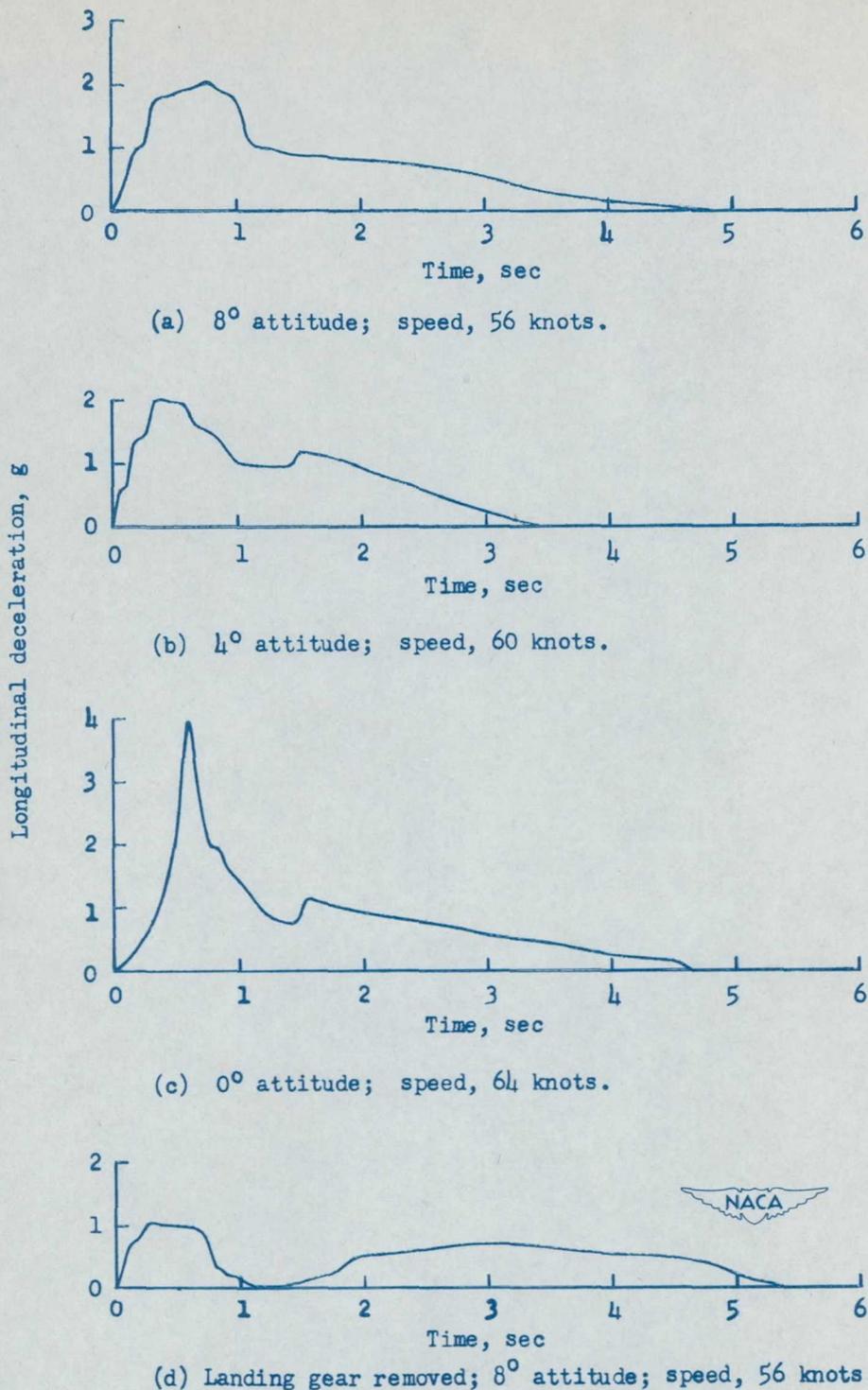
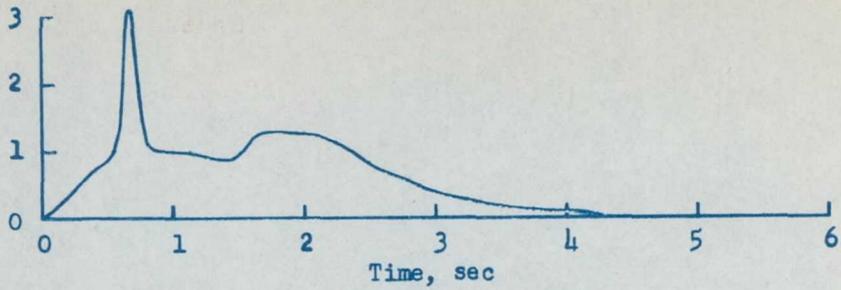
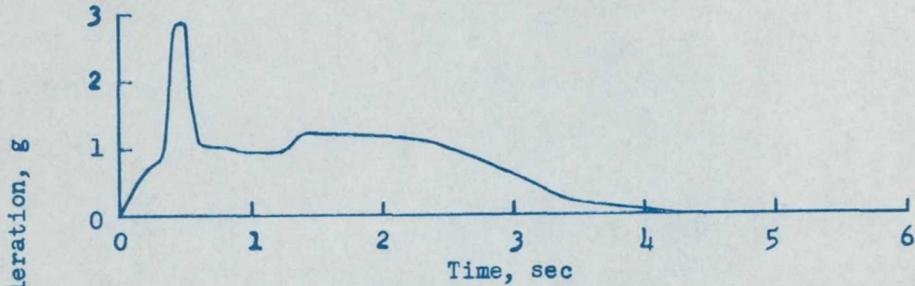


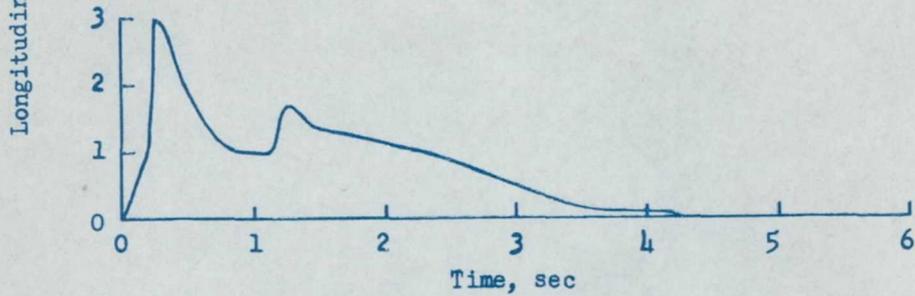
Figure 7.- Longitudinal decelerations at various landing attitudes with aluminum-covered framework of rigid bulkheads installed; pilot's compartment entry hatch and air exit door removed; flaps full down. (Full-scale values given.)



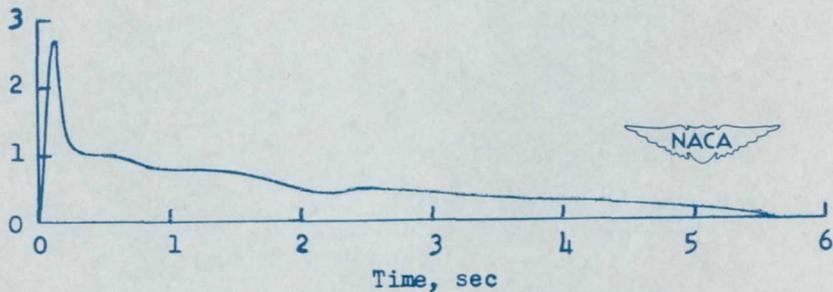
(a) 8° attitude; speed 56 knots.



(b) 4° attitude; speed 60 knots.

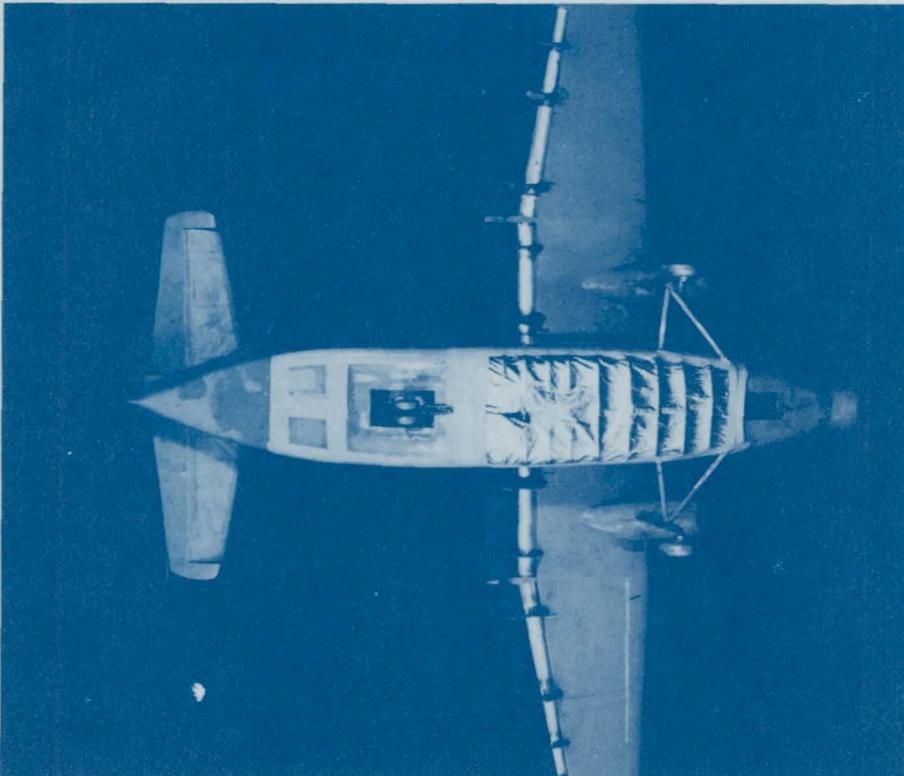


(c) 0° attitude; speed 64 knots.

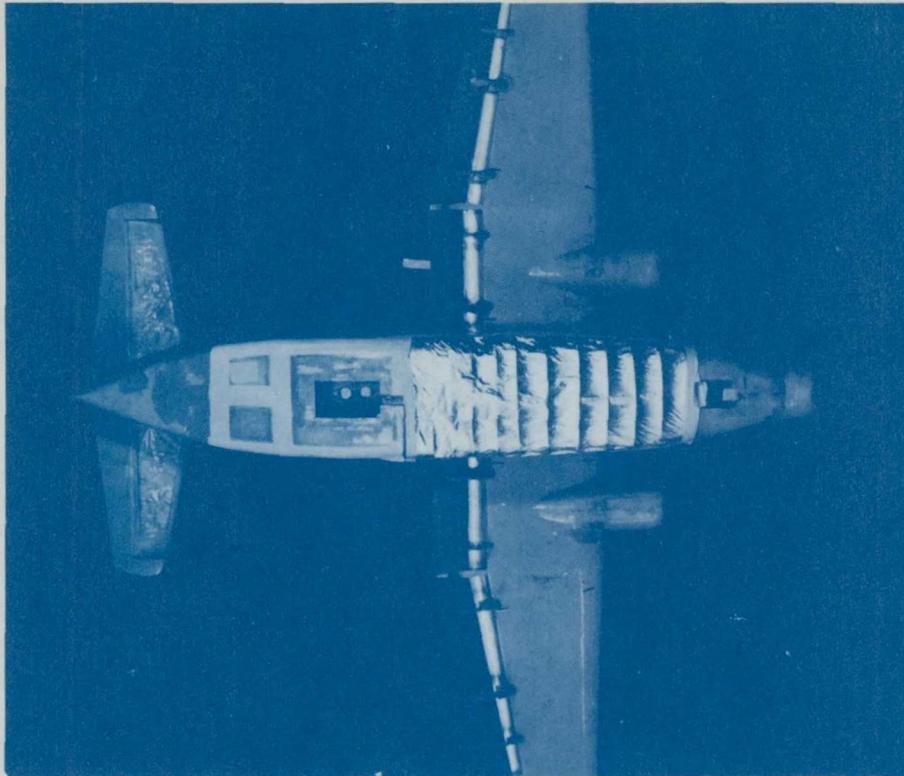


(d) Landing gear removed; 8° attitude; speed 56 knots.

Figure 8.- Longitudinal decelerations at various landing attitudes with framework of rigid bulkheads installed; pilot's compartment entry hatch and air exit door removed; flaps full down. (Full-scale values given.)



With landing gear fixed.



With landing gear removed.



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Figure 9.- Damage sustained by aluminum-covered framework of rigid bulkheads at the 8° attitude; flaps full down. (Full-scale values are given.)