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TESTS OF A DYNAMIC MODEL IN NACA TANK NO. 1 TO DETERMINE THE EFFECT OF LENGTH OF AFTERBODY, ANGLE OF AFTERBODY KEEL, GROSS LOAD, AND A POINTED STEP ON LANDING AND PLANING STABILITY

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NACA

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TESTS OF A DYNAMIC MODEL IN NACA TANK NO. 1 TO DETERMINE THE EFFECT OF LENGTH OF AFTERBODY, ANGLE OF AFTERBODY KEEL, GROSS LOAD, AND A POINTED STEP ON LANDING AND PLANING STABILITY

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SUMMARY

Tests were made in the NACA tank no. 1 to determine the effect of length of afterbody, angle of afterbody keel, and gross load on the limits of stable trims and on the landing characteristics of a model of a flying boat with conventional steps. The studies were made with four lengths of afterbody, four angles of afterbody keel, and five gross loads. In addition, tests were made of a pointed-step model. The model represented a hypothetical flying boat with a design gross load of 160,000 pounds and a wing span of 200 feet.

The tests showed that, between gross loads of 140,000 and 200,000 pounds, the stability at landing remained unchanged. Increasing gross loads raised the stable-trim range to higher trims and kept the stable range constant.

The tests also showed that there is an optimum angle of afterbody keel which results in the greatest range of stable trims but not necessarily the best landing stability. The model with the highest angle of afterbody keel tested showed the best landing stability at low landing trims; whereas the model with the lowest angle was the most stable at high landing trims.

With a constant angle of afterbody keel, the shortest afterbody tested exhibited the greatest stability at landing and the widest range of stable trims.

The one form of pointed step investigated showed a very narrow range of stable trims but had no tendency to skip on landing at any landing trim.

INTRODUCTION

Most of the tests of dynamic models at the NACA tanks have necessarily been of a specific nature - that is, tests of models of existing full-scale design. These tests are made to determine the characteristics of a design and, if possible, to improve it. The location, depth, or form of the step, length of afterbody, and angle of afterbody keel have been changed during the course of such tests and their effects on the dynamic characteristics determined. Because of the purpose of the investigations, few systematic studies of the effects of such changes are undertaken.

The effects of a series of changes of depth of step and load coefficients on the range of stable trims have been investigated (reference 1). As a continuation of the study of the effects of fundamental variables on hydrodynamic instability, NACA model 134 was tested with four angles of afterbody keel, four lengths of afterbody, and with a pointed step. In addition, inasmuch as the testing technique had been improved since the reference tests, a series of five gross loads on the basic configuration was investigated. The effect of these variables on landing instability - that is, skipping - and on trim limits was studied.

The NACA model 134 used for the present tests is a later design based on the same lines as NACA model 101, which was used in the reference tests.

APPARATUS AND PROCEDURE

The NACA tank no. 1, the towing apparatus, and the method of determining trim limits are essentially unchanged from the descriptions of reference 1.

Landing instability, or skipping, was studied by actual take-offs and landings made with the model. The carriage was accelerated until the model took off at approximately the desired landing trim. After take-off, the model was free to rise approximately 6 inches, further motion being restricted by a stop. The trim was then adjusted as closely as possible to the desired landing trim by means of the elevators. The carriage was decelerated at a fixed rate until the model had landed and had reached a definitely stable condition. The actual trim at contact and the speed of the carriage at contact were noted, and a motion-picture camera recorded the behavior of the model.

The afore-mentioned fixed rate of deceleration was not necessarily the scale value but was the only rate that could be repeated with reasonable accuracy with the existing technique of carriage operation. At this rate, speed was reduced from the contact speed (40 to 50 fps) to hump speed in about 10 seconds.

DESCRIPTION OF MODEL

The model is a 1/12-size representation of a hypothetical flying boat with a design gross load of 160,000 pounds and a span of 200 feet. A profile of the model, with the basic step and afterbody, is shown in figure 1. Profile and bottom plan views of the afterbodies tested are shown in figures 2 to 4, and figure 5 shows photographs of the complete model.

A full-size flying boat comparable to the model tested would be generally similar to the Martin XPB2M-1 Mars. The wing and tail surfaces are similar to those of the Mars in size and in location with respect to the step.

The hull lines are based on the lines of model 101. The bow was raised and shortened from the original form to provide a more practical, seaworthy forebody. The deck line was raised in order completely to submerge the wing root for aerodynamic cleanness and the tail extension was widened sufficiently to accommodate a turret.

The "basic" model with a depth of step 5.5 percent of the beam, angle of afterbody keel 5.5° from the base line, and a length of afterbody equal to 37.15 inches, represents conventional present-day design. The length-of-afterbody series included the basic afterbody, one longer afterbody (basic length increased by 1/2 beam), and two shorter afterbodies (1/2 beam and 1 beam shorter than the basic length), all with an angle of afterbody keel of 5.5°. The angle-of-afterbody-keel series included the basic afterbody 5.5°, one lower angle 4.0°, and two higher angles 7.0° and 8.5°, all with the basic length of afterbody of 37.15 inches.

The pointed step was laid out to give the same stern-post clearance as the basic hull, that is, the same angle between main-step stern-post line and base line.

It was anticipated that the depth of the main step, 5.5 percent of the beam, probably would not be great enough to eliminate skipping completely on the basic model. This condition was desirable in order to study the effect of variations in the afterbody on an already unstable model. Tests with a deeper step are contemplated.

The construction of the model followed the usual practice. The light plywood frames were notched to receive balsa stringers, mahogany keel, and chine strips, and the whole was planked with balsa. Exterior finish consisted of tissue laid in dope as a seal for fine cracks and pin holes and of several coats of pigmented varnish. The lower portion of the hull was constructed with two removable sections, a step section and an afterbody section.

Important dimensions of the model are as follows:

	Full-size	1/12-size model
Dimensions of hull		
Beam, maximum	14.24 ft	14.24 in.
Beam, at step	13.86 ft	13.86 in.
Length of forebody (bow to step)	51.70 ft	51.70 in.
(Length-beam ratio = 3.70)		
Length of tail extension	32.95 ft	32.95 in.
(Length-beam ratio = 2.31)		
Length, over-all	124.05 ft	124.05 in.
(Length-beam ratio = 8.70)		
Depth of step, at keel	0.78 ft	0.78 in.
Angle of dead rise at step:		
Excluding chine flare	20°	20°
Angle of forebody keel	1.3°	1.3°
Angles of afterbody keel:		
Model 134A (Basic)	5.5°	5.5°
Model 134B	4.0°	4.0°
Model 134C	7.0°	7.0°
Model 134D	8.5°	8.5°
Models 134E, 134F, 134G	5.5°	5.5°
Model 134H	2.0°	2.0°
Lengths of afterbody:		
Models 134A, 134B, 134C, 134D	37.15 ft	37.15 in.
(Length-beam ratio = 2.61)		
Model 134E	44.27 ft	44.27 in.
(Length-beam ratio = 3.11)		
Model 134F	30.03 ft	30.03 in.
(Length-beam ratio = 2.11)		
Model 134G	22.91 ft	22.91 in.
(Length-beam ratio = 1.61)		
Model 134H	32.12 ft	32.12 in.

	Full-size	1/12-size model
Angles between keel lines at step:		
Model 134A	6.8°	6.8°
Model 134B	5.3°	5.3°
Model 134C	8.3°	8.3°
Model 134D	9.8°	9.8°
Models 134E, 134F, 134G	6.8°	6.8°
Model 134H	3.3°	3.3°
Dimensions of wing		
Area	3683 sq ft	25.58 sq ft
Span	200 ft	200 in.
Root chord (sec. NACA 23020)	28 ft	28 in.
Tip chord (sec. NACA 23012)	9.33 ft	9.33 in.
Angle of incidence	5.5°	5.5°
L.E. at root, aft of F.P.	38.01 ft	38.01 in.
Length, M.A.C.	20.12 ft	20.12 in.
L.E. M.A.C., aft of F.P.	40.70 ft	40.70 in.
L.E. M.A.C., forward of step	11.00 ft	11.00 in.
Angle of incidence of M.A.C.	5.5°	5.5°
Dimensions of horizontal tail surface		
Type	Twin, V	
Area	505 sq ft	3.51 sq ft
Span	41.38 ft	41.38 in.
Incidence (normal)	3°	3°
Dihedral	14°	14°
L.E. of root chord of wing to L.E. of root chord of tail	65.77 ft	65.77 in.
Root chord (sec. NACA 0015)	14.83 ft	14.83 in.
Tip chord (sec. NACA 0015)	9.63 ft	9.63 in.
Loading conditions		
Gross loads:		
Model 134A	127,300 lb	73.1 lb
	140,000 lb	80.4 lb
(design)	160,000 lb	91.8 lb
	180,000 lb	103.3 lb
	200,000 lb	114.8 lb
Models 134B, 134C, 134D, 134E, 134F, 134G, 134H	160,000 lb	91.8 lb
c.g. forward of step (40 percent M.A.C.)	3.56 ft	3.56 in.
c.g. forward of step (20 percent M.A.C.)	5.99 ft	5.99 in.
c.g. above step	12.23 ft	12.23 in.
Pitching moment of inertia about c.g.	1.366×10^6 slug-ft^2	6.9 slug-ft^2

RESULTS AND DISCUSSION

The trim limits of stability are plotted against speed for model 134A for various gross loads in figures 6 to 10. The angle of afterbody keel was varied and the resulting curve is given for model 134B in figure 11, for 134C in figure 12, and for 134D in figure 13. The effect of changes in the length of afterbody on these limits of stability is given in figure 14 for model 134E, figure 15 for 134F, and figure 16 for 134G. Figure 17 is the curve of trim limits of stability against speed for the model with the pointed step, 134H.

The effect on the limits of stability of gross load is shown in figure 18, of angle of afterbody keel in figure 19, and of length of afterbody in figure 20. The critical trims from figures 6 to 10 have been cross-plotted against gross load in figure 21, against angle of afterbody keel in figure 22, and against length of afterbody in figure 23. In figures 21 to 23 speed is the parameter.

Trim Limits of Stability

Effect of load.- The effect of load on the trim limits of stability is best shown in figures 18 and 21. The general effect is to raise the complete set of limits to higher trims as the gross load is increased. Some inconsistent crossing of the faired limit curves may be observed in figure 18. This inconsistency is undoubtedly due in part to differences in the personal interpretations of the point at which instability began by three observers, each of whom ran a part of the tests. The critical trims (trim at upper and lower limits) from the faired curves of figures 6 to 10 have been cross-plotted against load in figure 21 at several speeds. This figure shows that the curves of critical trim against load are approximately linear. It should be sufficient, then, when a specific model is tested, to investigate only the extreme values of gross loads.

Effect of angle of afterbody keel.- Figures 19 and 22 summarize the results of the tests with various angles of afterbody keel. No marked changes in the position of the lower limit resulted from changes in this angle. This fact verifies the general observation that the afterbody has no effect on low-angle planing stability.

The upper limits were raised to higher trims as the angle of afterbody keel was increased. The change was not linear, as figure 22 shows. Increasing the angle from 4.0° to 5.5° raised both upper limits; a further change to 7.0° raised the upper limits a greater amount. The change from 7.0° to 8.5° produced little increase in the stable-trim range and entirely changed the character of the motion during high-angle porpoising. With an angle of afterbody keel of 8.5°, high-angle porpoising appeared to consist mainly in violent vertical motion and very little change in trim occurred. Lower angles of afterbody keel produced the usual high-angle porpoising of coupled trim and rise motions, the angular motion being centered at some point near the stern post.

Considerable loss in range of stable trims will result, then, if the angle of afterbody keel is far from the optimum. Not only may too great an angle show no increase in stability but it may even decrease the stable range or lead to a more violent type of porpoising.

Effect of length of afterbody.- Figures 20 and 23 summarize the effect of length of afterbody on the trim limits. In figure 20 some crossing of the lower limits may be noticed. A slight, almost negligible trend to raise the lower limit as the length of afterbody is increased may be seen on the cross plots of figure 23; the change is so slight as to be uncertain and of no practical significance.

The upper limits are raised to higher trims as the afterbody is shortened. This effect is especially pronounced for the change from the 30.03-inch length to the 22.91-inch length. An afterbody shorter than is conventional at the present time may therefore be expected to increase the stable-trim range of a flying boat.

It must be remembered that in the length-of-afterbody series a constant angle of afterbody keel was maintained, which results in more stern-post clearance as the afterbody is shortened.

Effect of a pointed step.- Figure 17 shows a comparison of the trim limits determined for the pointed-step model 134H and the basic model 134A. The pointed-step arrangement was tested, because it was believed to offer a naturally well-ventilated step which should have a desirable effect on landing and porpoising stability. It is evident from the curves that the pointed-step model has a much smaller range of stable trims than the conventional model. The lower limit.

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except at the hump speed, is considerably higher than for the conventional model, probably because of the high beam loading on the step at intermediate planing speeds and trims.

The upper limits with the pointed-step hull are lower than for the conventional hull. The resulting range of stable trims is very narrow, about 2.5°, at speeds between 32 and 35 feet per second.

Landing Stability

Effect of load.- An analysis of the motion pictures made of landings of model 134A at different attitudes with several gross loads gave the following results:

Trim at landing (deg) \ Gross load (lb)	Full size 140,000		160,000		180,000		200,000	
	Model 80.4		91.9		103.3		114.8	
	Number of skips	Landing speed (fps)	Number of skips	Landing speed (fps)	Number of skips	Landing speed (fps)	Number of skips	Landing speed (fps)
1	3	49.2	1	46.4	-----	-----	-----	-----
2	1	50.0	2	47.2	-----	-----	-----	-----
3	-----	-----	-----	-----	1	48.8	6	49.2
4	6	41.6	4	44.0	1	47.0	4	48.8
6	5	40.8	4	42.4	5	46.0	5	47.6
8	6	38.8	4	40.1	4	45.6	5	47.2
10	5	40.6	6	42.6	4	44.2	5	46.0
12	9^+	40.2	5	41.6	4	44.0	3	45.6

The number of skips given for each landing is the number of times the keel at the main step came clear of the water after the initial contact. This number gives no indication of the violence or magnitude of the jump but may be used as a rough comparison of relative instability for different conditions.

An inspection of the foregoing results shows no definite trend of the number of skips as the gross load is changed within the test limits; consequently investigations of landing instability with a given hull form, made at the design gross load, may be expected to represent behavior at lighter loads. Tentative conclusions reached from observations made from tests of other models verify this assumption.

Effect of angle of afterbody keel.- The following table gives the results of the landings made with the different angles of afterbody keel (models 134A, 134B, 134C, and 134D):

Trim at landing (deg) \ Angle of afterbody keel (deg)	4.0		5.5		7.0		8.5	
	Number of skips	Landing speed (fps)	Number of skips	Landing speed (fps)	Number of skips	Landing speed (fps)	Number of skips	Landing speed (fps)
2	1	46.4	2	47.2	1	47.2	0	50.2
4	4	44.0	4	44.0	0	44.2	1	46.2
6	3	42.8	4	42.4	1	43.0	1	45.6
8	3	43.6	4	40.1	5	43.6	6	46.8
10	1	42.2	6	42.6	9	43.4	8	44.8
12	5	43.0	5	41.6	11	40.8	4	43.6

It is evident that no angle of afterbody keel tested was optimum at all landing attitudes. The two highest angles of afterbody keel tested, 7.0° and 8.5°, showed the least skipping tendencies at landing trims below 6°. At higher landing trims, however, these angles were more unstable than the lowest angle, 4.0°. Inasmuch as most landings in full-size operation are probably made at the higher trims, a low angle of afterbody keel would be the design choice to minimize skipping.

If the test results shown in the preceding table are analyzed on the basis of trim of afterbody keel, the same conclusions are reached. Each of these four afterbodies showed the least tendency to skip when landing at negative afterbody trims. At positive afterbody trims, the lowest angle of afterbody keel of the series has the least tendency to skip.

Effect of length of afterbody.- The results of the landings made with different lengths of afterbody (models 134A, 134E, 134F, and 134G) are shown in the following table:

Trim at landing (deg) \ Length of afterbody (in., model, ft, full size)	22.91		30.03		37.15		44.27	
	Number of skips	Landing speed (fps)	Number of skips	Landing speed (fps)	Number of skips	Landing speed (fps)	Number of skips	Landing speed (fps)
1	0	48.0	0	46.0	1	46.4	0	52.8
2	0	50.5	1	44.0	2	47.2	0	52.0
4	3	44.6	1	42.8	4	44.0	0	49.6
6	3	42.6	7	44.0	4	42.4	12+	45.0
8	1	42.0	5	42.0	4	40.1	15	44.8
10	3	43.2	6	41.2	6	42.6	10	44.0
12	2	42.8	6	40.6	5	41.6	5	42.4

These data indicate that the shortest afterbody tested was definitely the most stable at any landing trim higher than 6°. At lower landing trims, the shortest afterbody was not more stable than the others but appeared to be just as stable. A short afterbody with the same angle of afterbody keel as a longer afterbody may be expected, therefore, to be the more stable at landing.

Effect of a pointed step.- The pointed-step hull (model 134H, fig. 4) exhibited no tendency to skip at any landing attitude tested. At high landing trims, the model trimmed down sharply after contact. This action, which was very sudden, may be as undesirable as light skipping. Further tests to explore the characteristics of this type of step would be of considerable interest.

CONCLUSIONS

1. Increasing the gross load of a flying boat raises the trim limits to higher trims. No marked change in the range of stable trim attitudes occurs with load change.

The shift in the trim limits to higher trims is approximately linear with the increase in load. No appreciable change in the landing instability (skipping) appears as the load is changed. Testing at only the extremes of gross-weight conditions should therefore be sufficient in investigations of trim limits and landing stability.

2. There is no obvious optimum angle of afterbody keel for the best over-all characteristics of the model tested. A relatively high angle of afterbody keel showed the greatest range of stable trims but was more unstable on landing except at low landing trims. The choice of an angle of afterbody keel for a given design should be made only after tests, at least until further research data are available.

3. With a fixed angle of afterbody keel, a short afterbody may be expected to be more desirable than a longer one for the purpose of securing greater range of stable trims and better stability at landing.

4. Tests of one pointed step indicated it to be considerably more stable at landing than a conventional step. The pointed step, however, had a narrower range of stable trims available than the conventional step.

5. Wide variations in angle of afterbody keel or length of afterbody had relatively small effects on the skipping characteristics of a model already unstable at landing. A change in plan form, however, that produced better natural ventilation of the step completely eliminated skipping.

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REFERENCE

1. Olson, Roland E., and Land, Norman S.: The Longitudinal Stability of Flying Boats as Determined by Tests of Models in the NACA Tank. I - Methods Used for the Investigation of Longitudinal-Stability Characteristics. NACA A.R.R., Nov. 1942.

The [illegible] in the [illegible] limits at higher trims is generally [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] landing stability.

7. There is no obvious optimum angle of afterbody keel from the over-all characteristics of the model tested. A relatively high angle of afterbody keel showed a greater range of stable trims but was more unstable on landing except at low landing trims. The choice of an angle of afterbody keel for a given hull should be made [illegible] until further research data are available.

8. With a fixed angle of afterbody keel, a short afterbody may be expected to be more favorable than a long afterbody from the standpoint of [illegible] range of stable trims and better stability at landing.

9. The [illegible] indicated [illegible] [illegible] [illegible] [illegible] the [illegible] [illegible] range of stable trims [illegible].

10. It is believed [illegible] of afterbody keel or length of afterbody [illegible] effects on the [illegible] stability, of a model [illegible] [illegible]. A [illegible], however, [illegible] of [illegible] completely [illegible].

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REFERENCE

1. Olson, Roland E., and Bond, Reuben L.: The Longitudinal Stability of Flying Boats as Determined by Tests of Models in the NACA Tank. I - Methods Used for the Investigation of Longitudinal-Stability Characteristics. NACA A.R.R., Nov. 1942.

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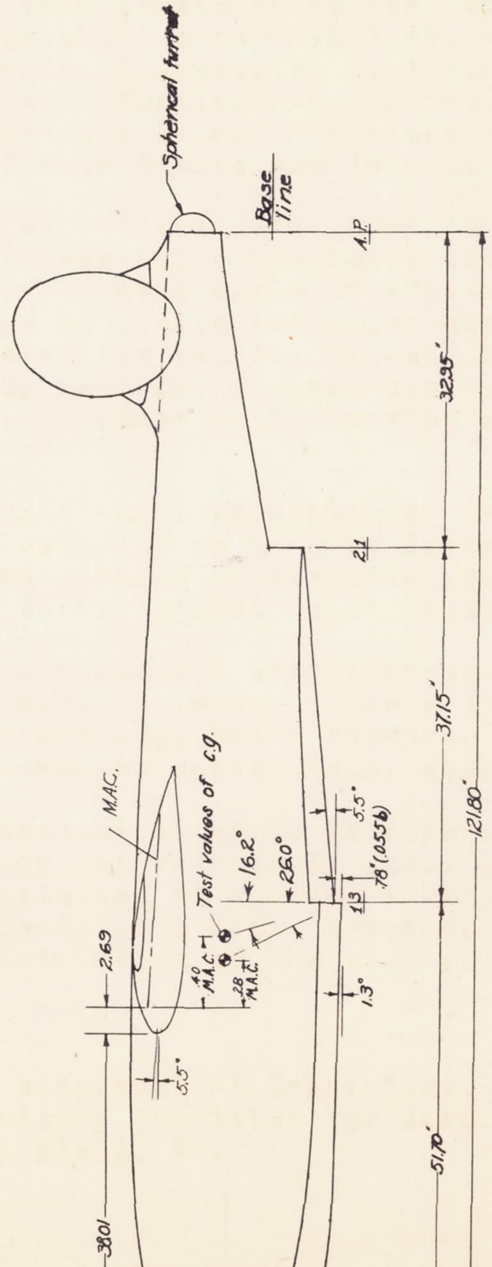

Figure 1.- Profile of model 134A with basic step and afterbody.

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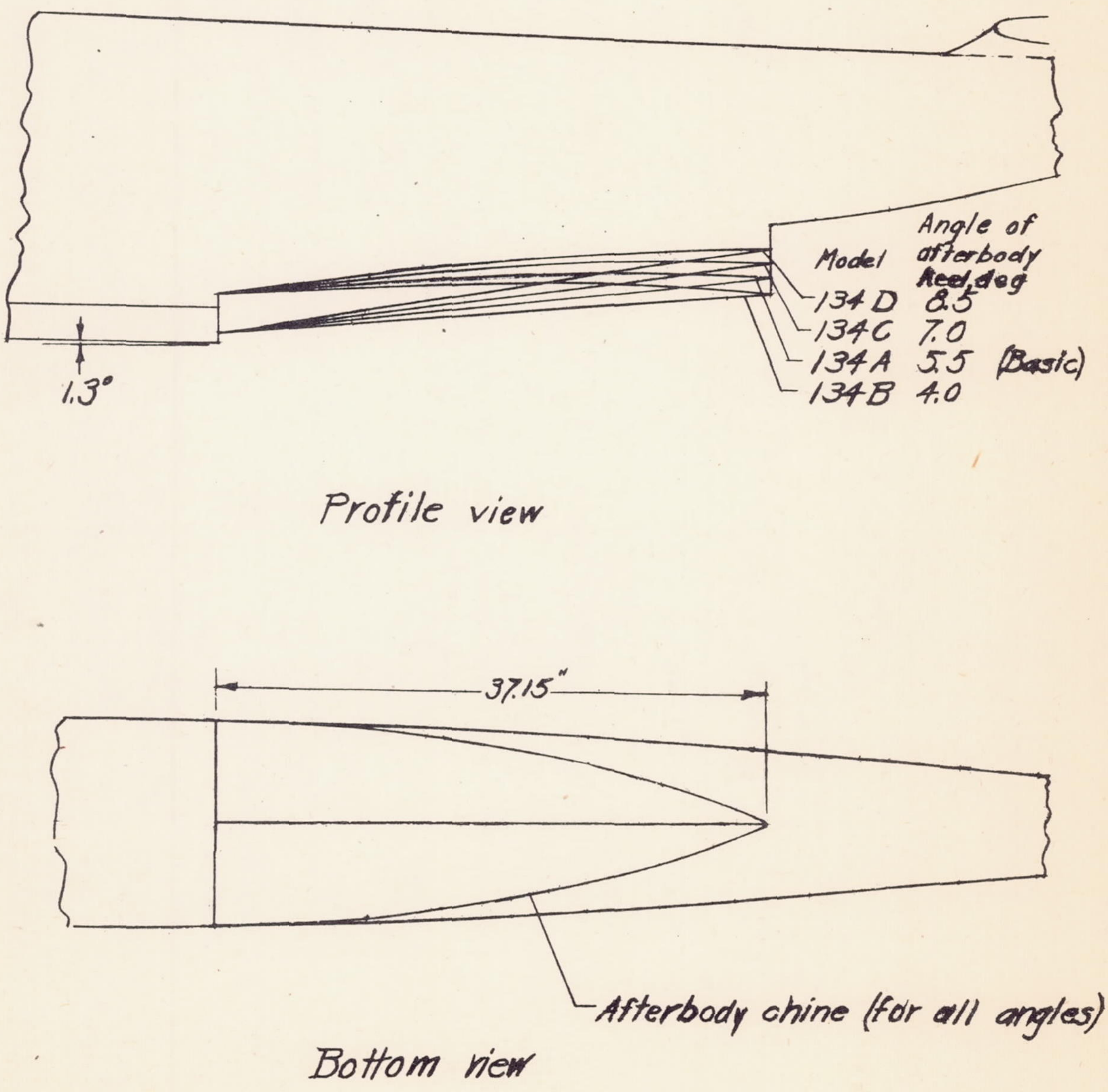
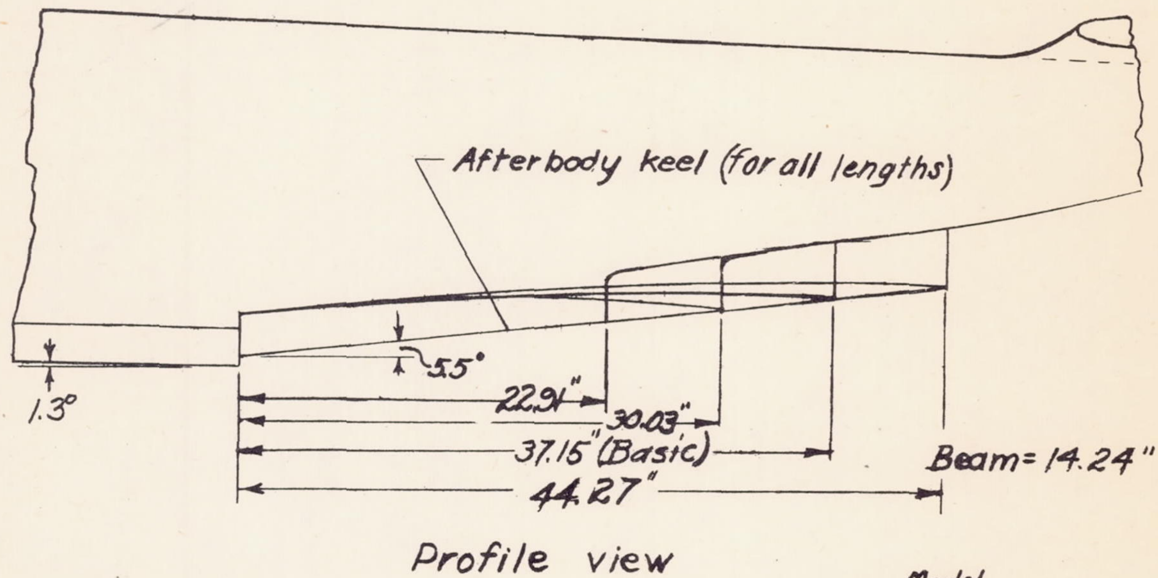


Figure 2.–Model 134. Variation of angles of afterbody keel.



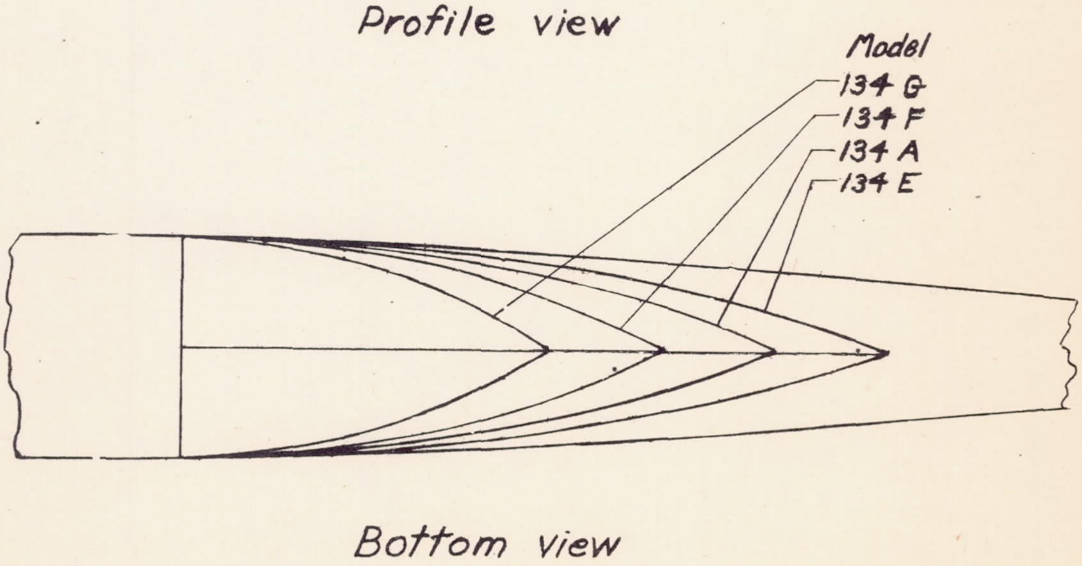
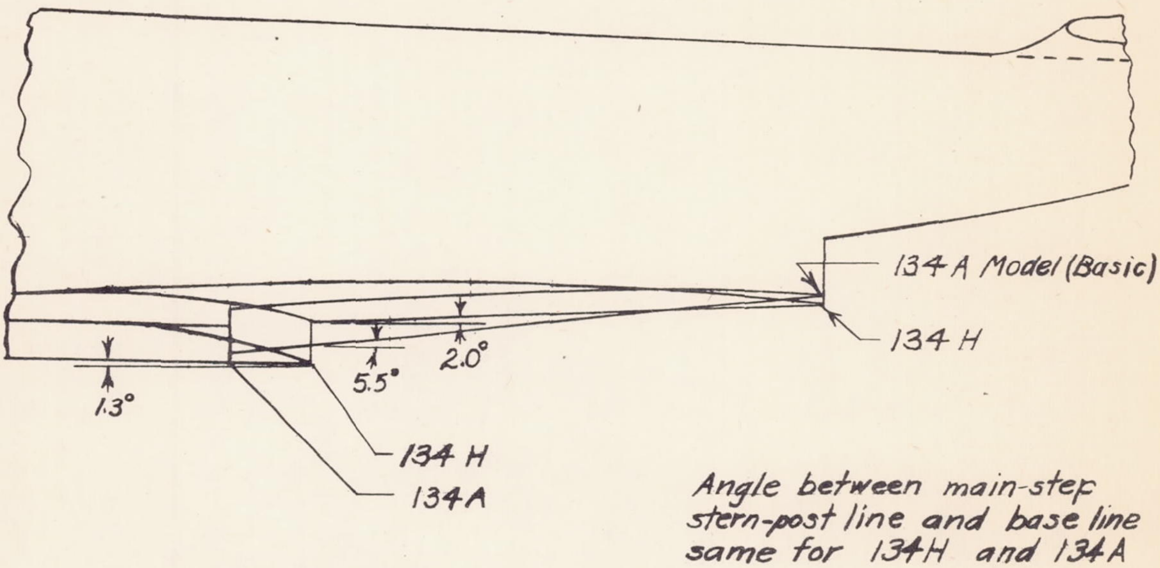
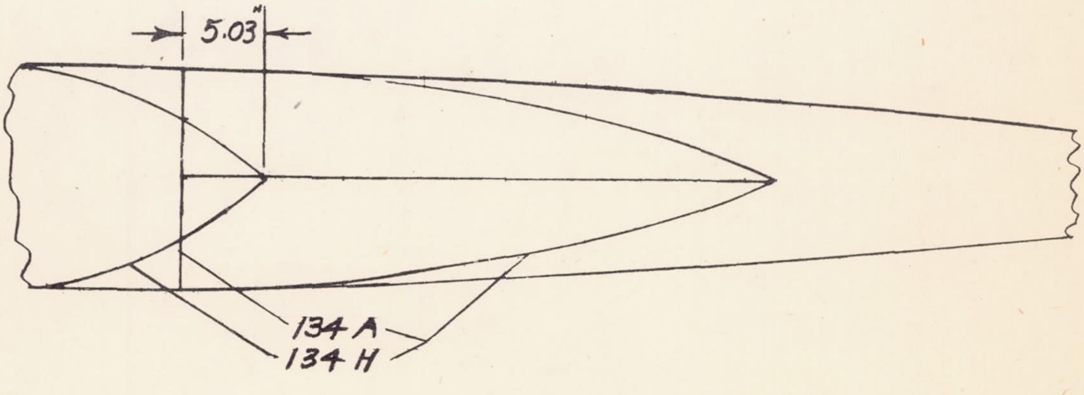


Figure 3. - Model 134. Variation of length of afterbody.



Profile view



Bottom view

Figure 4.- Model 134. Variation of plan form of step.

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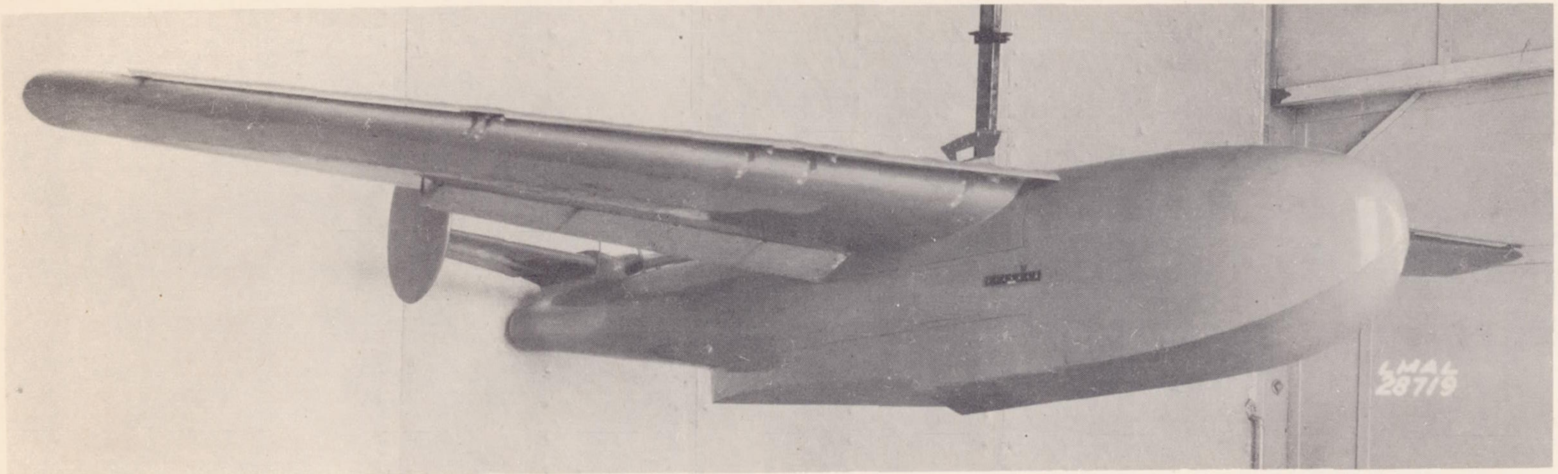
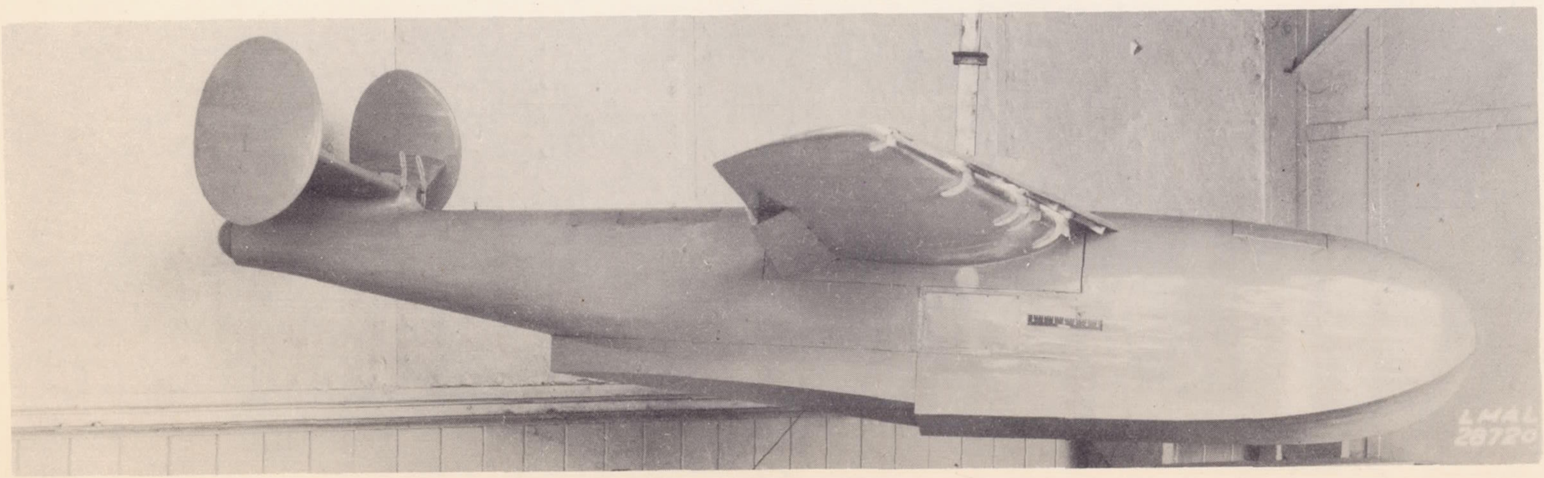


(a) Three-quarter front view.



(b) Profile view.

Figure 5.- Model 134A.

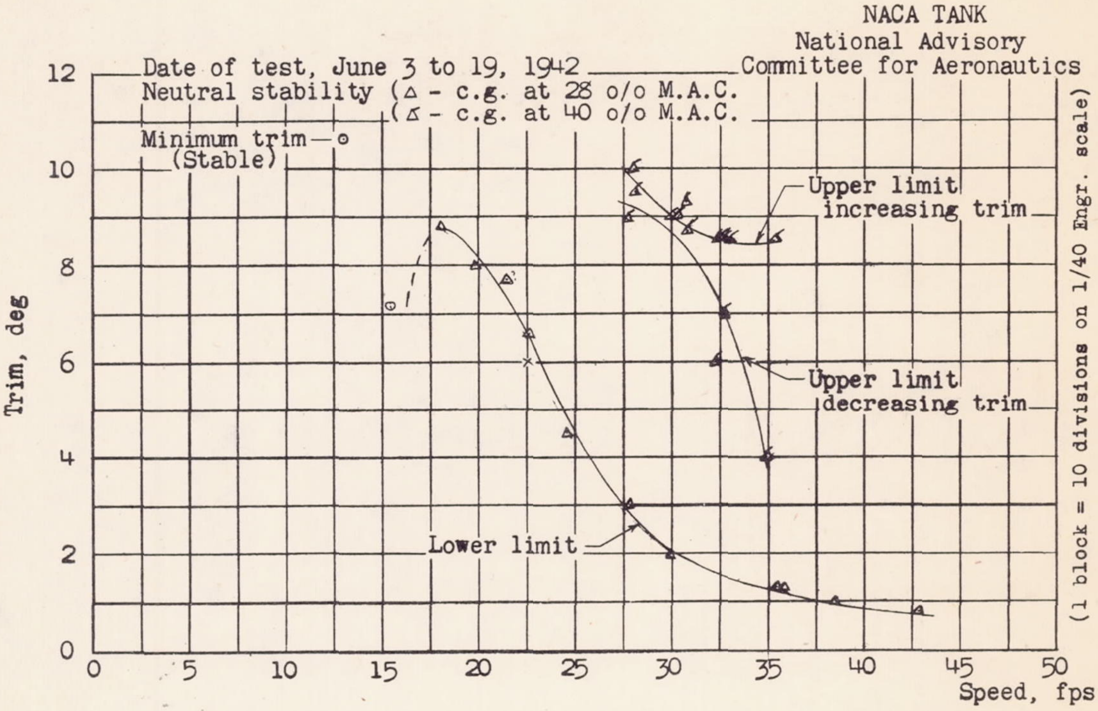


Fig. 6 . NACA Model 134-A (1/12-size dynamic model similar to XPB2M-1 airplane). Limits of stability. Δ_0= 127,300 lb, full-size; 73.07 lb, model. Angle of afterbody keel = 5.5°. Length of afterbody = 37.15".

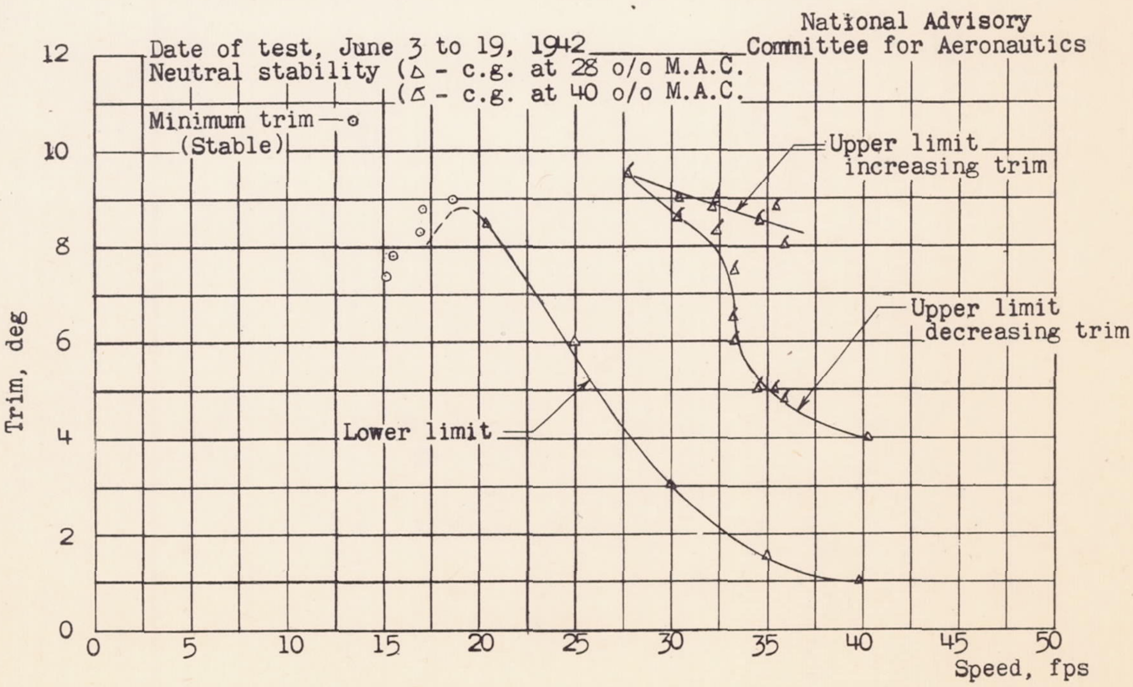


Fig. 7 . NACA Model 134-A (1/12-size dynamic model similar to XPB2M-1 airplane). Limits of stability. Δ_0 = 140,000 lb, full-size; 80.4 lb, model. Angle of afterbody keel = 5.5°. Length of afterbody = 37.15".

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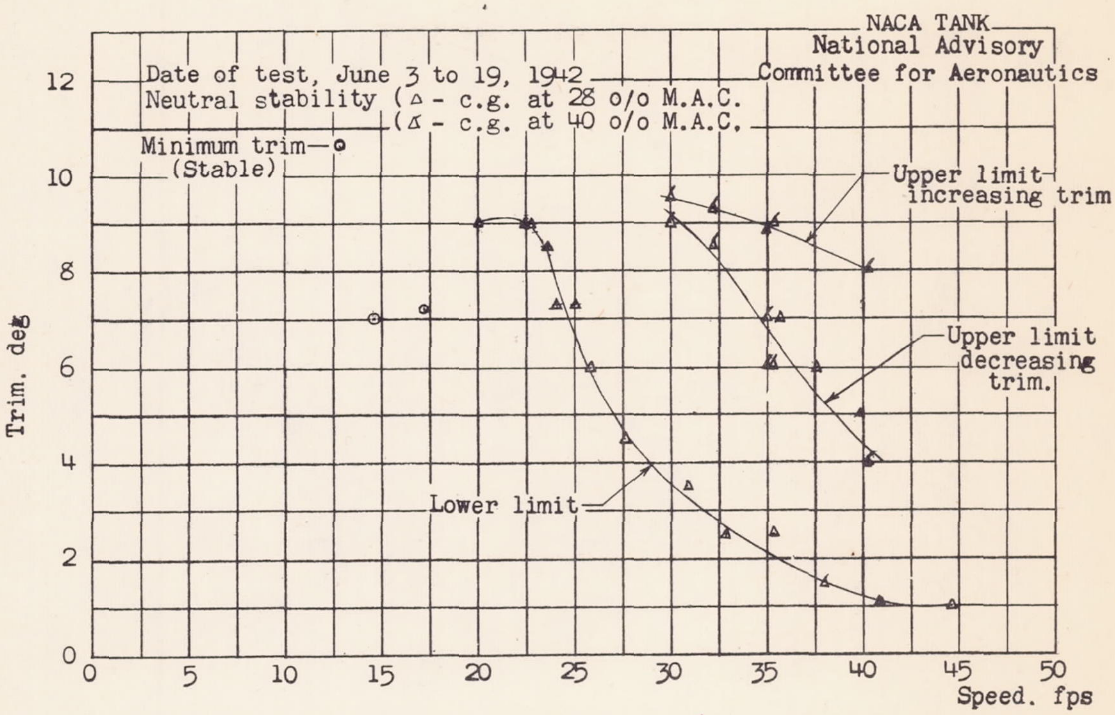


Fig. 8. NACA Model 134-A (1/12-size dynamic model similar to XPB2M-1 airplane). Limits of stability. Δ_0 = 160,000 lb, full-size; 91.9 lb, model. Angle of afterbody keel = 5.5°. Length of afterbody = 37.15".

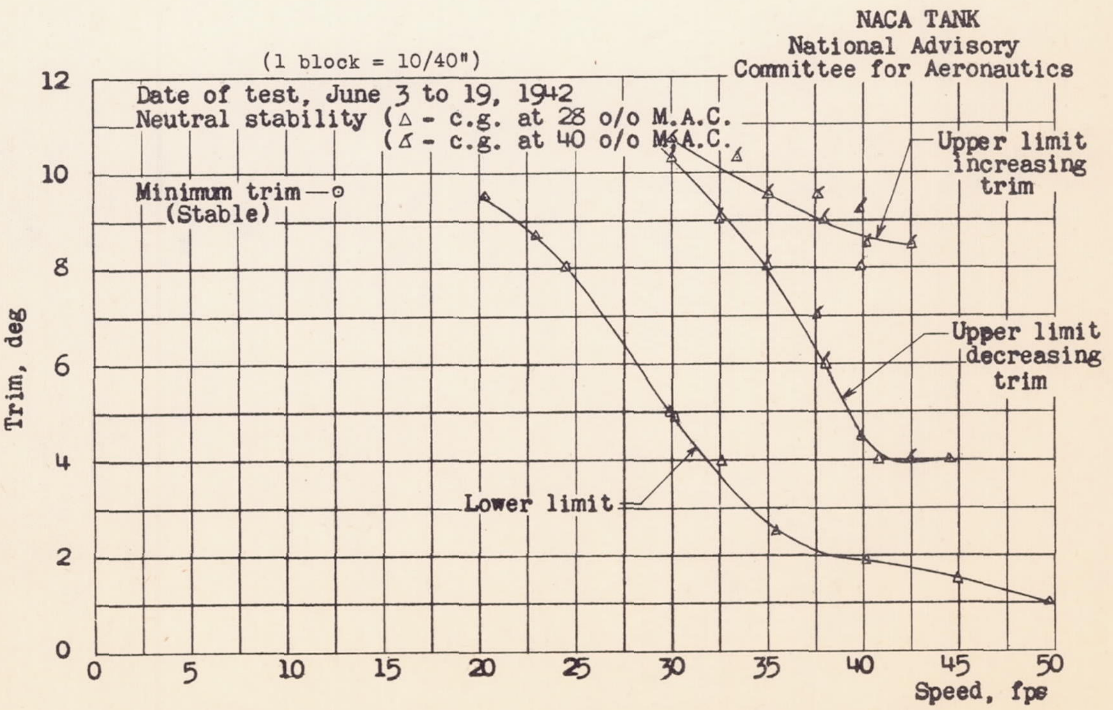


Fig. 9. NACA Model 134-A (1/12-size dynamic model similar to XPB2M-1 airplane). Limits of stability. Δ_0 = 180,000 lb, full-size; 103.4 lb, model. Angle of afterbody keel = 5.5°. Length of afterbody=37.15".

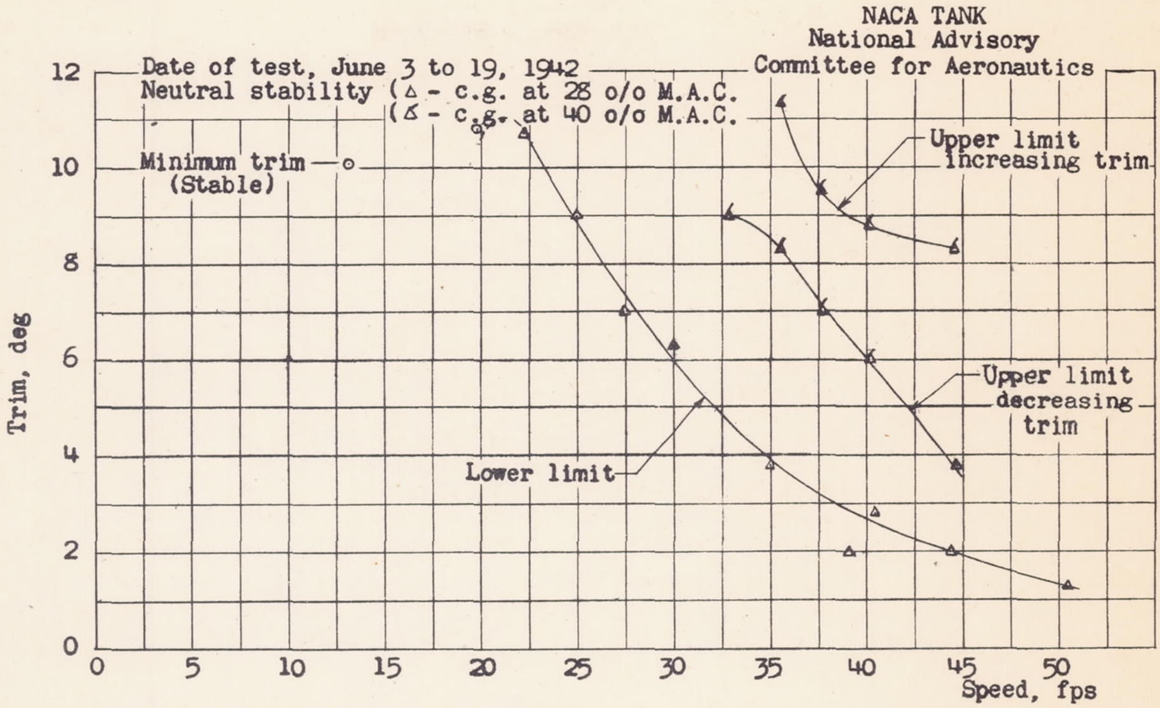


Fig. 10 . NACA Model 134-A (1/12-size dynamic model similar to XPB2M-1 airplane). Limits of stability. Δ_0 = 200,000 lb, full-size; 114.9 lb, model. Angle of afterbody keel = 5.5°. Length of afterbody = 37.15".

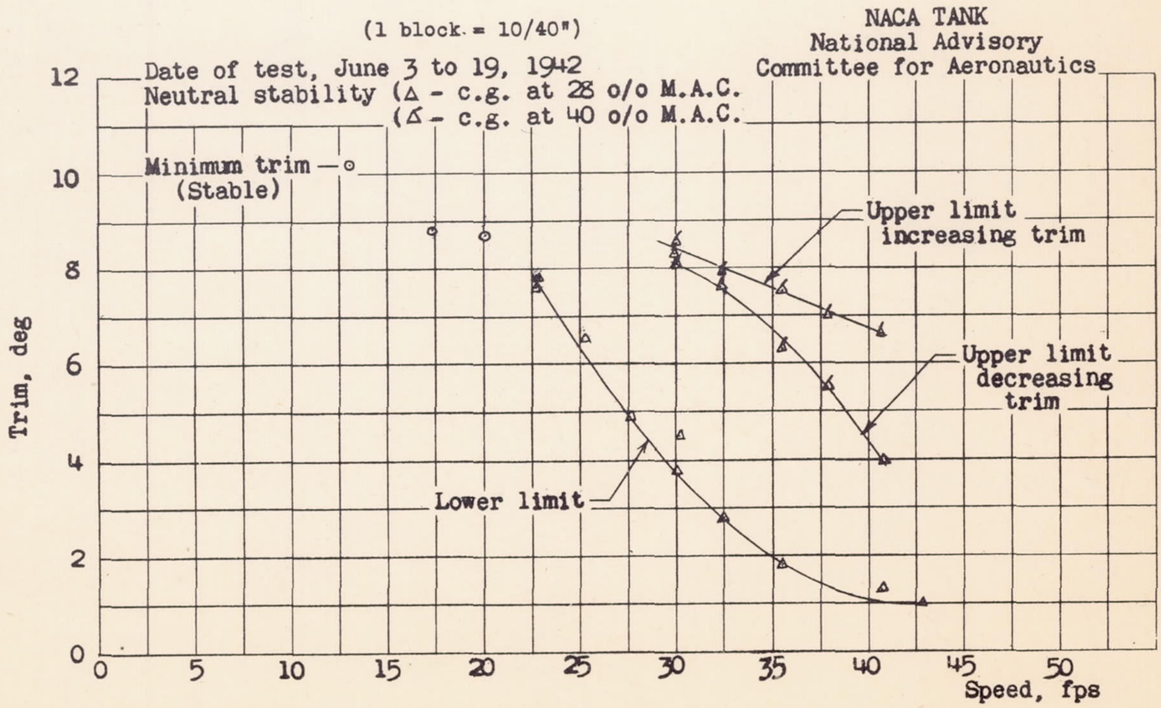


Fig. 11 . NACA Model 134-B (1/12-size dynamic model similar to XPB2M-1 airplane). Limits of stability. Δ_0 = 160,000 lb, full-size; 91.9 lb, model. Angle of afterbody keel=4.0°. Length of afterbody = 37.15".

L-400

L-400

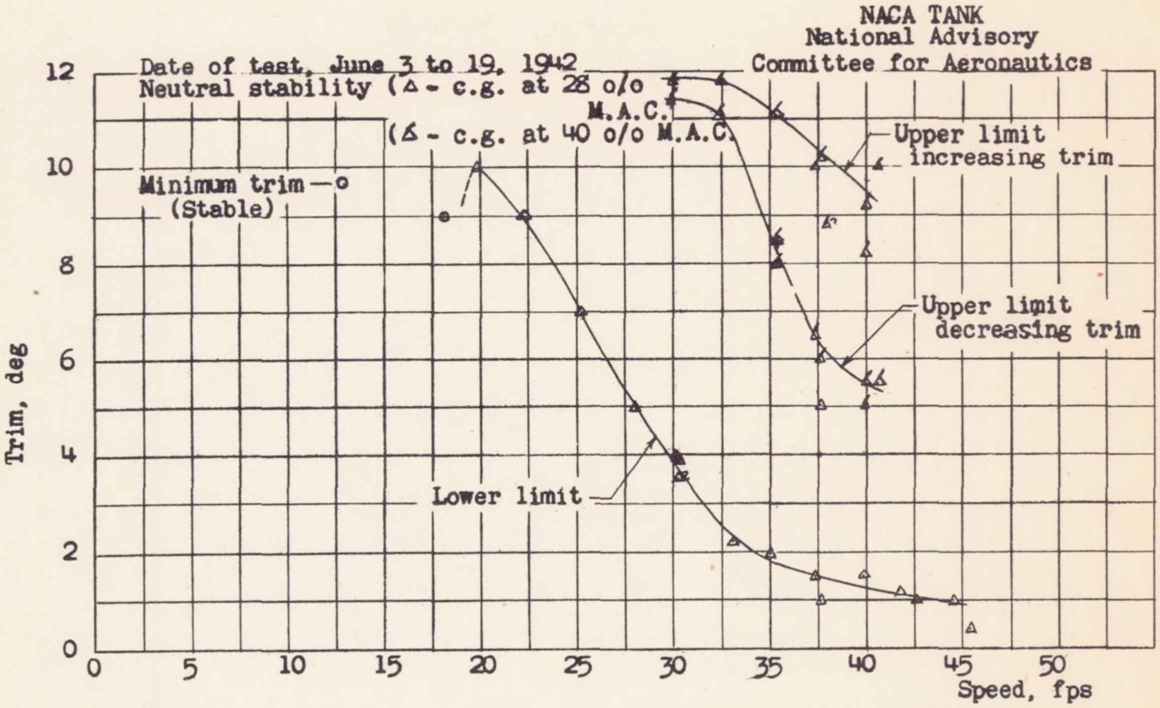


Fig. 12. NACA Model 134-C (1/12-size dynamic model similar to XPB2M-1 airplane). Limits of stability. Δ_0 = 160,000 lb, full-size; 91.9 lb, model. Angle of afterbody keel = 7.0°. Length of afterbody = 37.15".

(1 block = 10/40")

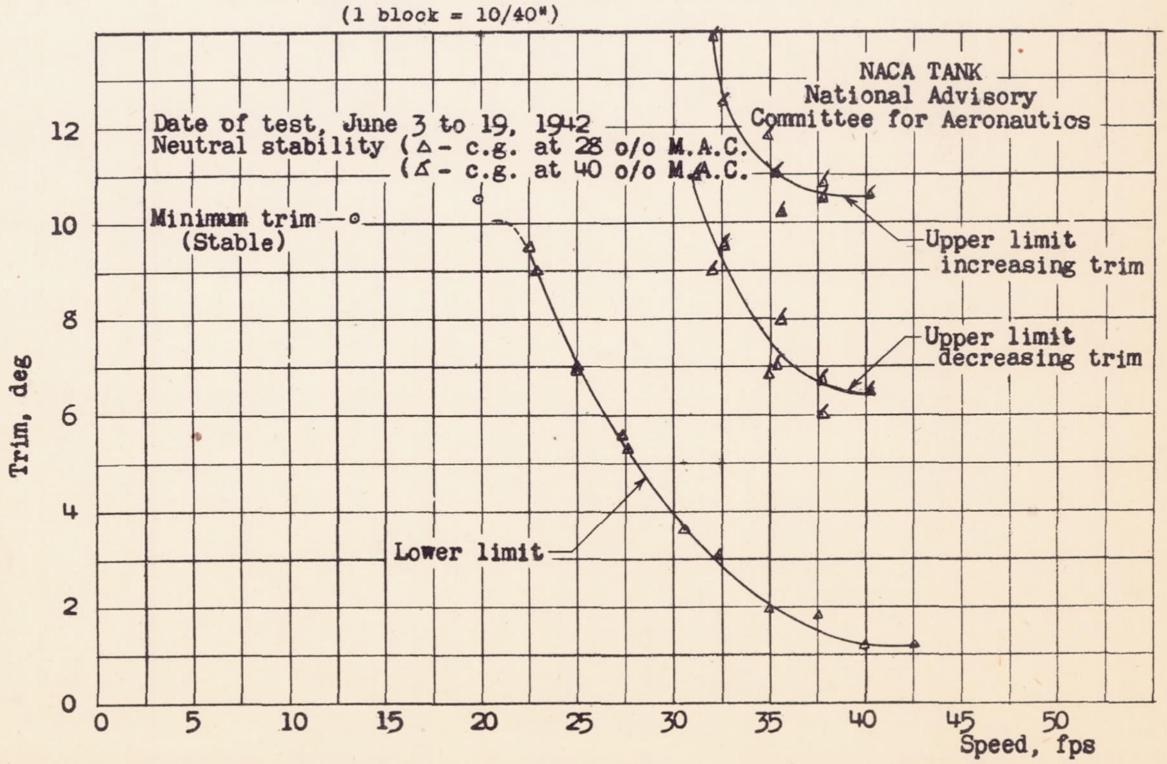


Fig. 13 NACA Model 134-D (1/12-size dynamic model similar to XPB2M-1 airplane). Limits of stability. Δ_0 = 160,000 lb, full-size; 91.9 lb, model. Angle of afterbody keel = 8.5°. Length of afterbody = 37.15".

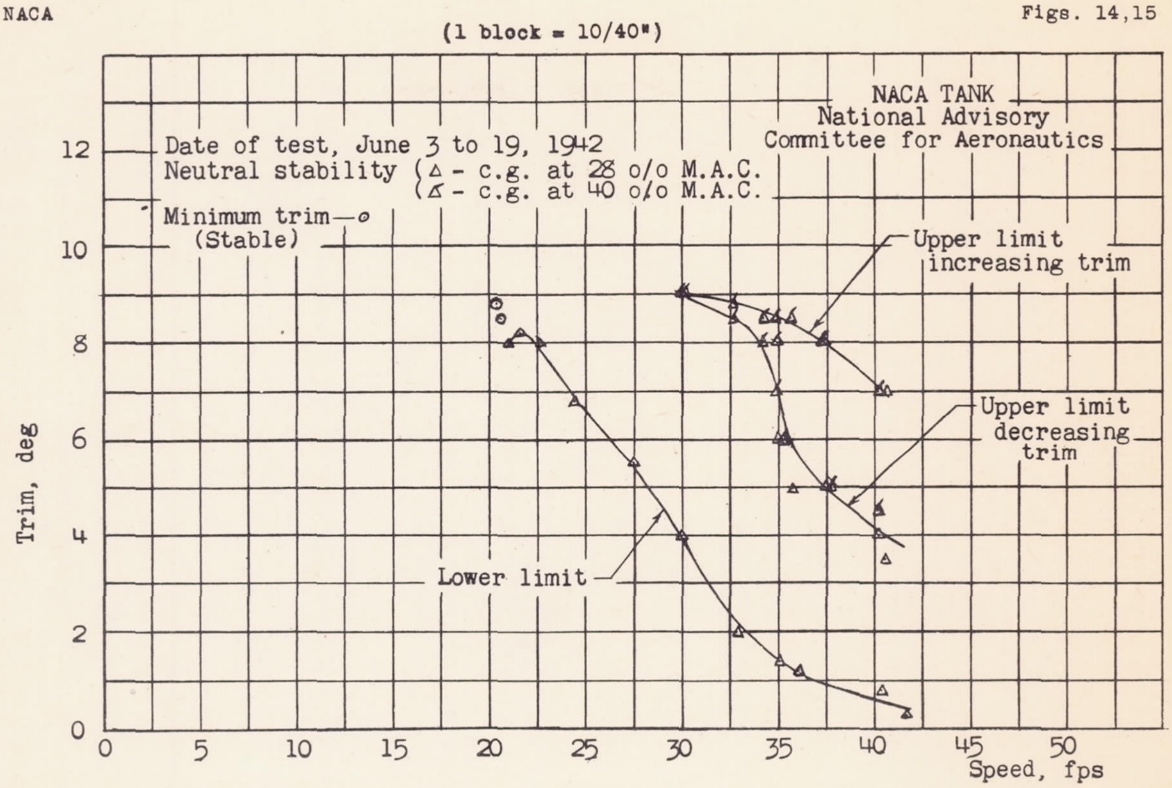


Fig.14. NACA Model 134-E (1/12-size dynamic model similar to XPB2M-1 airplane). Limits of stability. Δ_0 = 160,000 lb, full-size; 91.9 lb, model. Angle of afterbody keel = 5.5°. Length of afterbody = 44.27".

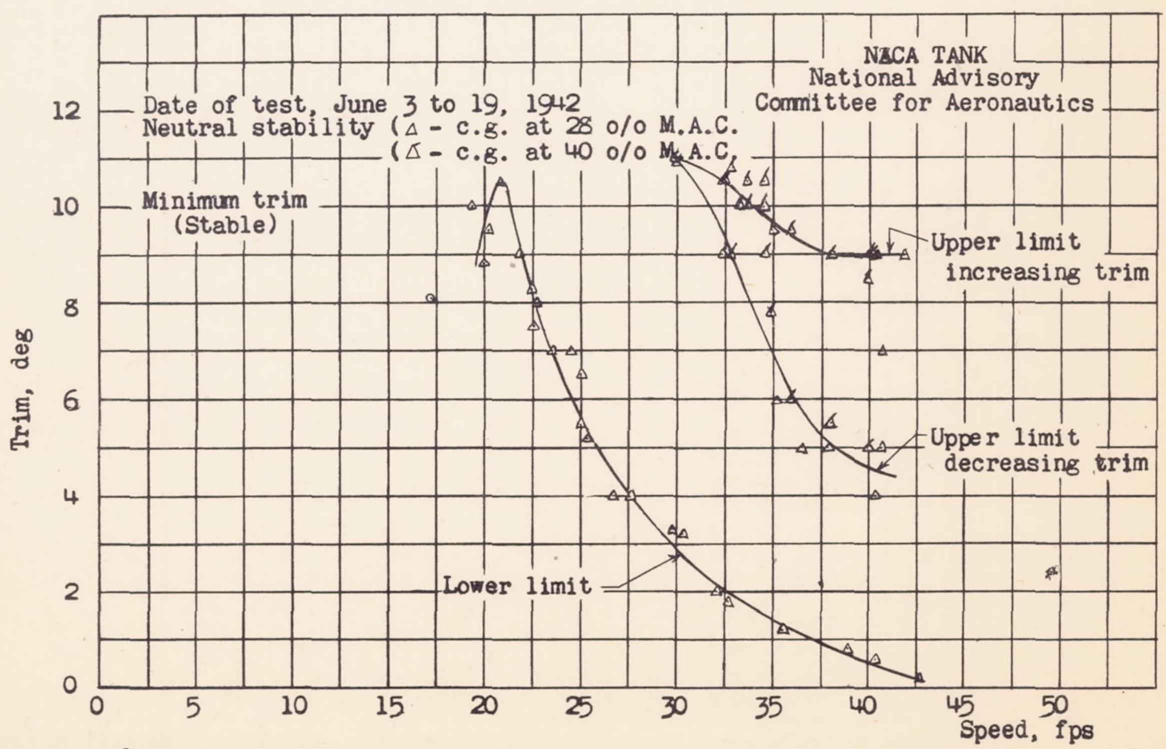


Fig.15 . NACA Model 134-F (1/12-size dynamic model similar to XPB2M-1 airplane). Limits of stability. Δ_0 = 160,000 lb, full-size ; 91.9 lb, model. Angle of afterbody keel = 5.5°. Length of afterbody = 30.03".

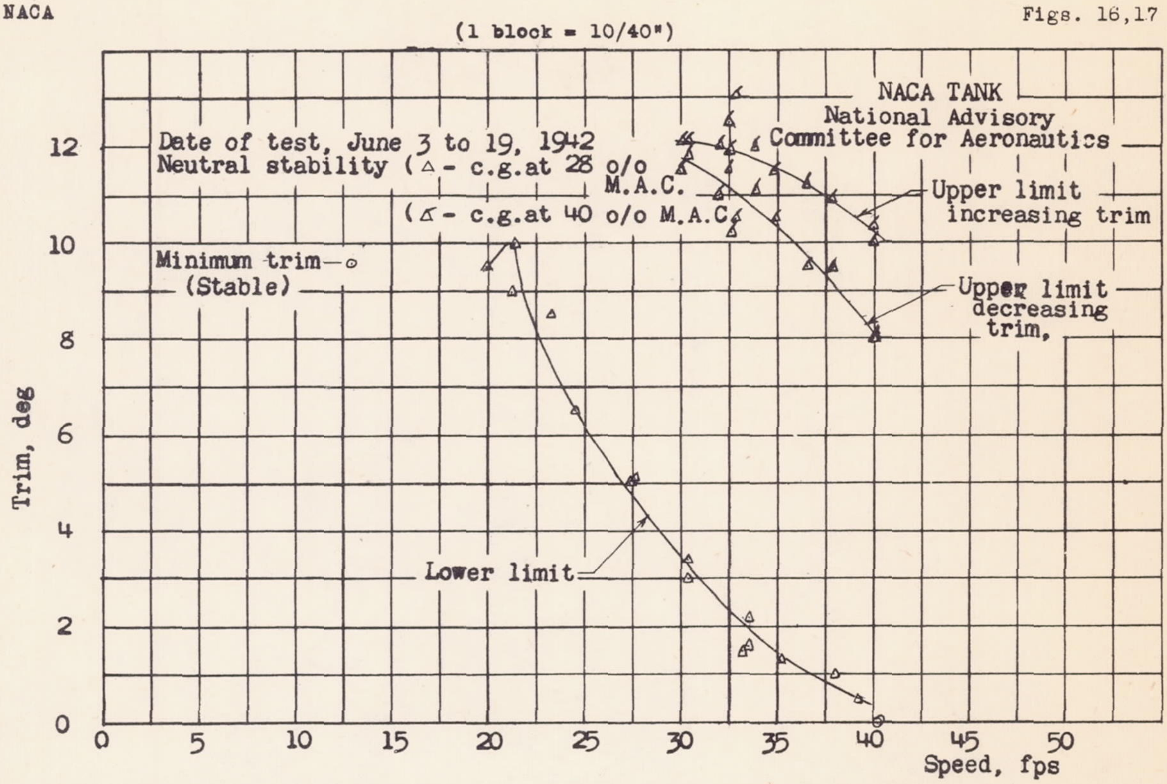


Fig. 16 . NACA Model 134-G (1/12-size dynamic model similar to XPB2M-1 airplane. Limits of stability. Δ_0 = 160,000 lb, full-size; 91.9 lb, model. Angle of afterbody keel=5.5°. Length of afterbody = 22.91".

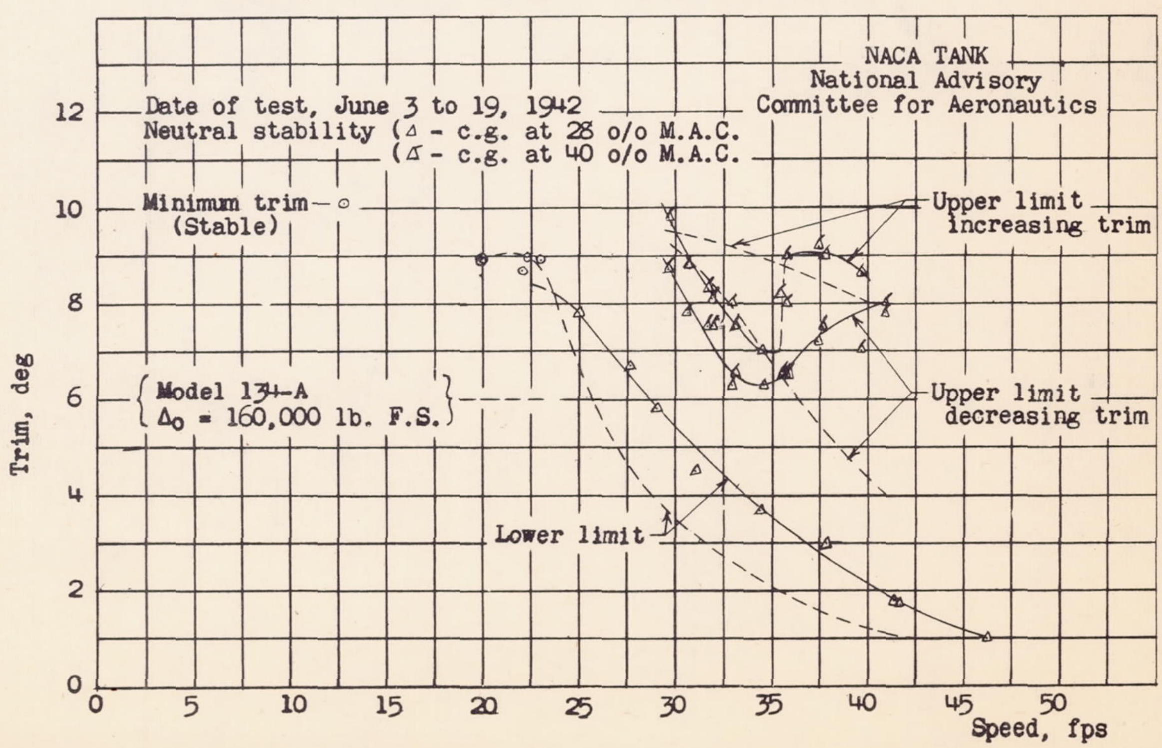


Fig. 17 . NACA Model 134-H (1/12-size dynamic model similar to XPB2M-1 airplane). Limits of stability. Δ_0 = 160,000 lb, full-size; 91.9 lb. model. Pointed step.

L-400

L-400

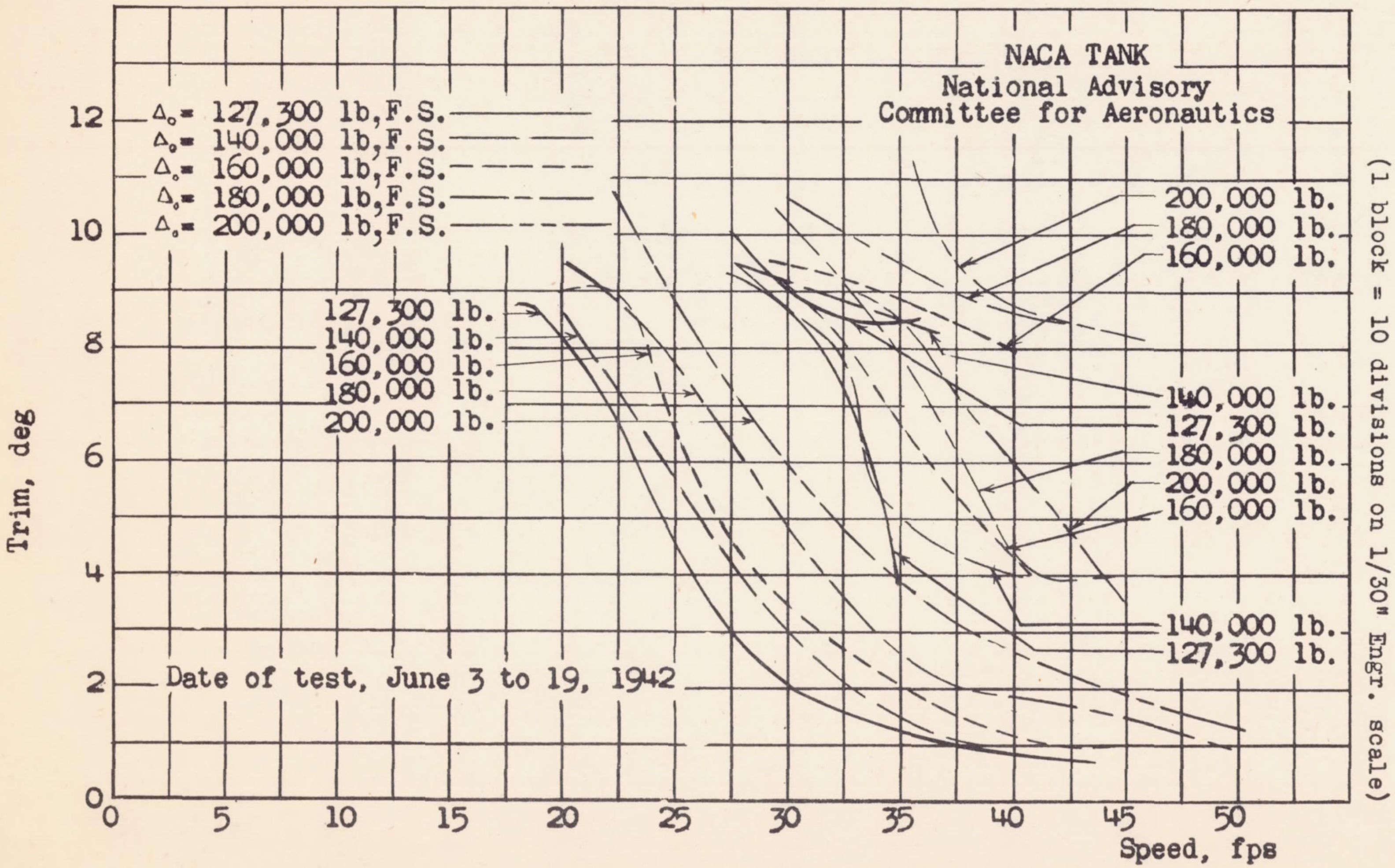


Fig. 18. NACA Model 134-A (1/12-size dynamic model similar to XPB2M-1 airplane). Effect of various loads on stable limits. Afterbody length = 37.15". Angle of afterbody keel = 5.5°.

L-400

NACA

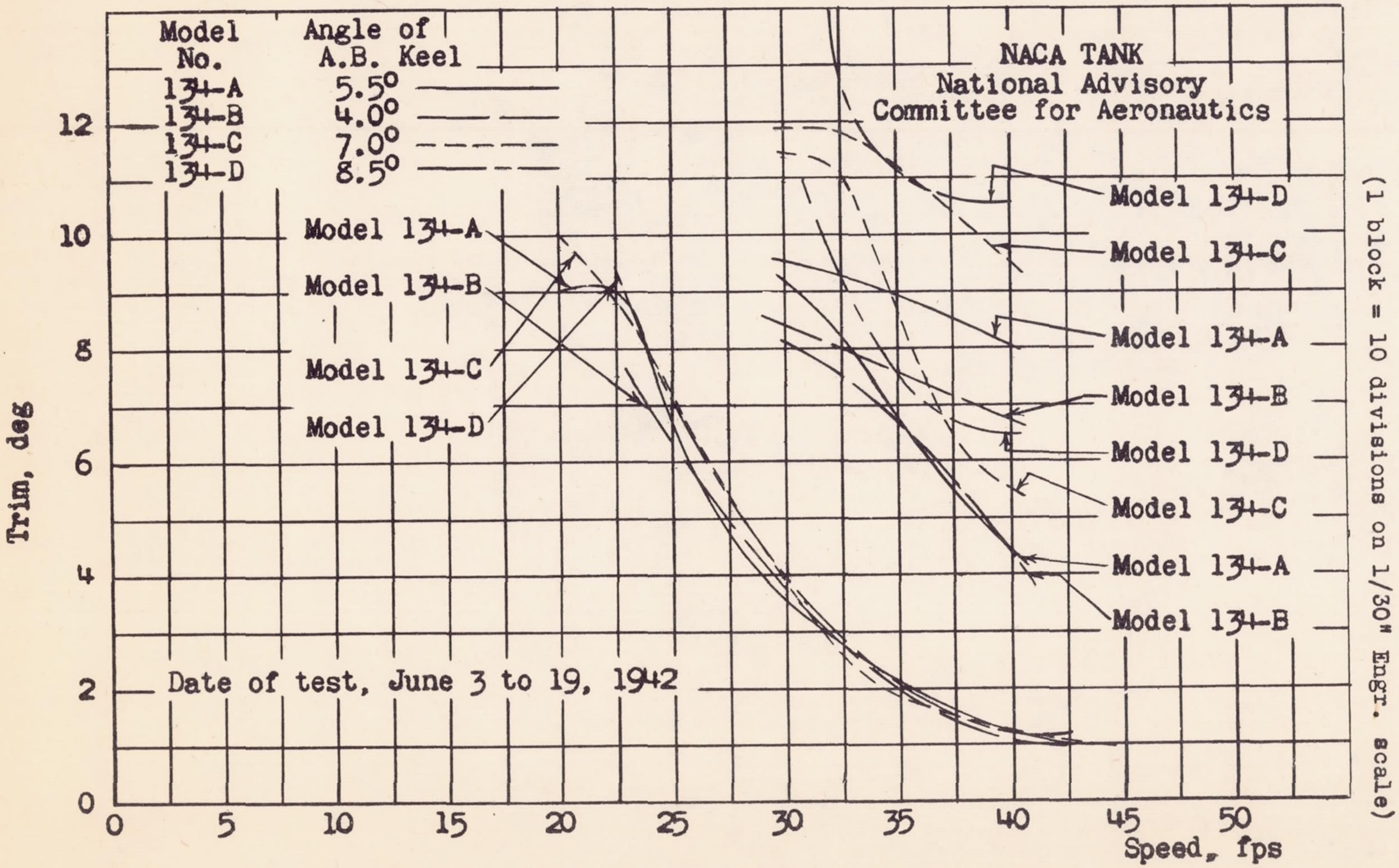


Fig. 19. NACA Model 134 (1/12-size dynamic model similar to XPB2M-1 airplane). Effect of angle of afterbody keel on stability limits. Δ_0 = 160,000 lb, full-size; 91.9 lb, model. Afterbody length = 37.15".

Fig. 19

L-400

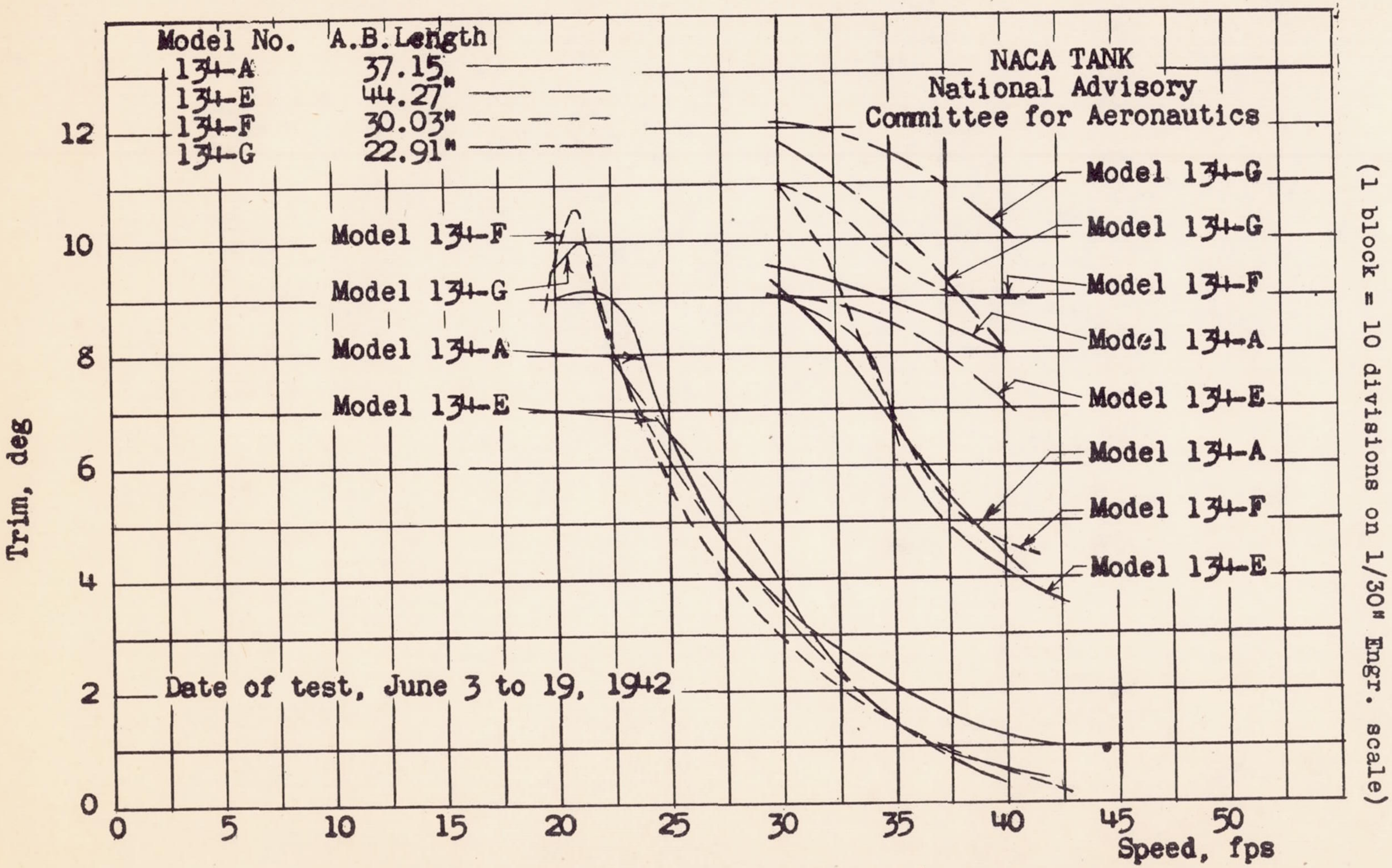
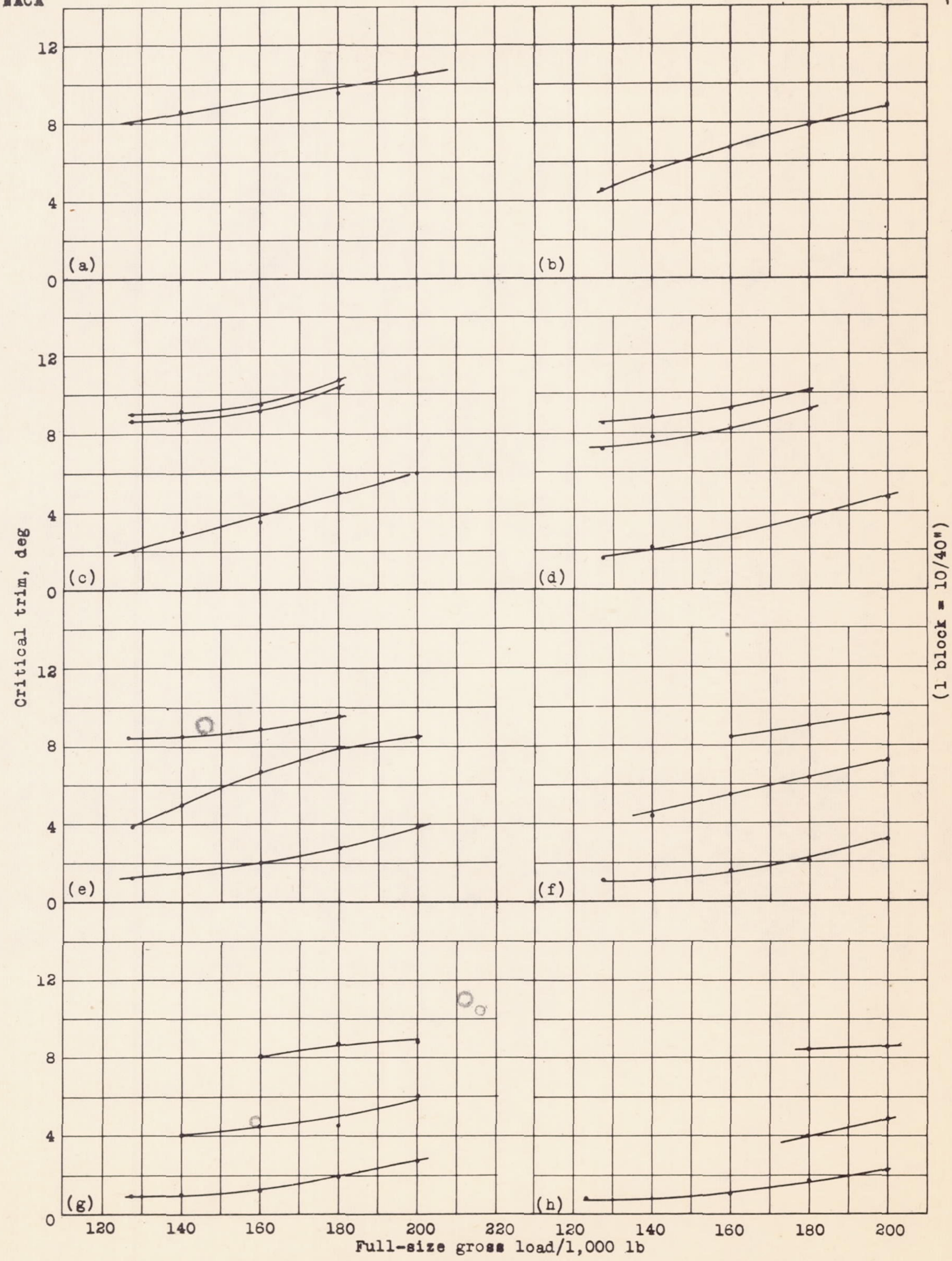


Fig. 20. NACA Model 134 (1/12-size dynamic model similar to XPB2M-1 airplane). Effect of afterbody length on stability limits. Δ_0 = 160,000 lb, full-size; 91.9 lb, model. Angle of afterbody keel = 5.5°.



(a) V = 20.0 fps (b) V = 25.0 fps (c) V = 30.0 fps (d) V = 32.5 fps (e) V = 35.0 fps
(f) V = 37.5 fps (g) V = 40.0 fps (h) V = 42.5 fps

Figure 21.- Model 134. Effects of various loads on stability limits. Afterbody length = 37.15". Angle of afterbody keel = 5.5°.

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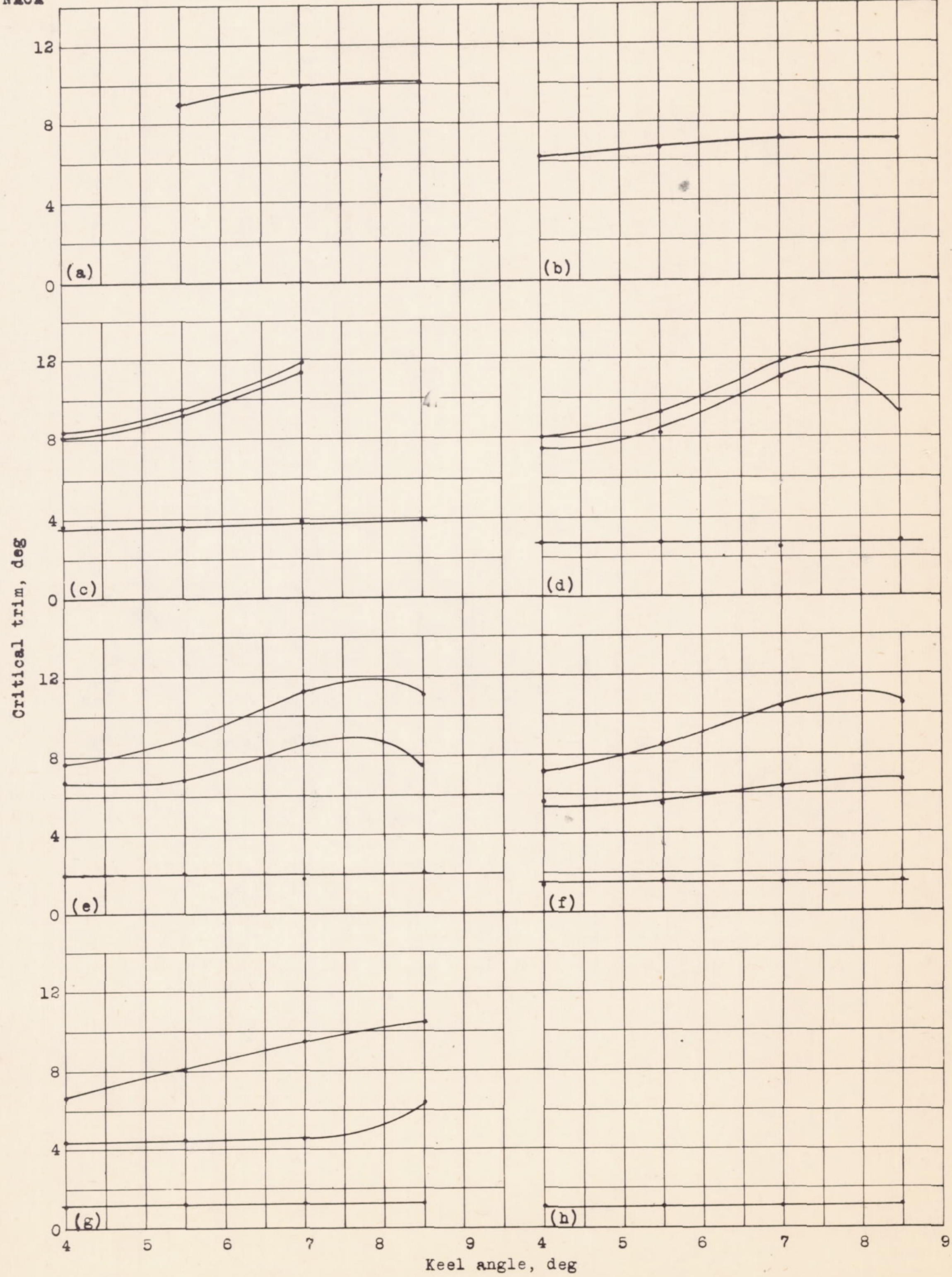

(a) V = 20.0 fps (b) V = 25.0 fps (c) V = 30.0 fps (d) V = 32.5 fps (e) V = 35.0 fps
(f) V = 37.5 fps (g) V = 40.0 fps (h) V = 42.5 fps

Figure 22.- Model 134. Effect of angle of afterbody keel on stability limits. Δ_0 = 160,000 lb, full-size; 91.9 lb, model. Afterbody length = 37.15".

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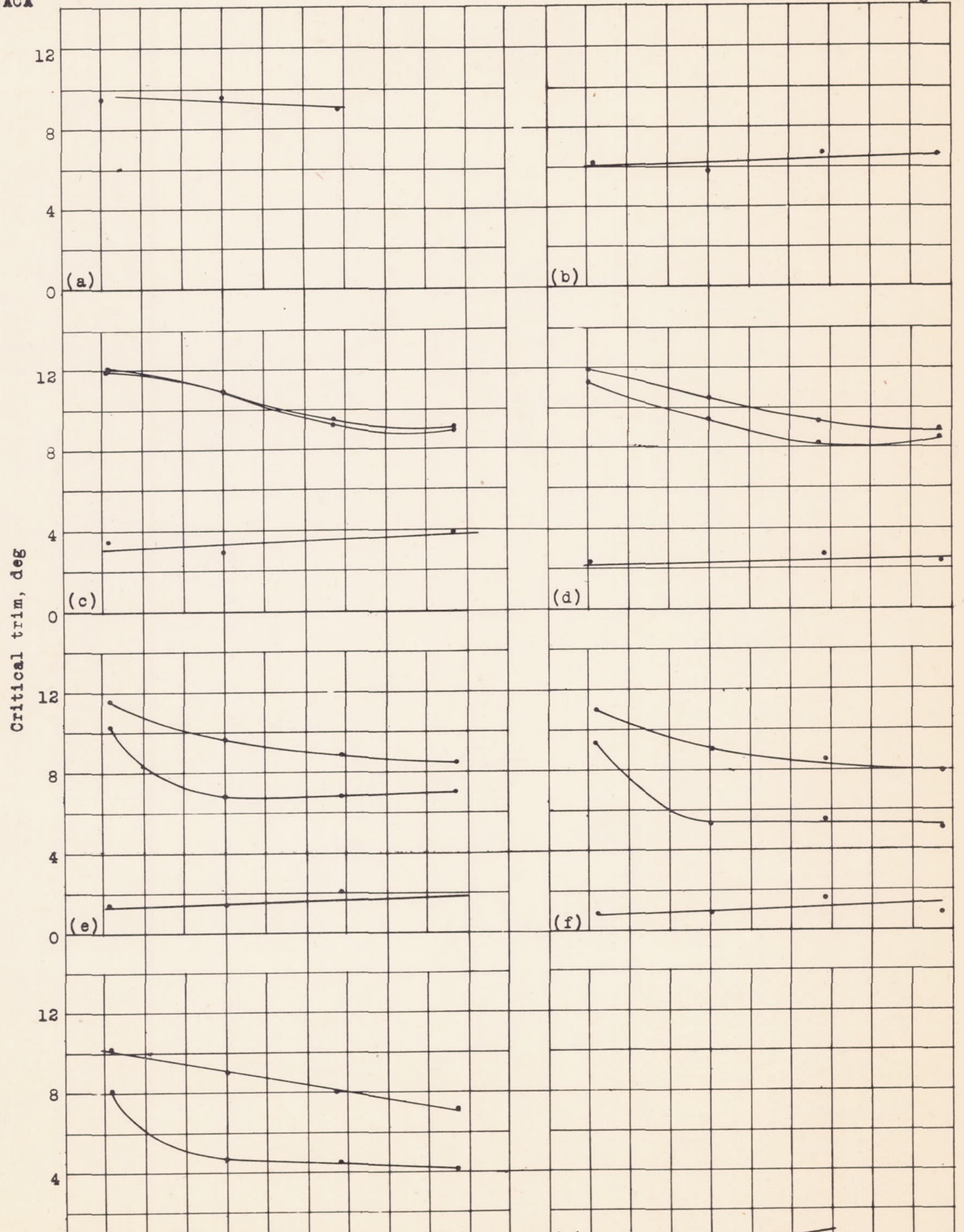

(a) V = 20.0 fps (b) V = 25.0 fps (c) V = 30.0 fps (d) V = 32.5 fps (e) V = 35.0 fps (f) V = 37.5 fps (g) V = 40.0 fps (h) V = 42.5 fps

Figure 23.- Model 134. Effect of afterbody length on stability limits. Δ_0 = 160,000 lb, full-size; 91.9 lb, model. Keel angle = 5.5°.

L-400