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RESEARCH MEMORANDUM

for the

Bureau of Aeronautics, Navy Department

WIND-TUNNEL TESTS OF A 0.182-SCALE MODEL OF AN F4U-1 AIRPLANE WITH EXTERNAL STORES

By

H. Norman Silvers and Kenneth P. Spreemann

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WIND-TUNNEL TESTS OF A 0.182-SCALE MODEL OF AN F4U-1 AIRPLANE WITH EXTERNAL STORES

By H. Norman Silvers and Kenneth P. Spreemann

SUMMARY

Tests were made in the Langley 7- by 10-foot tunnel on a 0.182-scale model of an F4U-1 airplane with external stores. This paper is concerned mainly with presenting the data obtained in this investigation and with a comparison of some of these data with flight-test results determining the feasibility of estimating flight buffet Mach number from tunnel data.

The results of this investigation indicate that the incremental drag coefficient due to external stores may be used to estimate the maximum Mach number that the F4U-1 airplane may reach in flight when it is equipped with external stores. This estimation is conservative for the five configurations investigated by amounts varying from 0 to 10 percent of the flight limit Mach number. The free-stream tunnel Mach number corresponding to sonic flow over the lower surface of the wing in the region of the store is a good indication of the lower limit of buffet in flight of the F4U-1 airplane when equipped with external stores. The fluctuations of total pressure over the horizontal tail are not sufficiently large (maximum of 1 percent q_o) to cause buffeting of the airplane.

INTRODUCTION

It has become standard practice on military airplanes to attach additional armament and fuel tanks externally to the aircraft to increase its utility and to facilitate maintenance. When airplanes equipped with external stores reach relatively high flight speeds a phenomenon is encountered that impairs the efficiency of the airplane as a gun platform and restricts its maximum speed. This phenomenon,

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called buffeting, has been characterized as a progressively increasing vibration of the airplane with increase in flight speed.

At the request of the Bureau of Aeronautics, Navy Department, the effect of external stores on the aerodynamic characteristics of airplanes is being investigated for the National Advisory Committee for Aeronautics. The first portion of this program was the determination of the low speed aerodynamic effects of external stores on the stability of models of military airplanes (reference 1). A theoretical approach to the problem was also published and is presented as reference 2. The results of flight tests conductod on the F4U airplane equipped with external stores are presented in reference 3. The flight results are confined to the Mach number at which buffeting of the airplane becomes objectionable in the opinion of the pilot.

The present investigation was conducted in the Langley high-speed 7- by 10-foot wind-tunnel to determine the feasibility of using wind-tunnel data as a means of predicting flight buffet Mach number. No attempt is made in this report to present a detailed analysis of the phenomenon of buffeting. This paper is confined to a presentation of the data obtained by this investigation and a comparison of wind-tunnel and flight-test results of the F4U-1 airplane with external stores.

COEFFICIENTS AND SYMBOLS

The coefficients and symbols referred to in this report are defined as follows:

ΔC_D change in drag coefficient due to external store, $\left(\frac{D_{ext} - D_{clean}}{qS}\right)$, positive when store increases the drag

ΔC_L change in lift coefficient due to external store, $\left(\frac{L_{ext} - L_{clean}}{qS}\right)$, positive when store increases the lift

ΔC_m change in pitching-moment coefficient due to external store, $\left(\frac{M_{ext} - M_{clean}}{qS\bar{c}}\right)$, positive when store increases the pitching moment

C refers to Mach number or coefficient

D	drag, pounds
L	lift, pounds
M	pitching moment, foot-pounds
$\frac{\Delta p}{q}$	pressure coefficient $\left(\frac{p - p_o}{q}\right)$
M	Mach number $\left(\frac{V}{a}\right)$
q	dynamic pressure, $\frac{1}{2}\rho V_o^2$, pounds per square foot
ρ	static pressure, pounds per square foot
S	wing area (9.85 sq ft on model)
$\bar{c}$	mean aerodynamic chord (1.49 ft on model)
c	chord of wing
V	velocity of air, feet per second
a	velocity of sound, feet per second
α	angle of attack of the thrust line
β	$\sqrt{1 - M^2}$
ϵ	blockage correction at high speeds

Subscripts:

o	denotes free-stream conditions
cr	critical - M_o at which compression shock is formed as manifested by pressure-distribution data
c_D	when used with M - denotes M_o for ΔC_D divergence
cor.	corrected Mach number or coefficient of force or moment
m	measured Mach number or coefficient of force or moment

Note: Mach numbers and pressures without subscripts denote local conditions

MODEL AND APPARATUS

The Langley high-speed 7- by 10-foot tunnel in which this investigation was conducted has a closed throat, rectangular cross section, and is of the single return type. The degree of turbulence in the air stream is very low. The model used in this investigation was a 0.182-scale model of a Chance Vought F4U-1 airplane. The model consisted of a fuselage and a wing of NACA 23018 section at the fuselage center line and an NACA 23009 section at the tip. A three-view drawing of the model showing the method of mounting in the tunnel and a typical store installation is shown in figure 1. Photographs of the model mounted in the tunnel are shown in figures 2(a) and 2(b). The locations of the static-pressure orifices on the lower surface of the wing are given in figure 3. The models of external stores used in this investigation were a Lockheed drop tank and a Navy Universal drop tank. Drawings of these stores showing pertinent geometric characteristics and static-pressure orifice locations are presented in figure 4. These stores were attached to the model by small scale duplications of full-scale pylon fairings. Models of these pylon fairings with the locations of pressure orifices are shown in figures 5 and 6. The various combinations of tanks and pylons tested are given in columns 1 through 4 of table I.

The duct configuration of the model and inlet velocity ratio corresponded approximately to that required for high-speed flight condition of the airplane.

Static-pressure measurements were photographically recorded on a 56-tube direct-reading manometer.

The survey of the fluctuations in the total pressure in the wake was made with a standard pitot-static tube, the static- and total-pressure chambers of which were connected to either side of an electrically sensitive diaphragm. This instrument was mounted on a remotely controlled carriage located in the tunnel test section. (See fig. 2.) Fluctuations in total pressure were recorded by movement of a light beam on a photographically sensitive drum of paper rotating at a known speed, thus making it possible to determine the period and amplitude of the wake fluctuations.

TESTS AND RESULTS

Procedure

Symmetrical store installations were tested in addition to asymmetrical arrangements because of the mutual interference effects

indicated by flight buffet Mach numbers. It was originally intended to obtain information on the aerodynamic characteristics of the model in the presence of 1000-pound bombs symmetrically and asymmetrically disposed from the plane of symmetry in addition to the two types of fuel tanks tested. Due to the time available for this investigation it was necessary to eliminate this portion of the program and also to measure pressures on only a few of the configurations on which force data as taken. Pressure tubes were connected for only two "basic" configurations, that is, the Lockheed tank on a Standard pylon and the Universal tank on a Standard pylon. By so doing, it was possible to obtain the necessary pressure measurements for various other store configurations without connecting additional pressure tubes by the simple expedient of adding either a store configuration similar to one of the basic configurations to the opposite wing or by inserting an extension to the pylon fairing. Due to the expeditious nature of this method of obtaining pressure distribution data it was possible to obtain considerably more information in the allotted time than would have been possible if configurations requiring additional pressure connections had been investigated.

Static-pressure distributions for all configurations tested were taken at a constant angle of attack of -2.75° through a Mach number range extending from 0.3 to approximately 0.715. The angle of attack was selected as that for which the model lift coefficient was comparable to the high-speed lift coefficient of the airplane. For several configurations, additional angles of attack were tested to obtain an estimate of the general effect of angle of attack upon the pressure-distribution characteristics. The static-pressure orifices in the pylons were located very close to the juncture of pylon and wing (fig. 5) and approximately in line with the static-pressure orifices of station $5\frac{1}{4}$ on the lower surface of the wing. The results of the chordwise distribution presented herein at station $5\frac{1}{4}$ are composed of data obtained over the lower surface of the wing and over the pylon at the pylon wing juncture. Unfortunately, it was not possible to use some of the pylon orifices because of the condition of the tubes. The peak minimum pressure in such cases was based upon an estimated fairing of the data. Pressure measurements for each Mach number were recorded simultaneously at all stations.

Force measurements were made at constant angles of attack of -3.5°, -2.75°, -1.5°, and 0.25° through a Mach number range similar to that of the pressure-distribution tests. Force measurements consisted of six component automatically recorded balance readings. Results of these tests are presented as increments of lift, drag,

and pitching-moment coefficients. These increments were obtained by a subtraction of the data for the model without stores from the data obtained with stores in place. Although all forces and moments were recorded, only those which showed any appreciable difference (drag, lift, and pitching moment) due to stores are presented.

Wake surveys were conducted in a plane located at the hinge line of the horizontal tail and perpendicular to the plane of symmetry. These tests were made at a constant angle of attack of -2.75° through a Mach number range from 0.3 to approximately 0.650. The region surveyed extended from the plane of symmetry outboard 12 inches and from the center line of the tank vertically upward 18 inches.

The results of these tests (pressure and force measurements and wake surveys) were compared with the results of flight tests which consisted of the Mach number at which buffet was first encountered (column 5, table I) and the Mach number at which buffet became objectionable (column 6, table I).

Corrections

All Mach numbers and force and moment coefficients were corrected for blocking by the following equation obtained from reference 4.

$$C_{cor} = C_m\left[1 - \epsilon(2 - M_o^2)\right]$$

where

$$\epsilon = \epsilon_{solid} + \epsilon_{wake}$$

$$\epsilon_{solid} = \frac{0.00955}{\beta^4}$$

$$\epsilon_{wake} = \frac{0.0533\ C_D}{\beta^2}$$

An increment in drag coefficient of 0.0013 has been added to account for the horizontal buoyancy resulting from the longitudinal pressure gradient in the tunnel.

Presentation of Results

An outline of the figures used in this report is given below.

	Figure no.
Pressure distribution on the lower wing surface of a 0.182-scale model of the F4U-1 airplane with external stores, $\alpha = -2.75^{\circ}$	7
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Universal tank on left standard pylon	7(c)
Universal tanks on left and right standard pylons	7(d)
Universal tank on left standard pylon with 6 inches extension	7(e)
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Lockheed tank on left standard pylon	8(a)
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DISCUSSION

Pressure Distribution

Pressure distributions over the lower surface of the wing obtained by pressure orifices located on the lower surface of the wing and in the pylon at the wing-pylon juncture are shown in figure 7. As previously noted, pressure could not be transmitted through certain tubes. Unfortunately the orifices for these tubes were located in what appears to be a region of high velocities. However, consideration of the characteristics of the data available indicate that the minimum pressures presented may give a close approximation to the exact minimum pressures.

It has been established that when a local Mach number of one is exceeded on a wing the boundary layer tends to separate, resulting in wake vorticity. The precise local Mach number at which this phenomenon occurs depends to some extent upon initial boundary-layer conditions. It is felt that buffet is first experienced in flight when the turbulent wake associated with local supersonic velocities

over the lower surface of the wing passes over the tail surfaces of the airplane. It follows that M_o corresponding to local sonic flow over the lower surface of the wing might be used as a rough estimate of the flight Mach number at which buffet is first encountered. Pressure-distribution data indicate that the local velocity of sound is first attained on the lower surface of the wing at approximately 28 percent chord. The free-stream Mach number corresponding to this local sonic velocity as determined by cross plotting peak minimum pressure against Mach number and critical pressure against test Mach number is tabulated in column 7 of table I. The agreement between these data and the flight initial buffet Mach number (column 5) is better than might be expected in light of the previous discussion and since the precise attitude of the airplane during the flight tests was unknown. Recent work (unpublished) has indicated that sideslip may have considerable effect upon data of this nature. In addition flight results presented herein were based upon human reaction to the vibrations of the airplane when stores were added and as such should be considered as only a qualitative index to the onset of this disturbance. In column 6 is presented the flight buffet Mach number at which buffeting of the airplane becomes so severe that the airplane was rendered useless as a gun platform or was damaged structurally due to the vibration. Tabulated in column 8 is the free-stream Mach number at which a well defined compression shock is formed on the lower surface of the wing as manifested by a breaking down in the variation of peak minimum pressure against M_o. It is obvious that this Mach number is, with the exception of one configuration, considerably higher than either the initial buffet (column 5) or the limit buffet (column 6) Mach numbers. It appears, therefore, that the formation of a compression shock may not be essential to the phenomenon of buffeting, but rather that the turbulence associated with local sonic velocities prior to the development of a well defined compression shock is sufficient in itself to be prohibitive.

Pressure distributions over the tanks used in this investigation are presented in figure 8. The velocities over the tanks in all cases are lower than those over the lower wing surface at the same M_o, and, therefore, the critical Mach number of the tanks is higher than the critical Mach number of the lower surface of the wing.

A variation in angle of attack of -3.5° to -1.5° seems to have small effect upon the results discussed previously. Increasing the angle of attack appears, however, to increase slightly the free-stream Mach number that corresponds to the attainment of the

local speed of sound over the pylon. This may be attributed to the decreases in the peak minimum pressures of the pylons that are caused by changes in local pressures over the lower surface of the wing.

Force Tests

The results of the force tests are presented as incremental variations due to stores of drag, lift, and pitching-moment coefficients. Results are presented for each tank in combination with various pylons at model angles of attack of -3.5°, -2.75°, -1.5°, and 0.25°. These tests were conducted in an attempt to recognize as discontinuities in the incremental force data those adverse flow characteristics that were shown to exist by pressure-distribution methods. Due to the nature of the problem the variation of ΔC_D with free-stream Mach number was thought to be of fundamental interest. The free-stream Mach numbers for which rapid positive increases in incremental drag coefficient occurred are given in column 9, table I, for each model configuration at an angle of attack of -2.75°. These Mach numbers were obtained from inspection of the curves of the variation of ΔC_D with Mach number. The Mach number for divergence of ΔC_D agrees closely with the limit flight buffet Mach number (column 6). The tunnel results were in all instances either equal to or lower than limit flight buffet Mach number. In view of the qualitative nature of the flight results and the unknown effects of boundary layer and sideslip, it is considered significant that the incremental drag measurements agree within 10 percent with the five flight configurations on which data were available. It is important to remember, however, that an underestimation of the flight limit buffet Mach number by 10 percent may be of the same order of magnitude as the decrease in the critical speed of the airplane caused by the addition of stores. As might be expected, increasing the angle of attack generally seems to increase slightly M_{c_D}.

It is apparent that the addition of stores to this model generally resulted in a decrease in lift coefficient at constant angle of attack at low Mach numbers. As Mach number is increased the incremental lift coefficient seems to increase positively in an orderly manner for the lower angles of attack. However, for angles of attack of -1.50° and 0.25° the variation of ΔC_L with Mach number does not follow any general pattern. The addition of stores to the model generally caused a positive incremental change in pitching-moment coefficient which increased in magnitude with an increase

in Mach number for angles of attack of -3.5° and -2.75°. When the angle of attack was increased to -1.5° the incremental pitching-moment coefficient remained fairly constant to a Mach number of approximately 0.675. Further increases in M_o resulted in decreases in ΔC_m. At an angle of attack of 0.25° the variation of ΔC_m with M_o seemed to be rather erratic, although a small general decrease was noted.

Wake Survey

At the onset of this investigation it was felt that if pulsating wake characteristics existed in the plane of the horizontal tail the concurrent changes in aerodynamic characteristics of the horizontal tail (primarily lift) would furnish ample cause for buffeting of the airplane. Such results could be affected by either changes in dynamic pressure or angularity of the wake or a combination of the two. It was, therefore, decided that a survey should be conducted to establish grounds for such a hypothesis. Due to the time limitations of this investigation, it was possible to obtain a survey of the fluctuations of only the total pressure which is analogous to the fluctuations in dynamic pressure.

The results of the survey of the fluctuations of total pressure in the wake are not presented herein because the magnitude of these disturbances over the horizontal tail preclude their analysis as related to buffeting. The maximum fluctuation of total pressure as indicated by this survey was of the order of 6 percent free-stream dynamic pressure and was located on the center line of the tank. However, the amplitude of these fluctuations decreased rapidly with increase in distance from the store center line so that the flow over the horizontal tail was relatively unaffected (maximum fluctuations 1 percent of q). It is felt that more fruitful results pertaining to quantitative information on the comparative merits of various store installations may be obtained by surveying the dynamic angularity characteristics of the wake.

CONCLUSIONS

Based on a comparison between high-speed wind-tunnel tests of a model of the F4U-1 airplane equipped with external stores and flight tests, it is possible to conclude that:

1. The incremental drag coefficient due to external stores may be used to estimate the maximum Mach number that the F4U-1 airplane may reach in flight when it is equipped with external stores. The data indicate that this estimation is conservative for the five configurations investigated by amounts varying from 0 to 10 percent of the flight limit Mach number.

2. The free-stream tunnel Mach number corresponding to sonic flow over the lower surface of the wing in the region of the store is a good indication of the lower limit of buffet in flight of the F4U-1 airplane when equipped with external stores.

3. The fluctuations of total pressure over the horizontal tail are not sufficiently large (maximum of 1 percent q_o) to cause buffeting of the airplane.

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TABLE I

Tank	Mounting	Pylon	Extension	Flight-test results		Wind-tunnel results		
				Initial buffet	Limit buffet	M = 1.0 (pylon)	M_{cr} (pylon)	M_{c_D}
Lockheed	Left wing	Standard	None	0.51	0.56	0.545	0.640	0.525
Lockheed	Left wing	Standard	6 inch	.60	.64			.575
Lockheed	Left wing	MK 51	None					.60
Lockheed	Left and right wing	Standard	None			.495	.550	.525
Lockheed	Left and right wing	Standard	6 inch					.525
Lockheed	Left and right wing	MK 51	None					(a)
Universal	Left wing	Standard	None	.62	.65	.540	.585	.65
Universal	Left wing	Standard	6 inch			.570	(b)	.675
Universal	Left wing	MK 51	None	None	[c].70			.675
Universal	Left and right wing	Standard	None	.54	.58	.535	.610	.575
Universal	Left and right wing	Standard	6 inch					.525
Universal	Left and right wing	MK 51	None					(a)

[a]No clearly defined M_{c_D}.
[b]Insufficient data.
[c]Restricted dive speed of clean airplane 410 knots at 5,000.

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FIGURE LEGENDS

Figure 1.- Three-view drawing of a 0.182-scale model of the F4U-1 airplane.

Figure 2.- Photograph of a 0.182-scale model of an F4U-1 airplane mounted in the high-speed 7- by 10-foot tunnel showing external store installation.

(a) Front view.

Figure 2.- Concluded.

(b) Rear view.

Figure 3.- Location of wing pressure orifices on a 0.182-scale model of a F4U-1 airplane.

Figure 4.- Location of pressure orifices on models of Lockheed and Universal auxiliary fuel tanks as tested on a 0.182-scale model of the F4U-1 airplane.

Figure 5.- Location of pressure orifices on a model of a Standard pylon as tested on a 0.182-scale model of the F4U-1 airplane.

Figure 6.- Location of pressure orifices on a model of a Mark 51 pylon as tested on a 0.182-scale model of the F4U-1 airplane.

Figure 7.- Pressure distribution on the lower surface of the wing of a 0.182-scale model of the F4U-1 airplane with external stores. $\alpha = -2.75^{\circ}$.

(a) Lockheed tank on left standard pylon.

Figure 7.- Continued.

(b) Lockheed tanks on left and right standard pylons.

Figure 7.- Continued.

(c) Universal tank on left standard pylon.

Figure 7.- Continued.

(d) Universal tanks on left and right standard pylons.

FIGURE LEGENDS – Continued

Figure 7.– Concluded.

(e) Universal tank on left standard pylon with 6" extension.

Figure 8.– Pressure distribution over droppable fuel tanks mounted on the wing of a 0.182-scale model of the F4U-1 airplane. Inboard orifice row, $\alpha = -2.75^{\circ}$.

(a) Lockheed tank on left standard pylon.

Figure 8.– Continued.

(b) Lockheed tanks on left and right standard pylons.

Figure 8.– Continued.

(c) Universal tank on left standard pylon.

Figure 8.– Continued.

(d) Universal tanks on left and right standard pylons.

Figure 8.– Concluded.

(e) Universal tank on left standard pylon with 6" extension.

Figure 9.– Pressure distribution on the lower surface of the wing of a 0.182-scale model of the F4U-1 airplane with external stores. $\alpha = -3.5^{\circ}$.

(a) Lockheed tanks on left and right standard pylons.

Figure 9.– Concluded.

(b) Universal tanks on left and right standard pylons.

Figure 10.– Pressure distribution over droppable fuel tanks mounted on the wing of a 0.182-scale model of the F4U-1 airplane. Inboard orifice row, $\alpha = -3.5^{\circ}$.

(a) Lockheed tanks on left and right standard pylons.

Figure 10.– Concluded.

(b) Universal tanks on left and right standard pylons.

FIGURE LEGENDS – Continued

Figure 11.– Pressure distribution on the lower surface of the wing of a 0.182-scale model of the F4U-1 airplane with external stores. $\alpha = -1.5^{\circ}$.

(a) Lockheed tanks on left and right standard pylons.

Figure 11.– Concluded.

(b) Universal tanks on left and right standard pylons.

Figure 12.– Pressure distribution over droppable fuel tanks mounted on the wing of a 0.182-scale model of the F4U-1 airplane, $\alpha = -1.5^{\circ}$.

(a) Lockheed tanks on left and right standard pylons.

Figure 12.– Concluded.

(b) Universal tanks on left and right standard pylons.

Figure 13.– Effect of various pylon configurations on the aerodynamic characteristics of a 0.182-scale model of an F4U-1 airplane with Lockheed drop tank.

(a) $\alpha = -3.5^{\circ}$.

Figure 13.– Continued.

(a) Concluded.

Figure 13.– Continued.

(b) $\alpha = -2.75^{\circ}$.

Figure 13.– Continued.

(b) Concluded.

Figure 13.– Continued.

(c) $\alpha = -1.5^{\circ}$.

Figure 13.– Continued.

(c) Concluded.

FIGURE LEGENDS – Concluded

Figure 13.– Continued.

(d) $\alpha = .25^{\circ}$.

Figure 13.– Concluded.

(d) Concluded.

Figure 14.– Effect of various pylon configurations on the aerodynamic characteristics of a 0.182-scale model of an F4U-1 airplane with Universal drop tank.

(a) $\alpha = -3.5^{\circ}$.

Figure 14.– Continued.

(a) Concluded.

Figure 14.– Continued.

(b) $\alpha = -2.75^{\circ}$.

Figure 14.– Continued.

(b) Concluded.

Figure 14.– Continued.

(c) $\alpha = -1.5^{\circ}$.

Figure 14.– Continued.

(c) Concluded.

Figure 14.– Continued.

(d) $\alpha = .25^{\circ}$.

Figure 14.– Concluded.

(d) Concluded.

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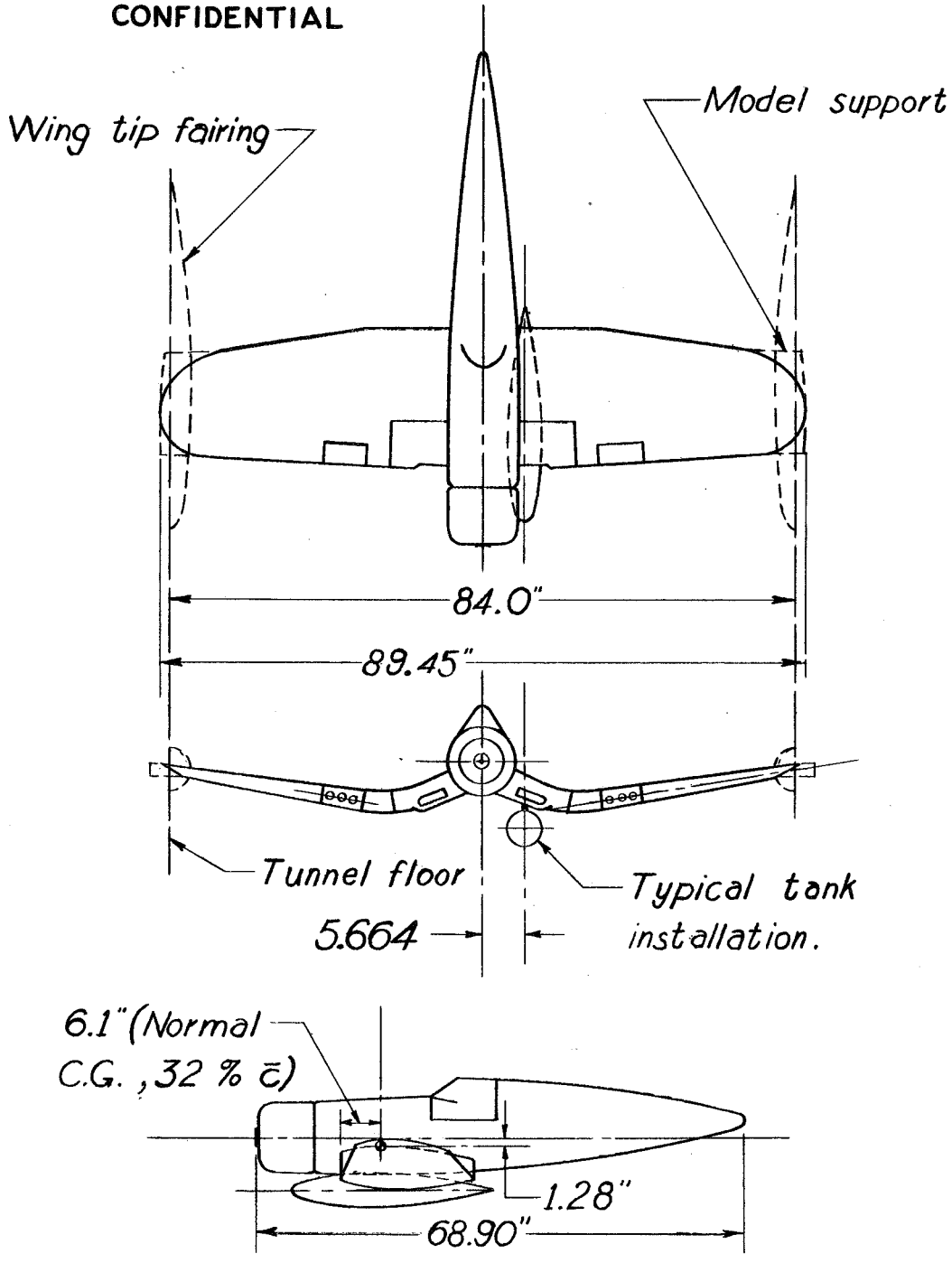

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Figure 1 .- Three-view drawing of a 0.182 scale model of the F4U-1 airplane.

(a) Front view.

Figure 2.- Photograph of a 0.182-scale model of an F4U-1 airplane mounted in the high-speed 7- by 10-foot tunnel showing external store installation.

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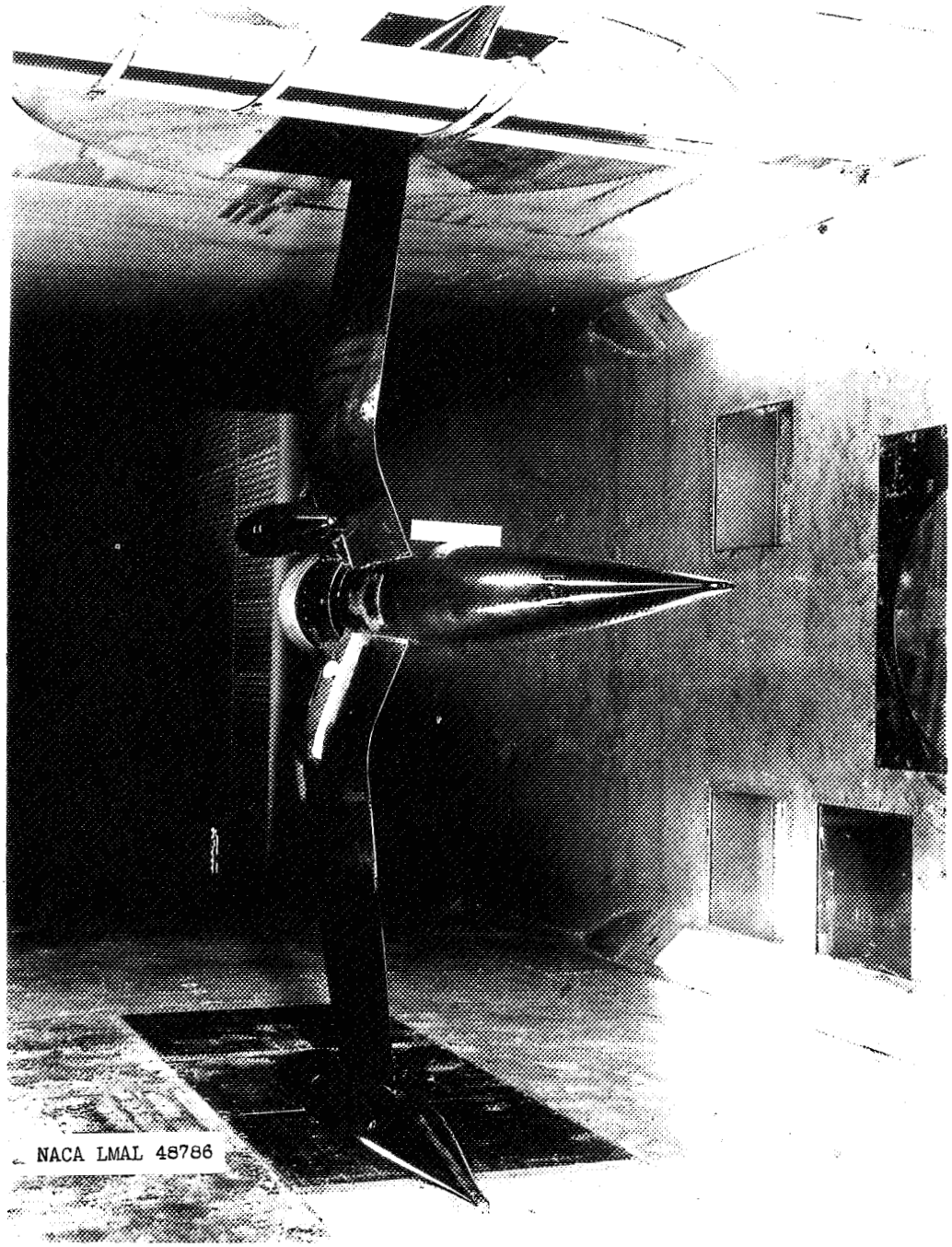

(b) Rear view. CONFIDENTIAL

Figure 2.- Concluded.

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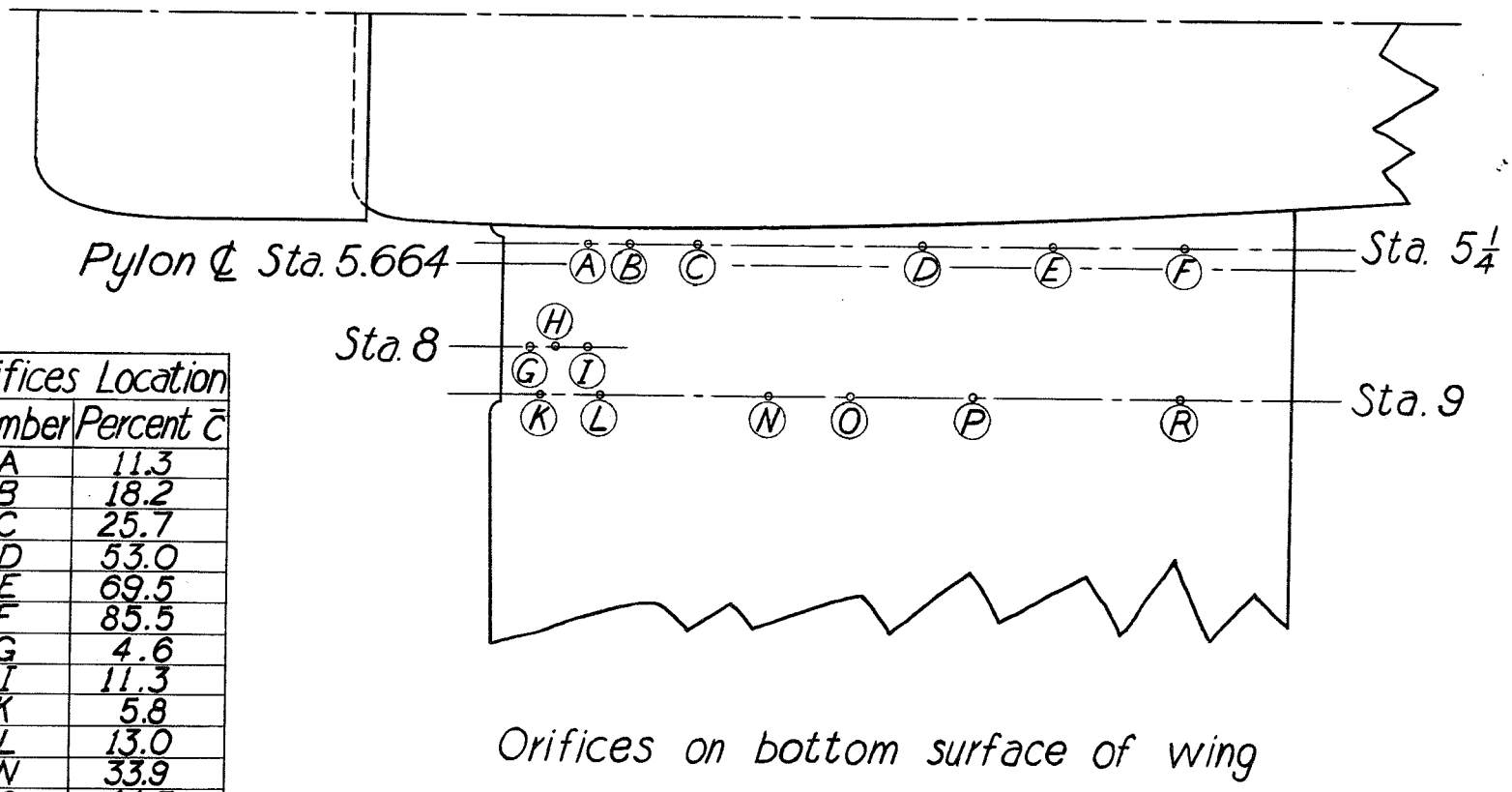

Orifices Location	
Number	Percent $\bar{c}$
A	11.3
B	18.2
C	25.7
D	53.0
E	69.5
F	85.5
G	4.6
I	11.3
K	5.8
L	13.0
N	33.9
O	44.3
P	59.4
R	85.2
H	7.7

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Figure 3.- Location of wing pressure orifices on a 0.182-scale model of a F4U-1 airplane.

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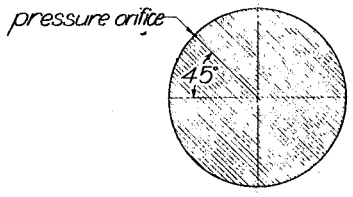
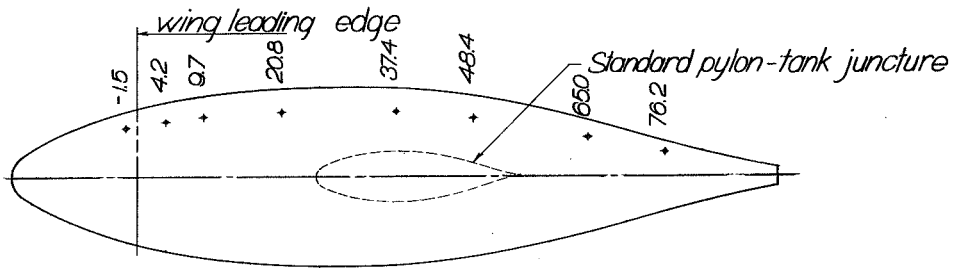
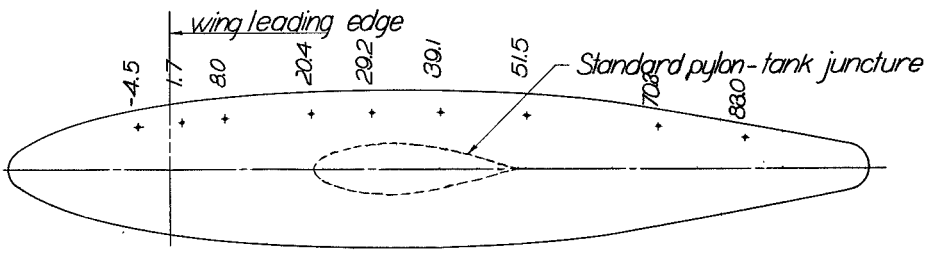


typical section



Lockheed Tank



Universal Tank

Ordinates for Lockheed tank	
x	y
0	0
1.25	±2.46
2.5	±3.40
5.0	±4.47
7.5	±5.99
10	±6.94
15	±8.38
20	±9.47
30	±10.82
40	±11.52
50	±11.46
60	±10.41
70	±8.48
80	±5.85
90	±3.31
95	±2.12
100	±1.08
L.E. radius 3.03	

Ordinates for Universal tank	
x	y
0	0
1.25	±2.02
2.5	±2.98
5.0	±4.25
7.5	±5.15
10	±5.87
15	±6.94
20	±7.75
30	±8.74
40	±9.16
50	±9.16
60	±8.70
70	±7.64
80	±5.93
90	±4.09
95	±3.15
100	0
L.E. radius 2.25	
T.E. radius 2.72	

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pressure orifice locations in percent wing chord

Figure 4.- Location of pressure orifices on models of Lockheed and Universal auxiliary fuel tanks as tested on a 0.182-scale model of the F4U-1 airplane.

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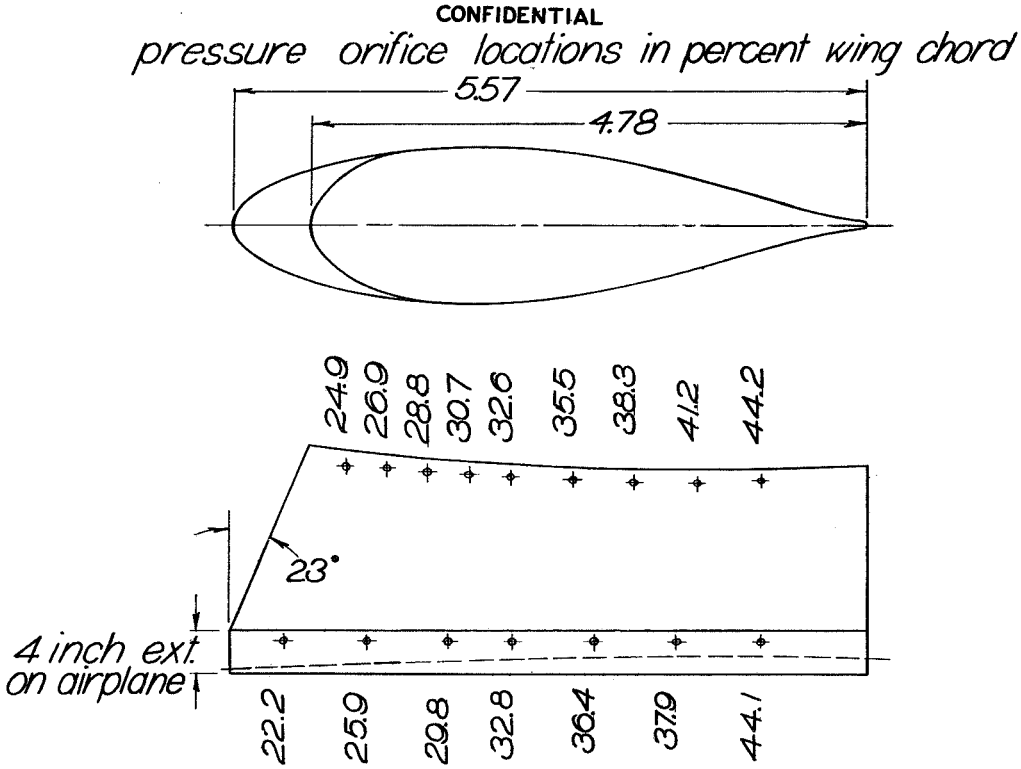

Pylon Ordinates		
X	upper juncture	lower juncture
0	0	0
1.25	±2.69	±3.77
2.5	±4.13	±5.65
5.0	±5.93	±7.95
7.5	±7.00	±8.78
10	±8.27	±11.30
15	±9.70	±12.98
20	±10.78	±13.80
30	±11.86	±14.01
40	±12.02	±13.60
50	±11.49	±12.33
60	±10.23	±10.25
70	±7.90	±7.95
80	±5.21	±5.02
90	±2.33	±2.30
95	±1.26	±1.05
100	±0.36	±0.42
L.E. radius	3.95	5.65

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Figure 5.- Location of pressure orifices on a model of a Standard pylon as tested on a 0.182-scale model of the F4U-1 airplane.

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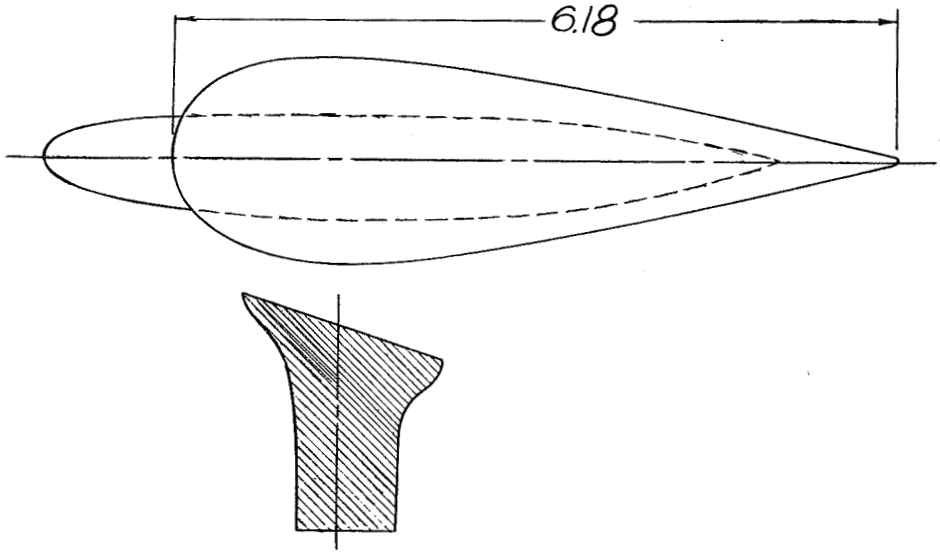
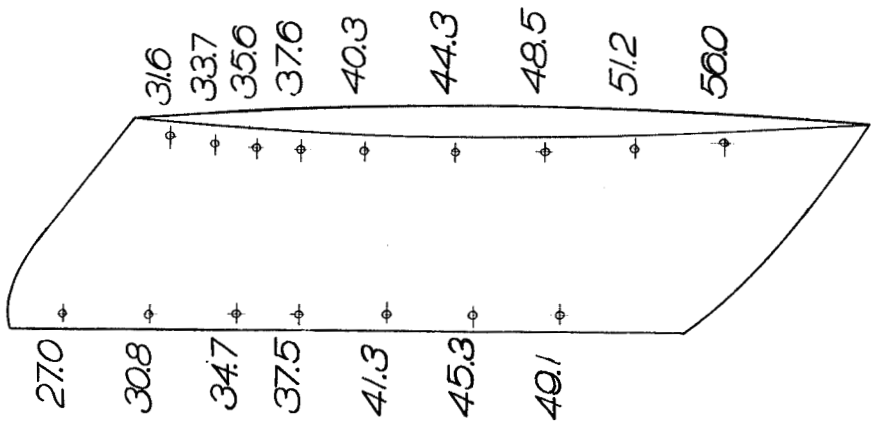


typical section



pressure orifice locations in percent wing chord

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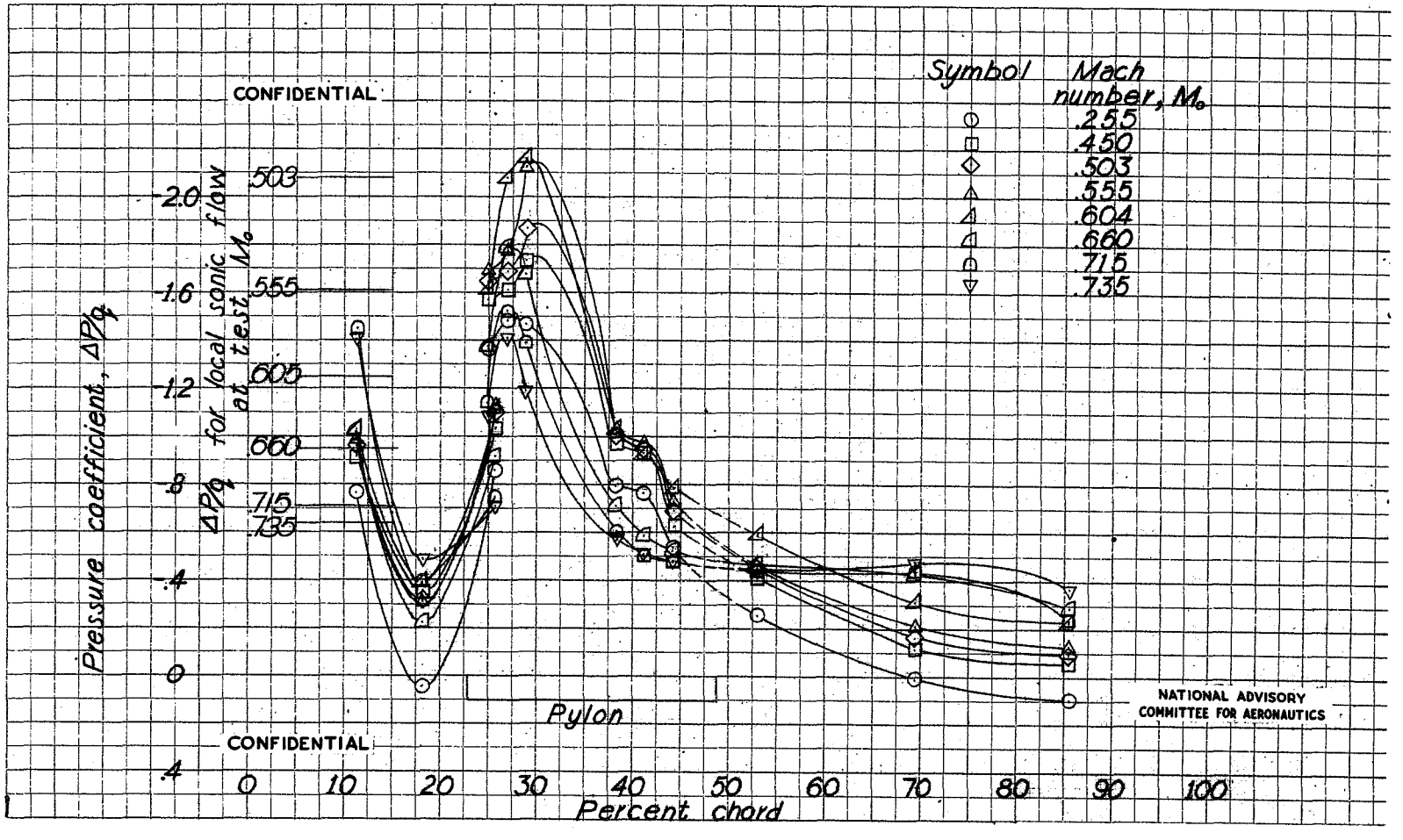
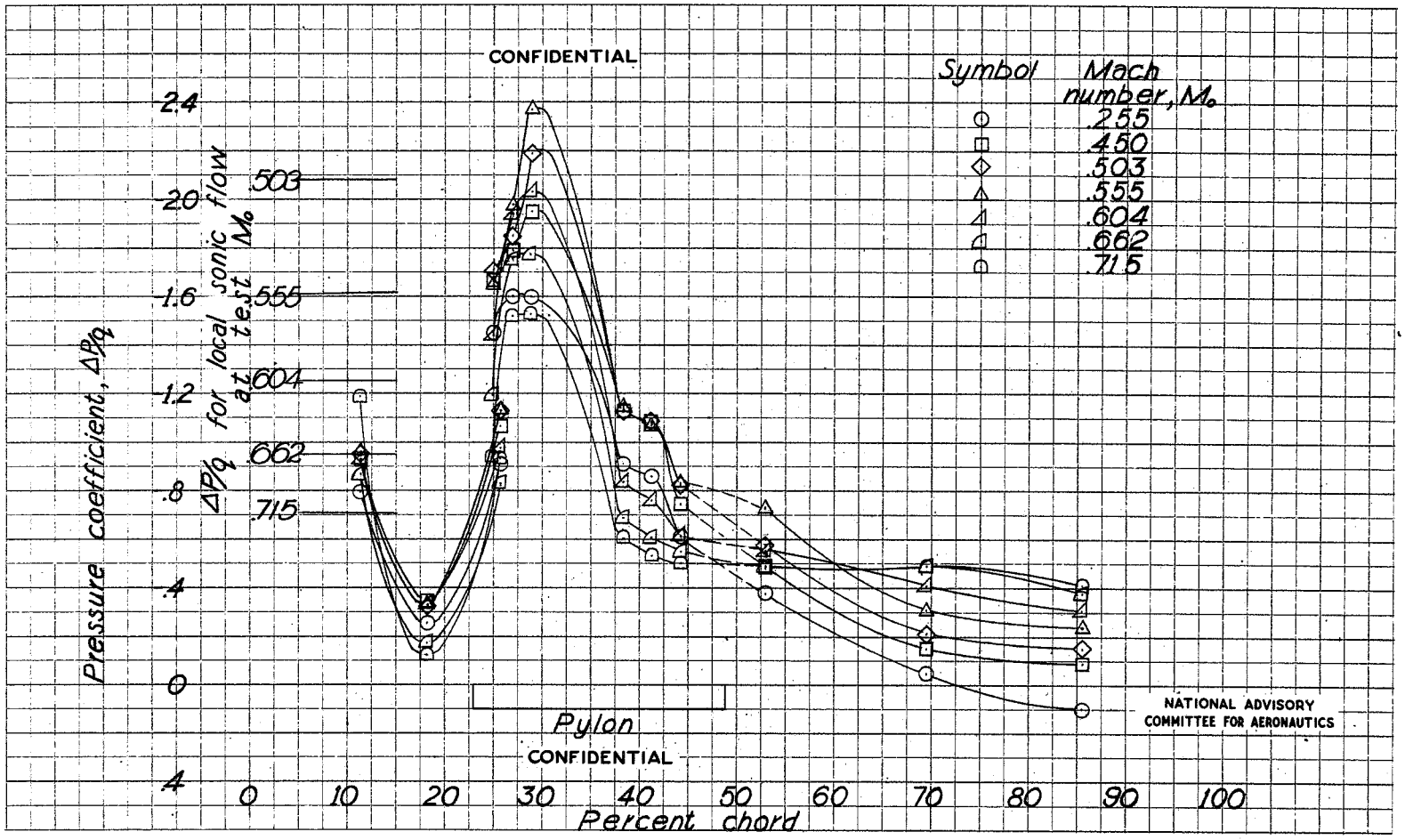
Figure 6.-Location of pressure orifices on a model of a Mark 51 pylon as tested on a 0.182-scale model of the F4U-1 airplane.



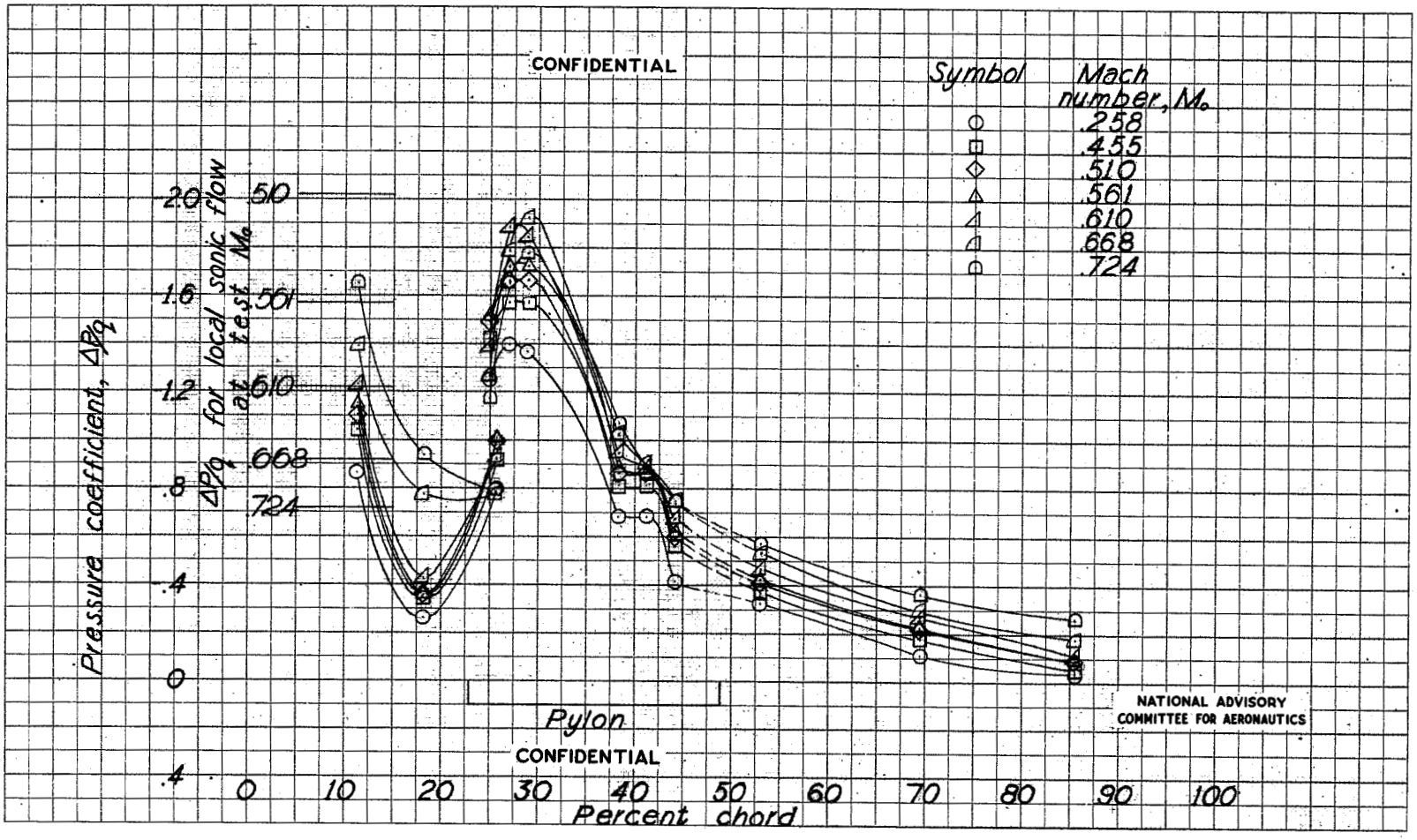
(a) Lockheed tank on left standard pylon.

Figure 7. - Pressure distribution on the lower surface of the wing of a 0.182-scale model of the F4U-1 airplane with external stores. $\alpha = -2.75^{\circ}$



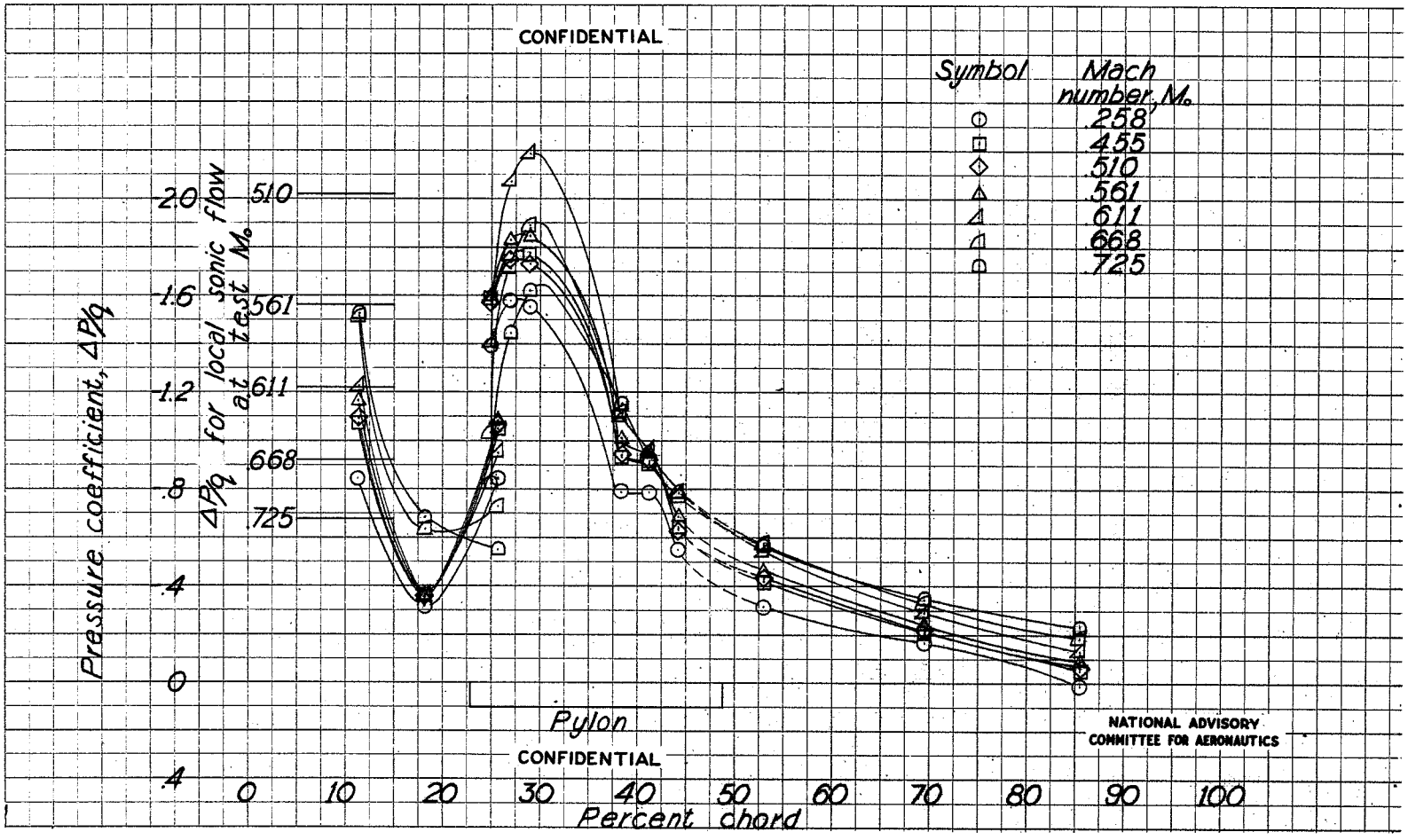
(b) Lockheed tanks on left and right standard pylons.

Figure 7.- Continued.



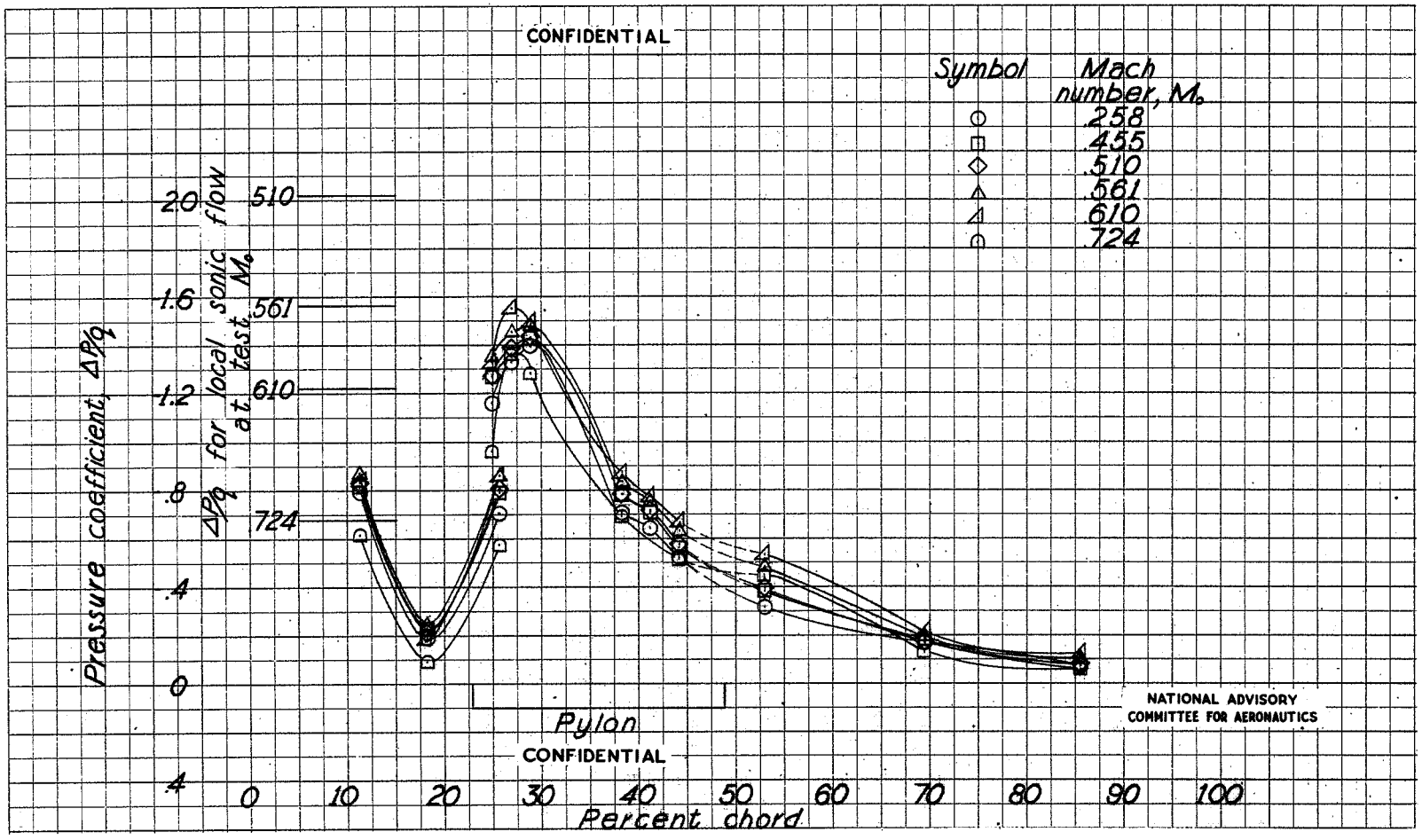
(c) Universal tank on left standard pylon.

Figure 7. - Continued.



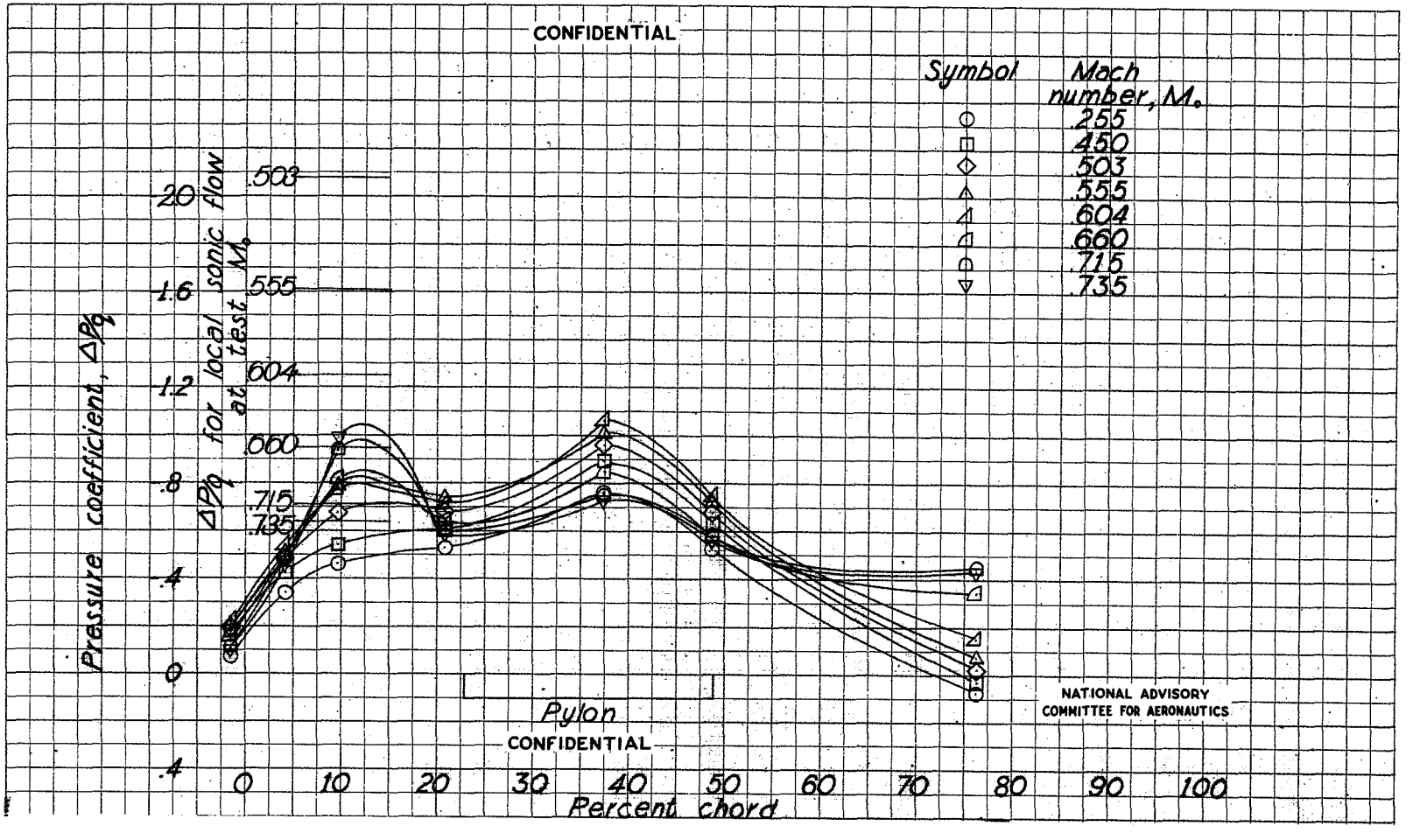
(d) Universal tanks on left and right standard pylons.

Figure 7. - Continued.



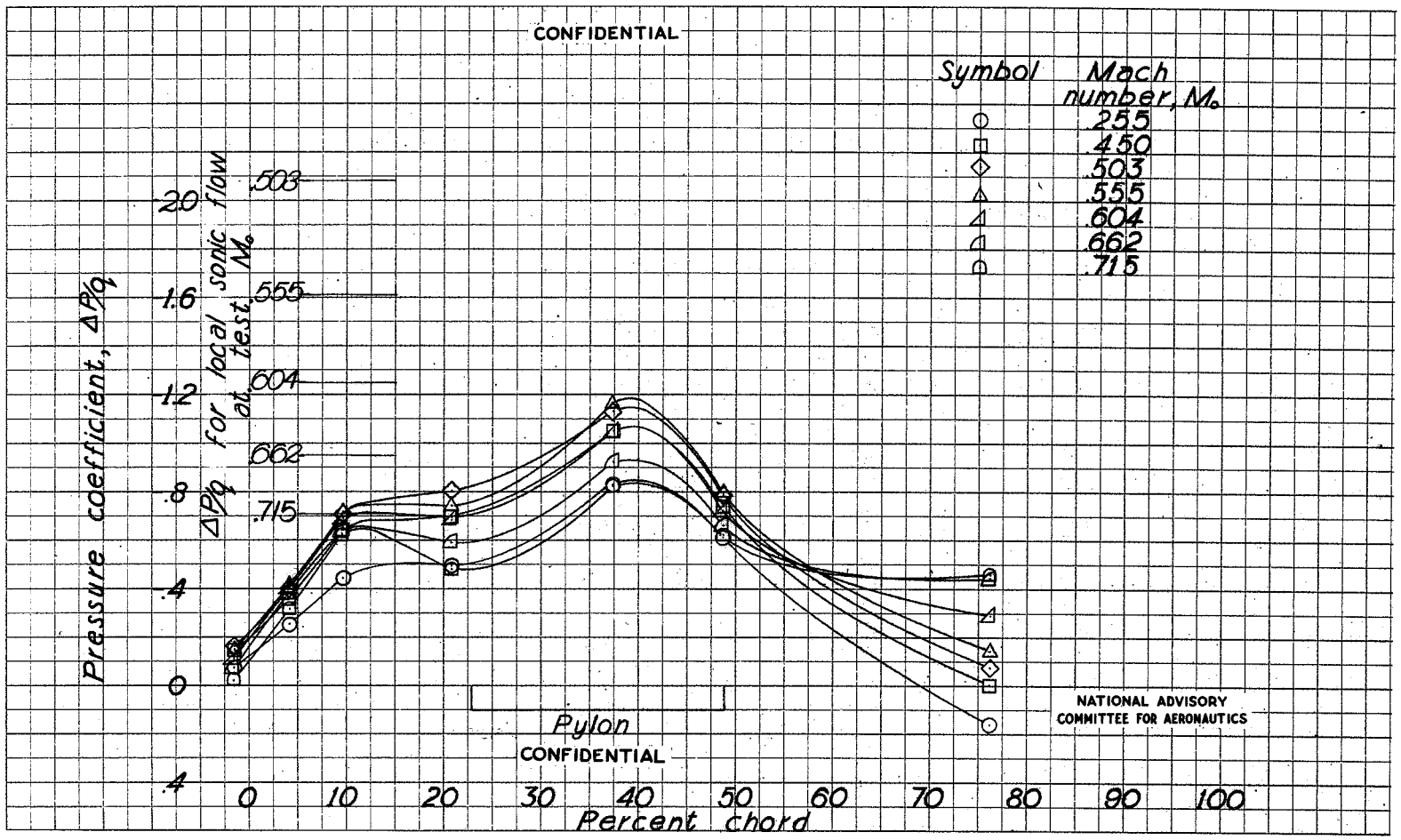
(e) Universal tank on left standard pylon with 6" extension.

Figure 7. - Concluded.



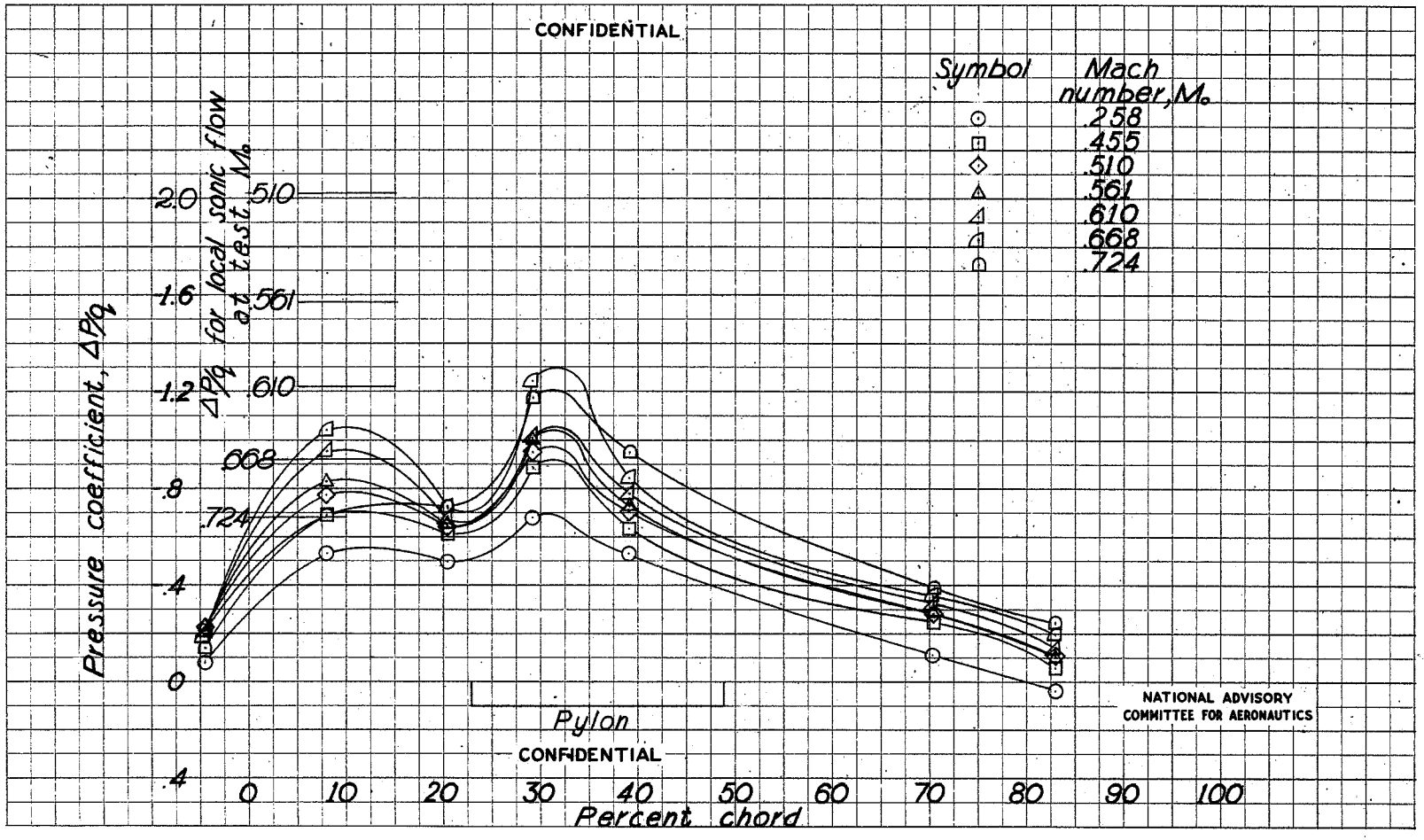
(a) Lockheed tank on left standard pylon.

Figure 8. - Pressure distribution over droppable fuel tanks mounted on the wing of a 0.182-scale model of the F4U-1 airplane. Inboard orifice row, $\alpha = -2.75^{\circ}$.



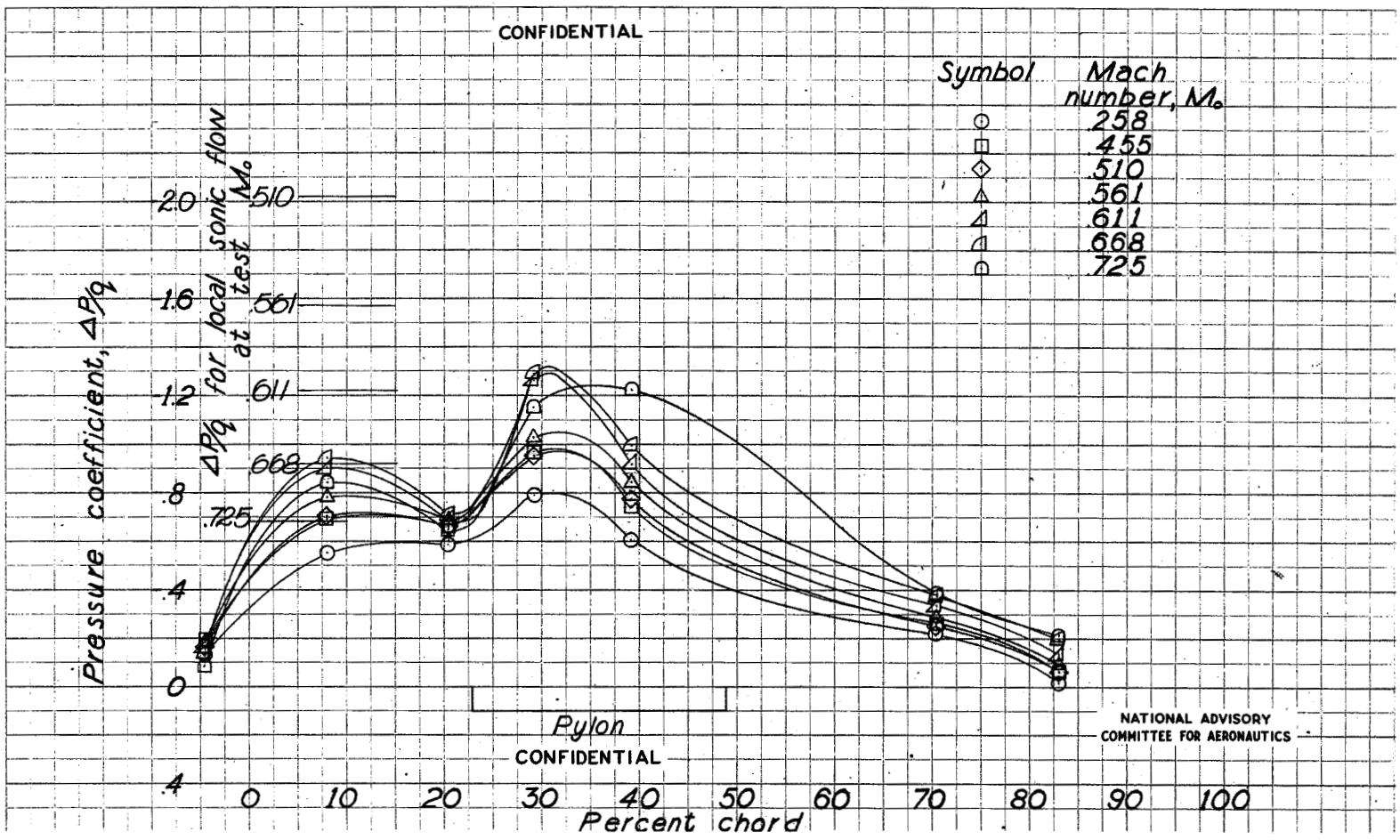
(b) Lockheed tanks on left and right standard pylons.

Figure 8. - Continued.



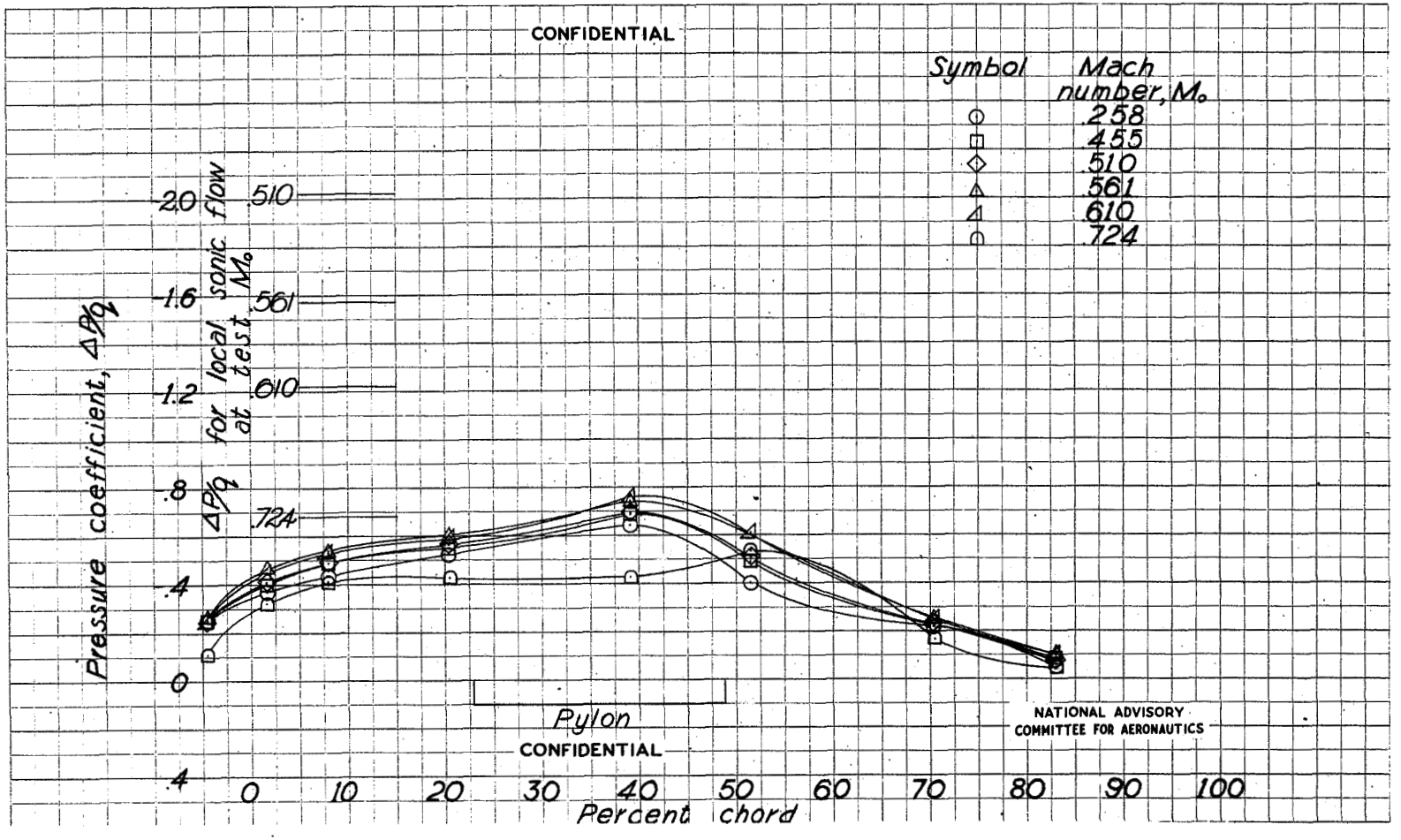
(c) Universal tank on left standard pylon.

Figure 8. - Continued.



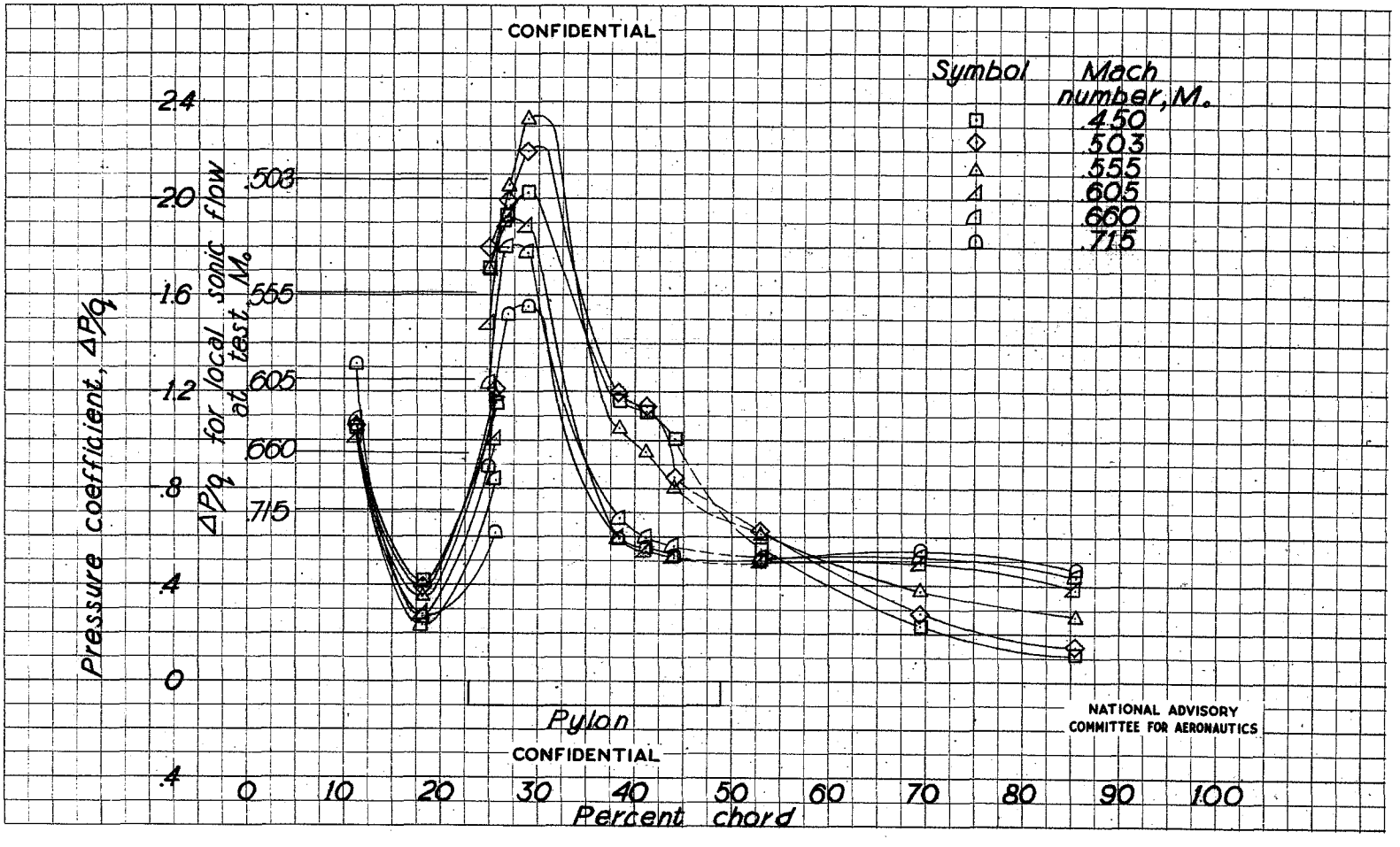
(d) Universal tanks on left and right standard pylons.

Figure 8. - Continued.



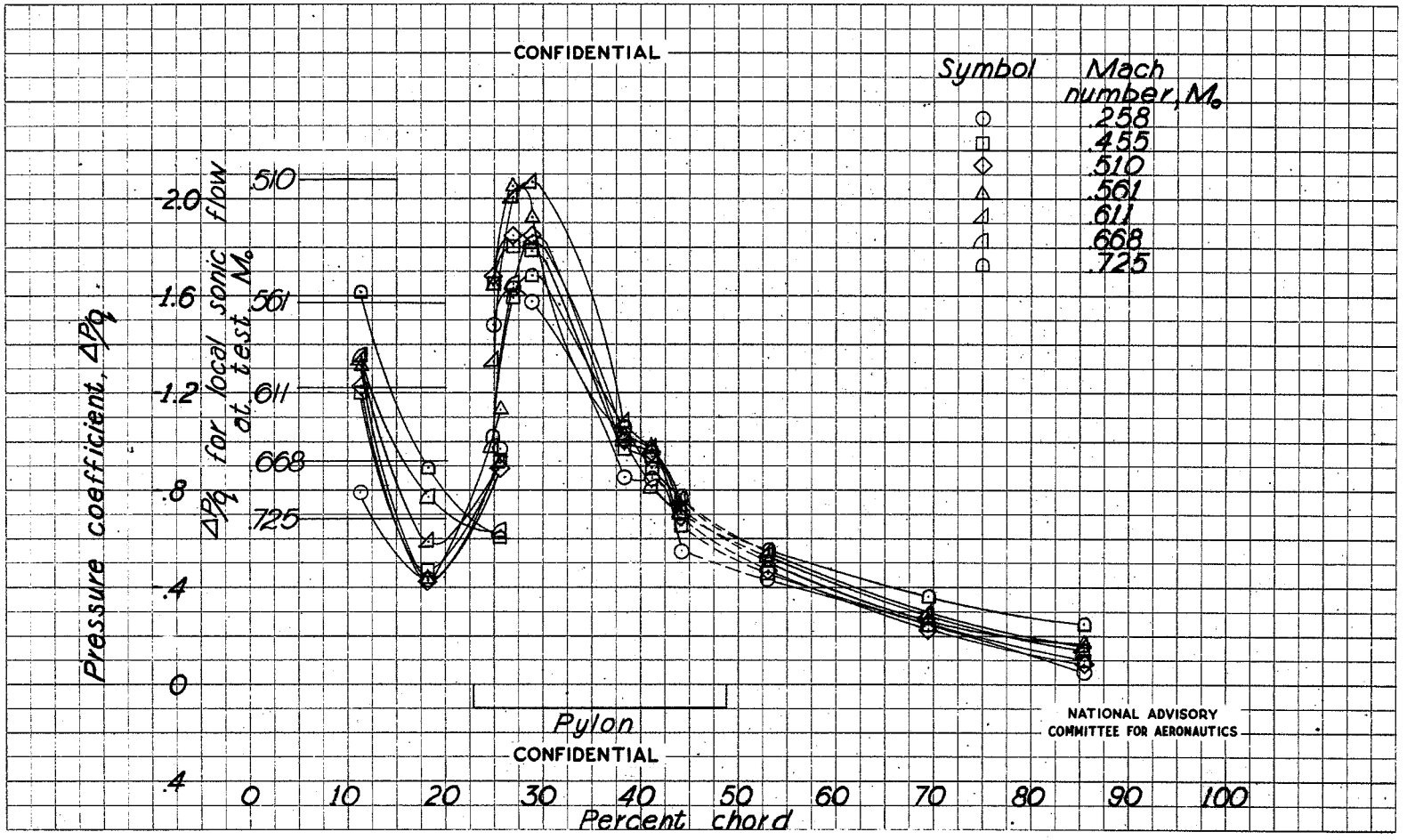
(e) Universal tank on left standard pylon with 6" extension.

Figure 8. - Concluded.



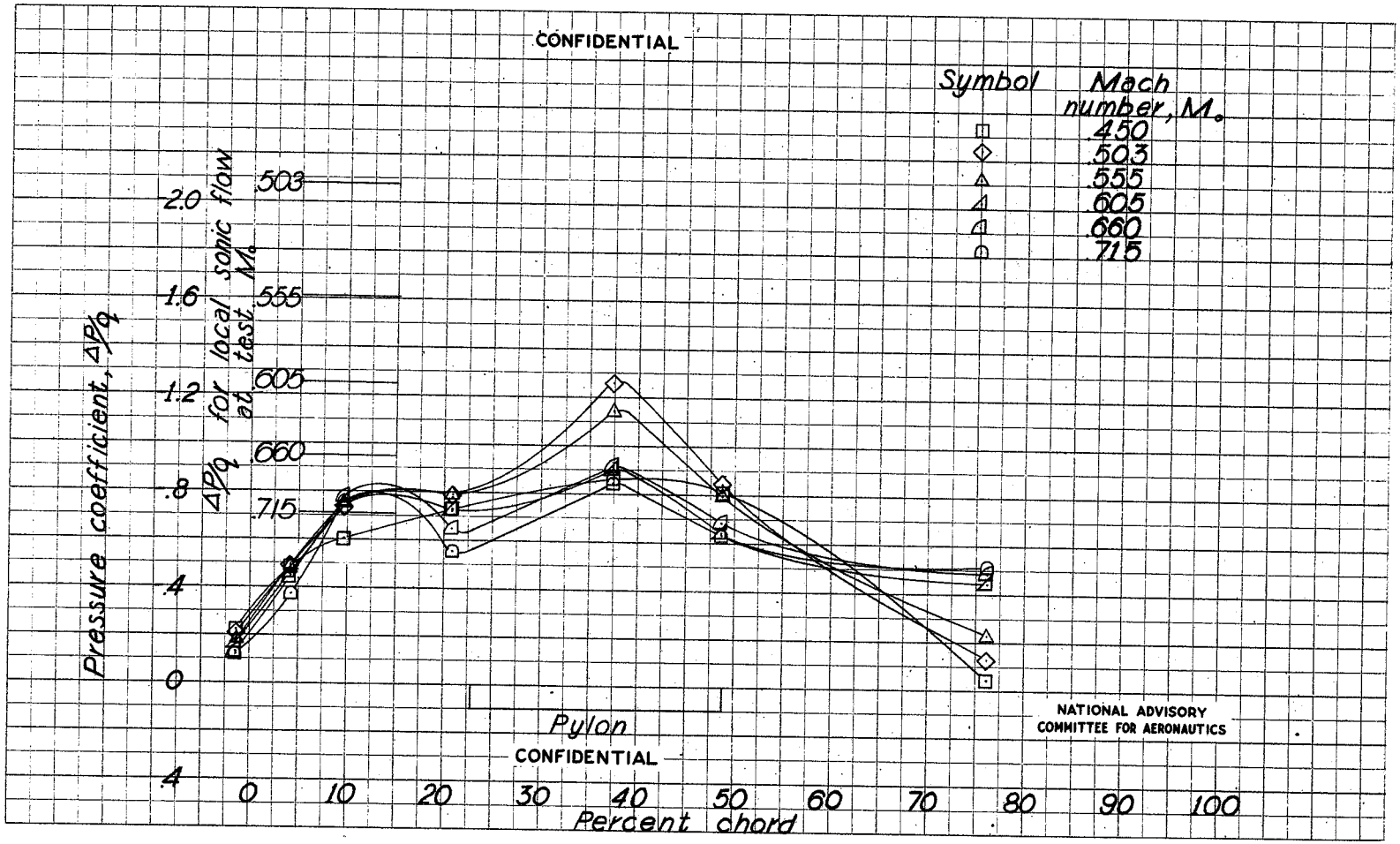
(a) Lockheed tanks on left and right standard pylons.

Figure 9. - Pressure distribution on the lower surface of the wing of a 0.182-scale model of the F4U-1 airplane with external stores. $\alpha = -3.5^{\circ}$.



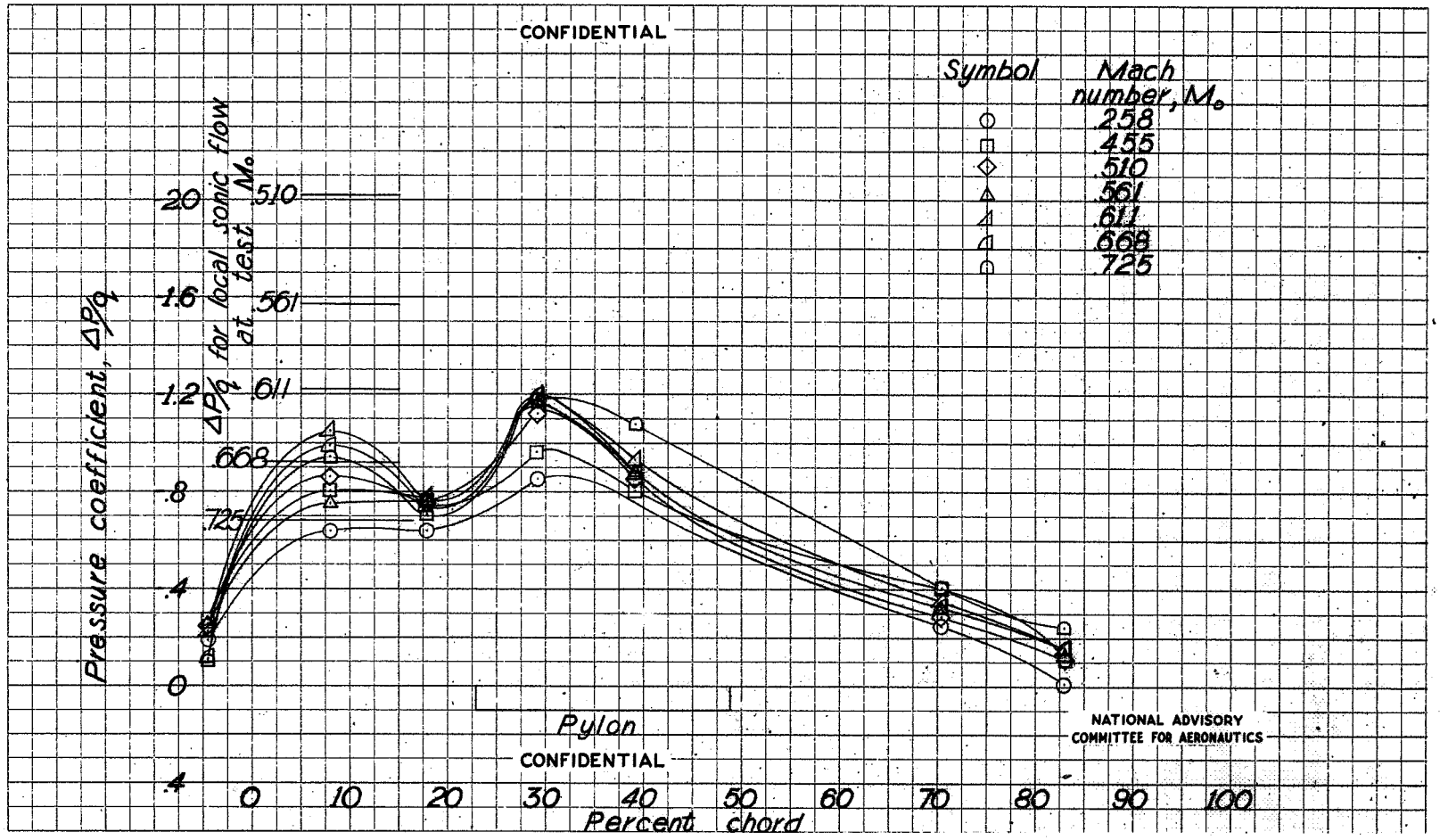
(b) Universal tanks on left and right standard pylons.

Figure 9. - Concluded.



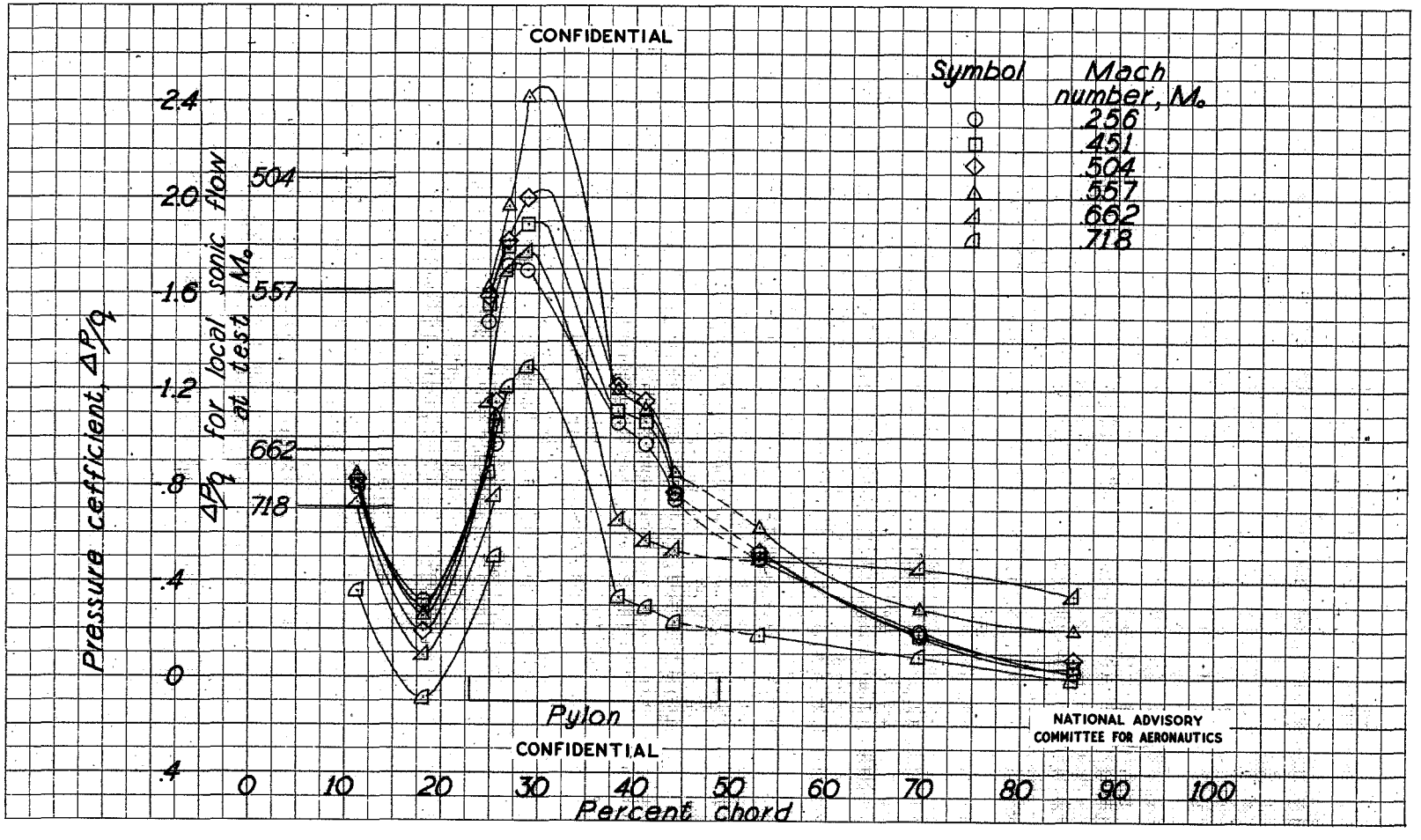
(a) Lockheed tanks on left and right standard pylons.

Figure 10. - Pressure distribution over droppable fuel tanks mounted on the wing of a 0.182-scale model of the F4U-1 airplane Inboard orifice row, $\alpha = -3.5^{\circ}$.



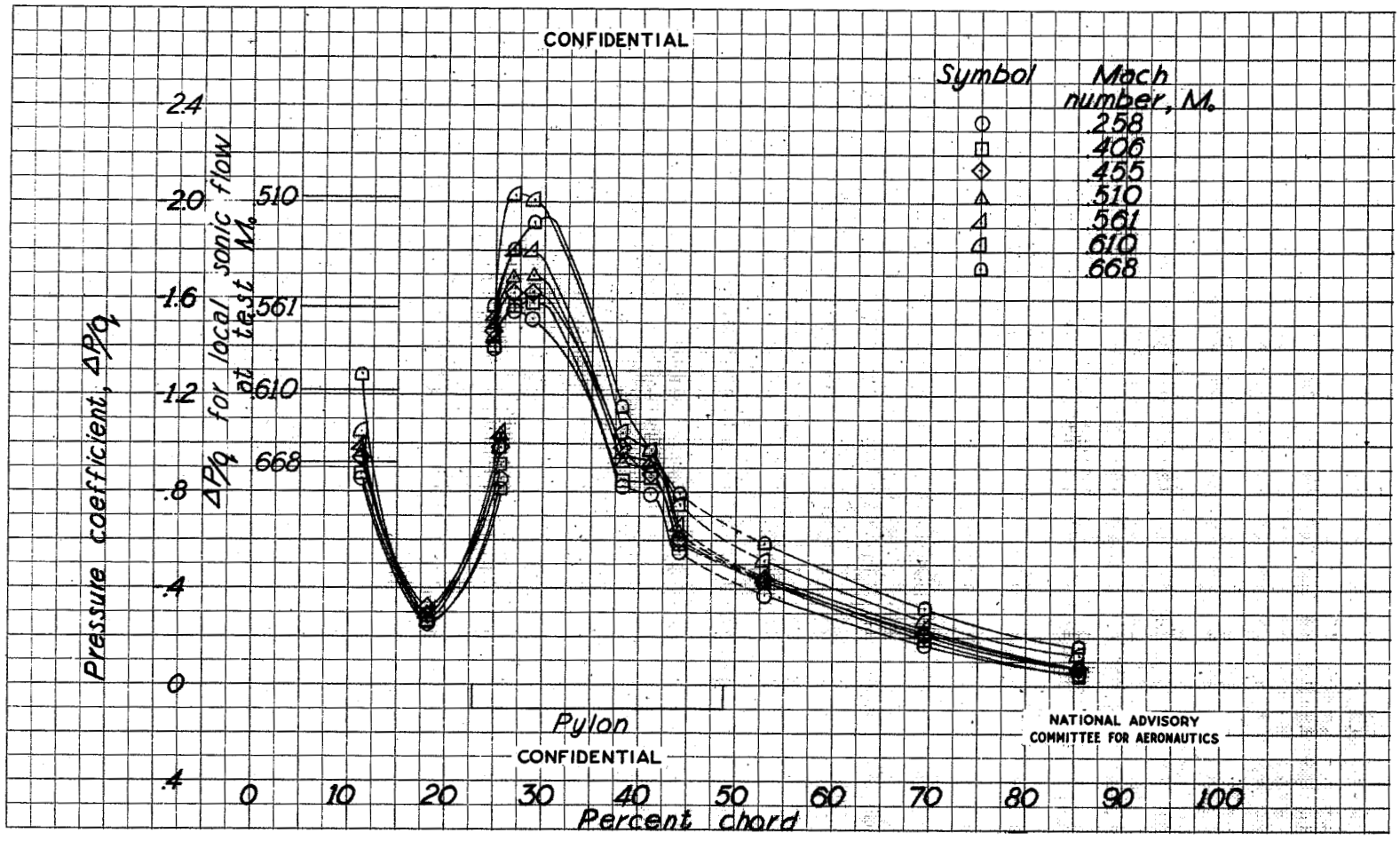
(b) Universal tanks on left and right standard pylons.

Figure 10. - Concluded.



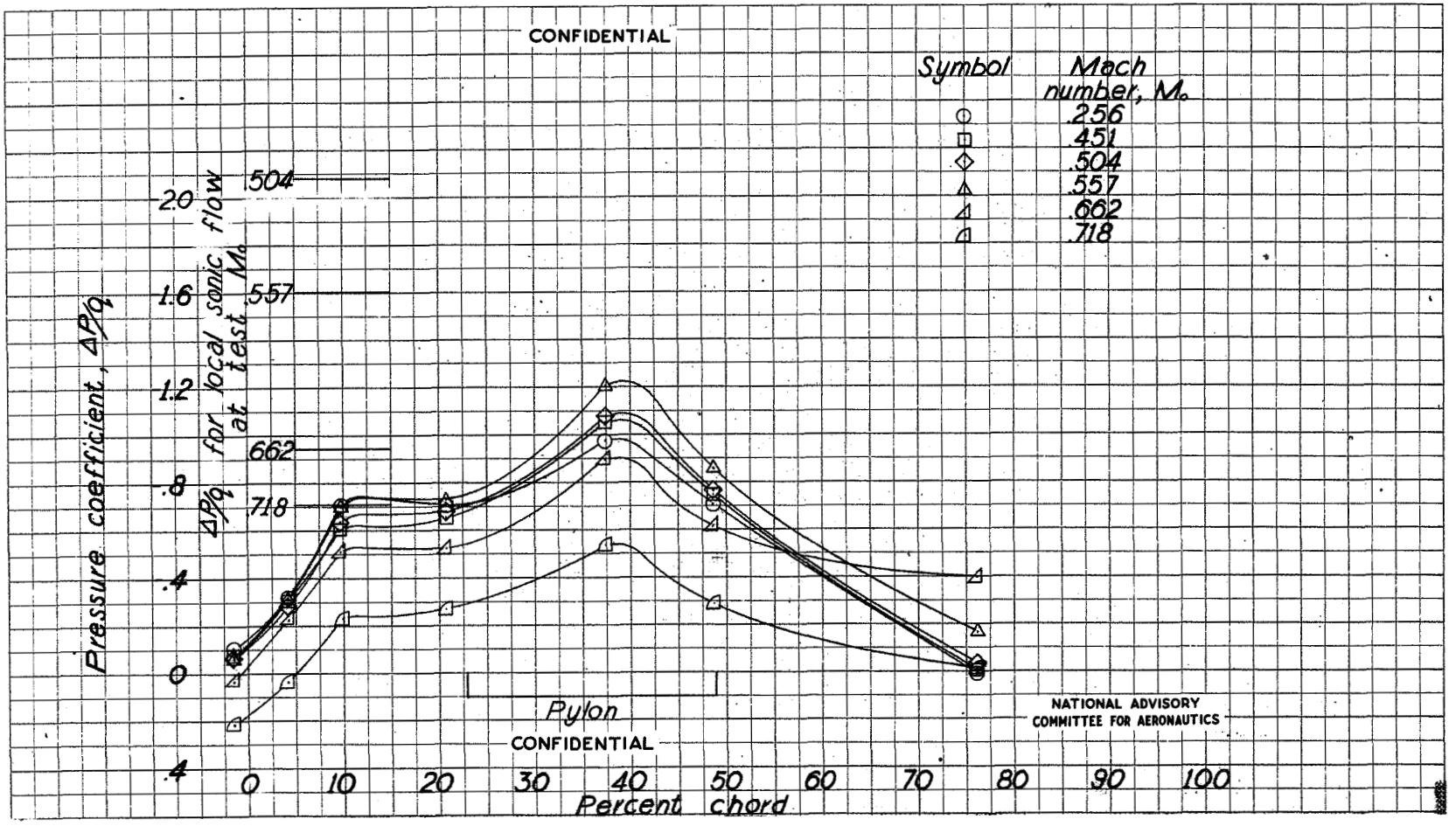
(a) Lockheed tanks on left and right standard pylons.

Figure 11. - Pressure distribution on the lower surface of the wing of a 0.182-scale model of the F4U-1 airplane with external stores. $\alpha = -1.5^{\circ}$



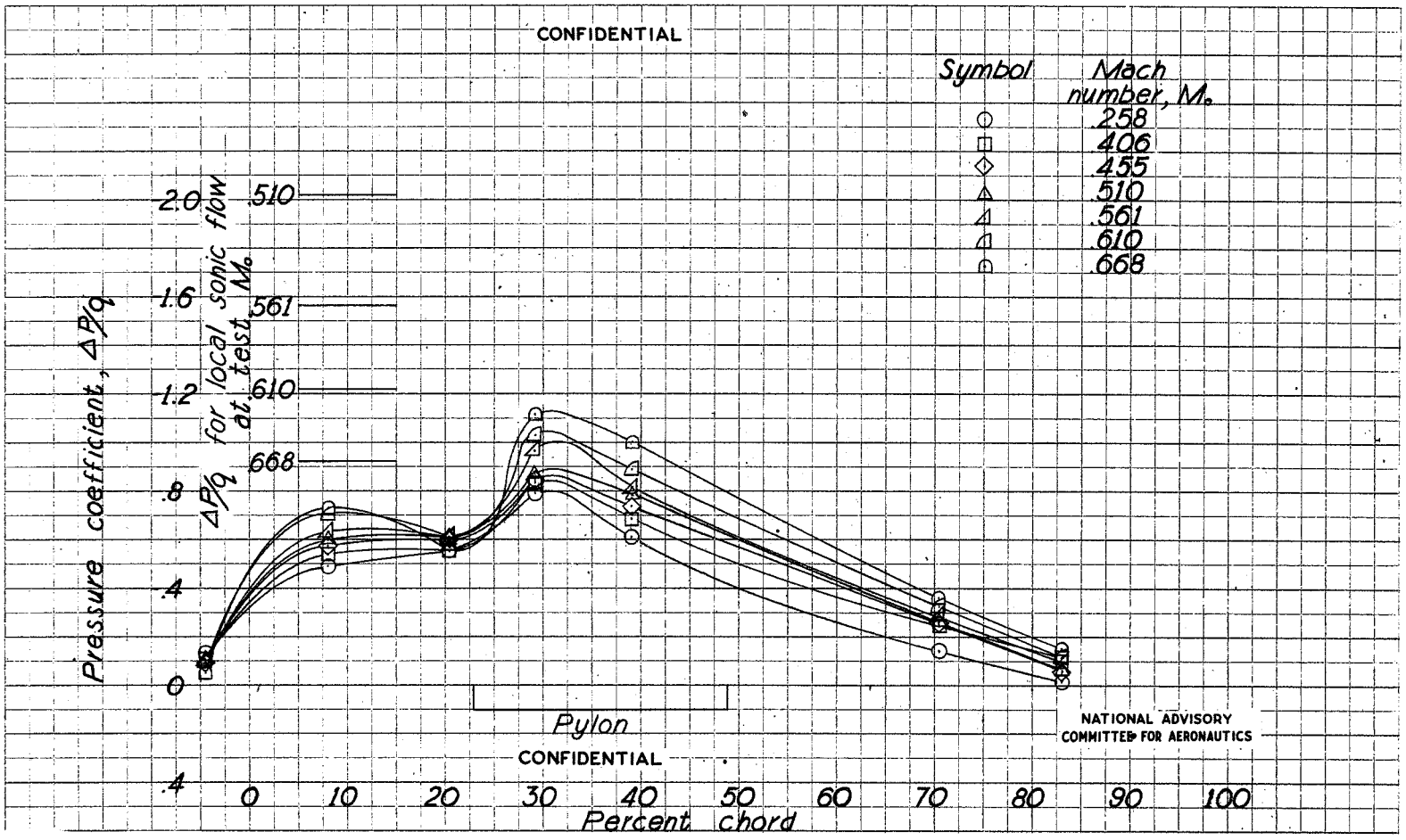
(b) Universal tanks on left and right standard pylons.

Figure 11. - Concluded.



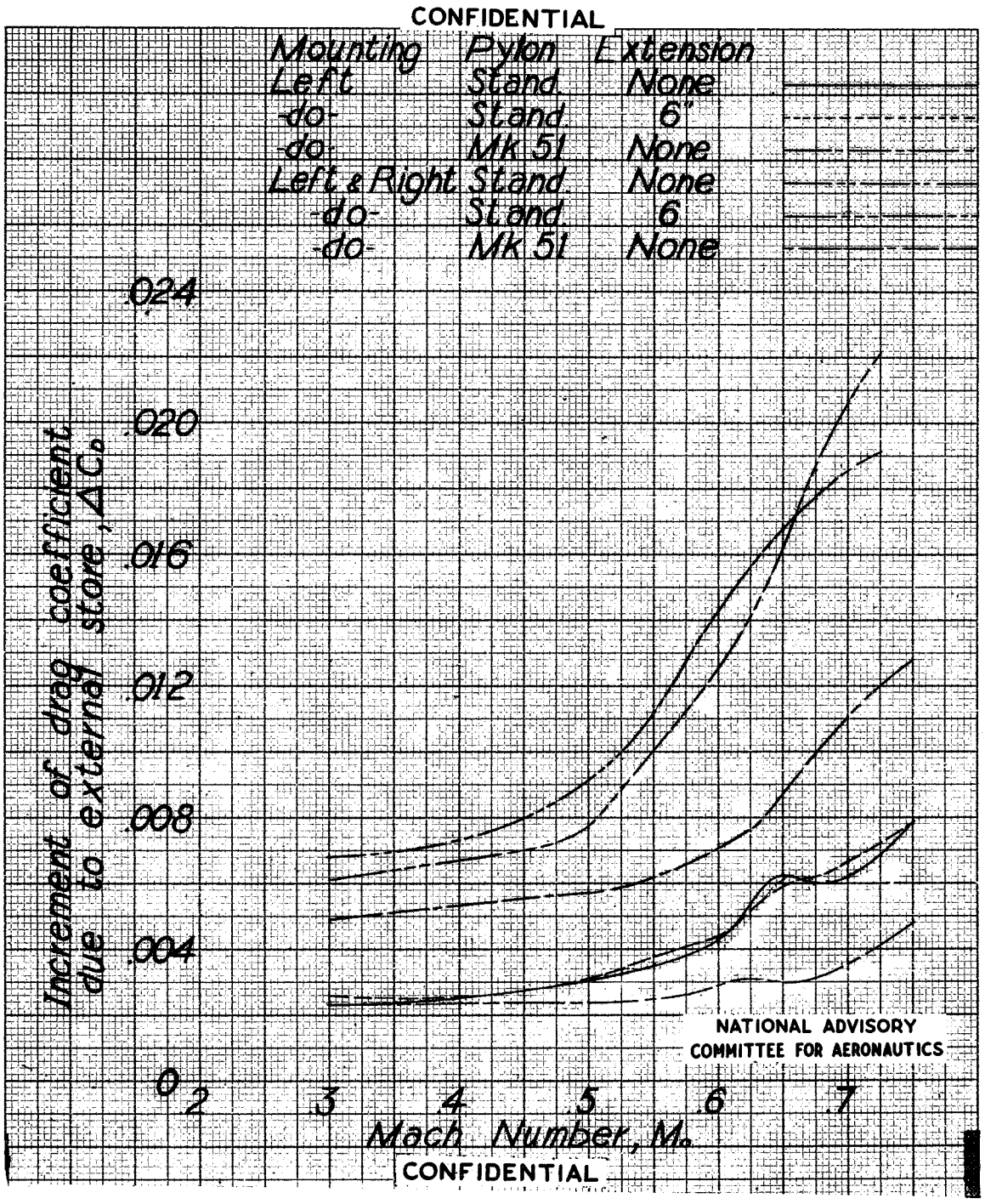
(a) Lockheed tanks on left and right standard pylons.

Figure 12. - Pressure distribution over droppable fuel tanks mounted on the wing of a 0.182-scale model of the F4U-1 airplane, $\alpha = -1.5^{\circ}$



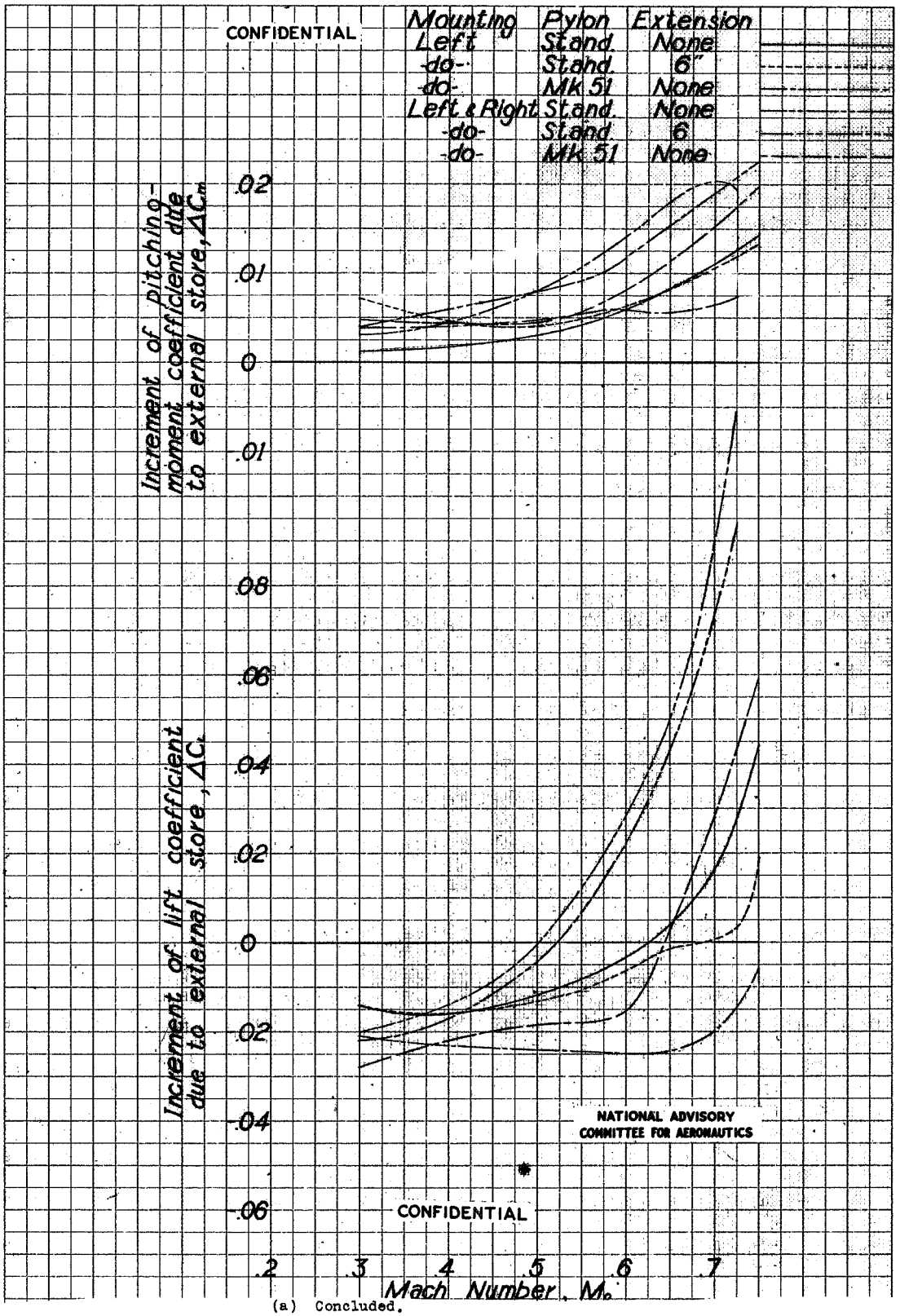
(b) Universal tanks on left and right standard pylons.

Figure 12. - Concluded.



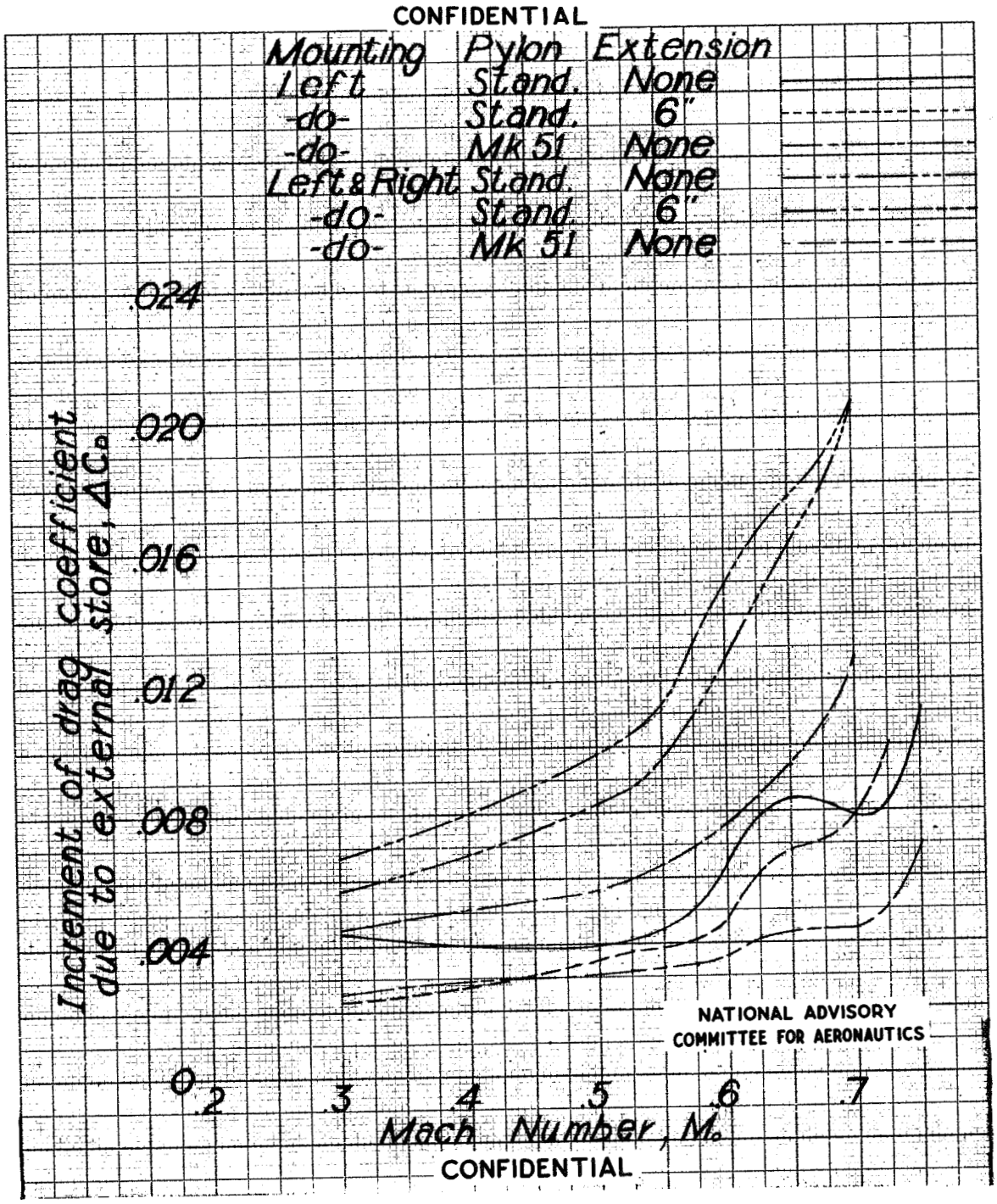
(a) $\alpha = -3.5^{\circ}$

Figure 13. - Effect of various pylon configurations on the aerodynamic characteristics of a 0.182-scale model of an F4U-1 airplane with Lockheed drop tank.



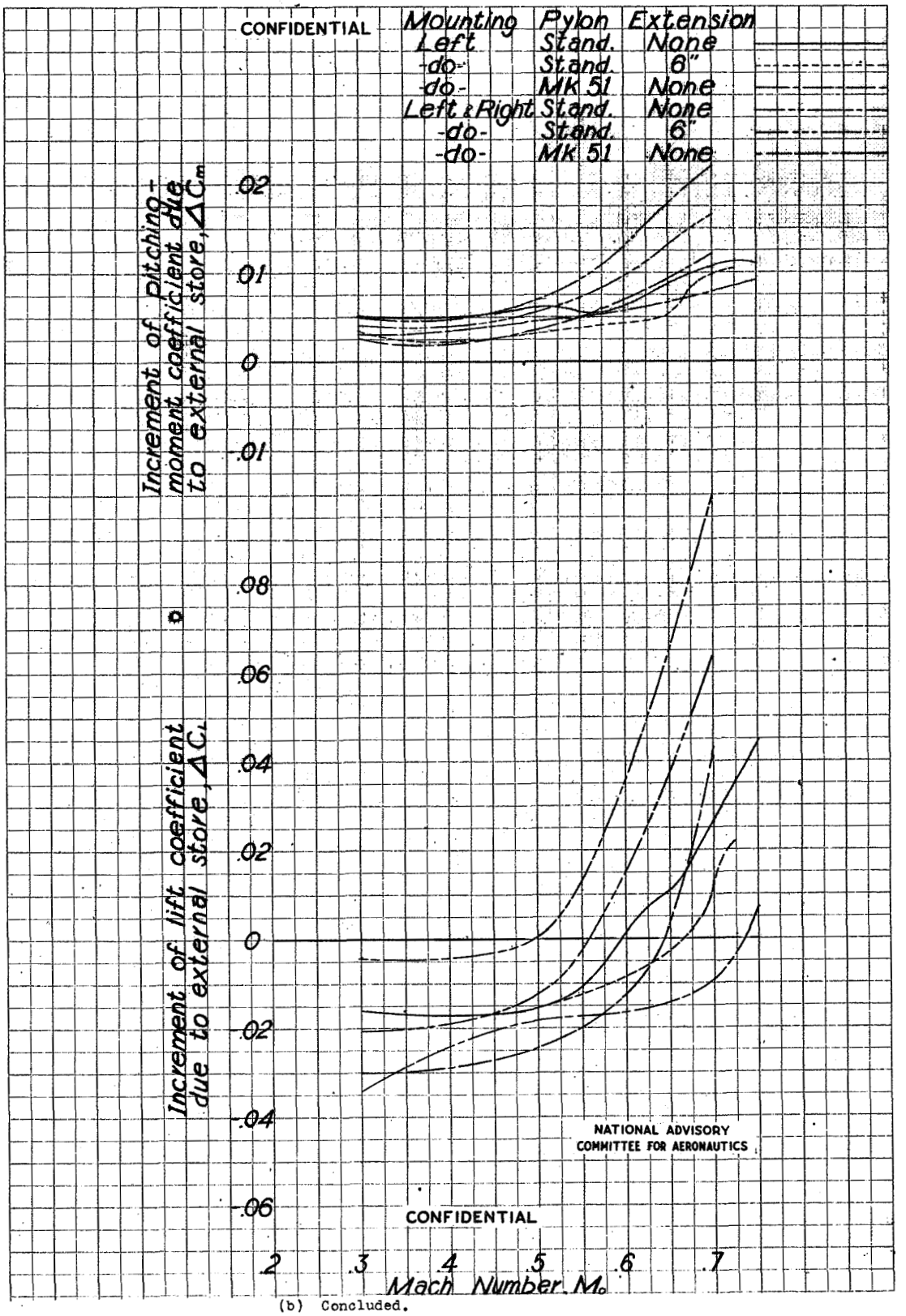
(a) Concluded.

Figure 13. - Continued.



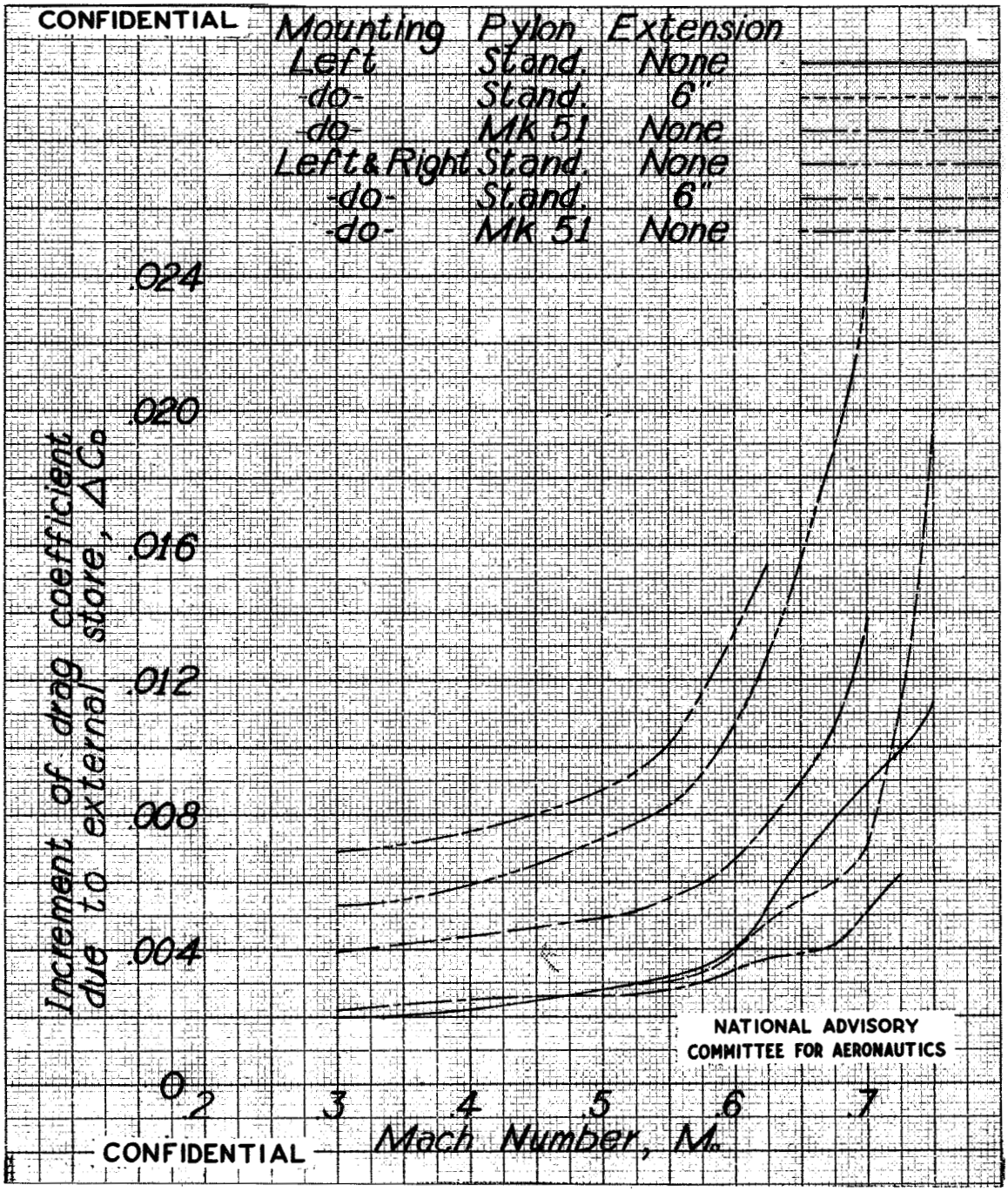
(b) $\alpha = -2.75^\circ$

Figure 13. - Continued.



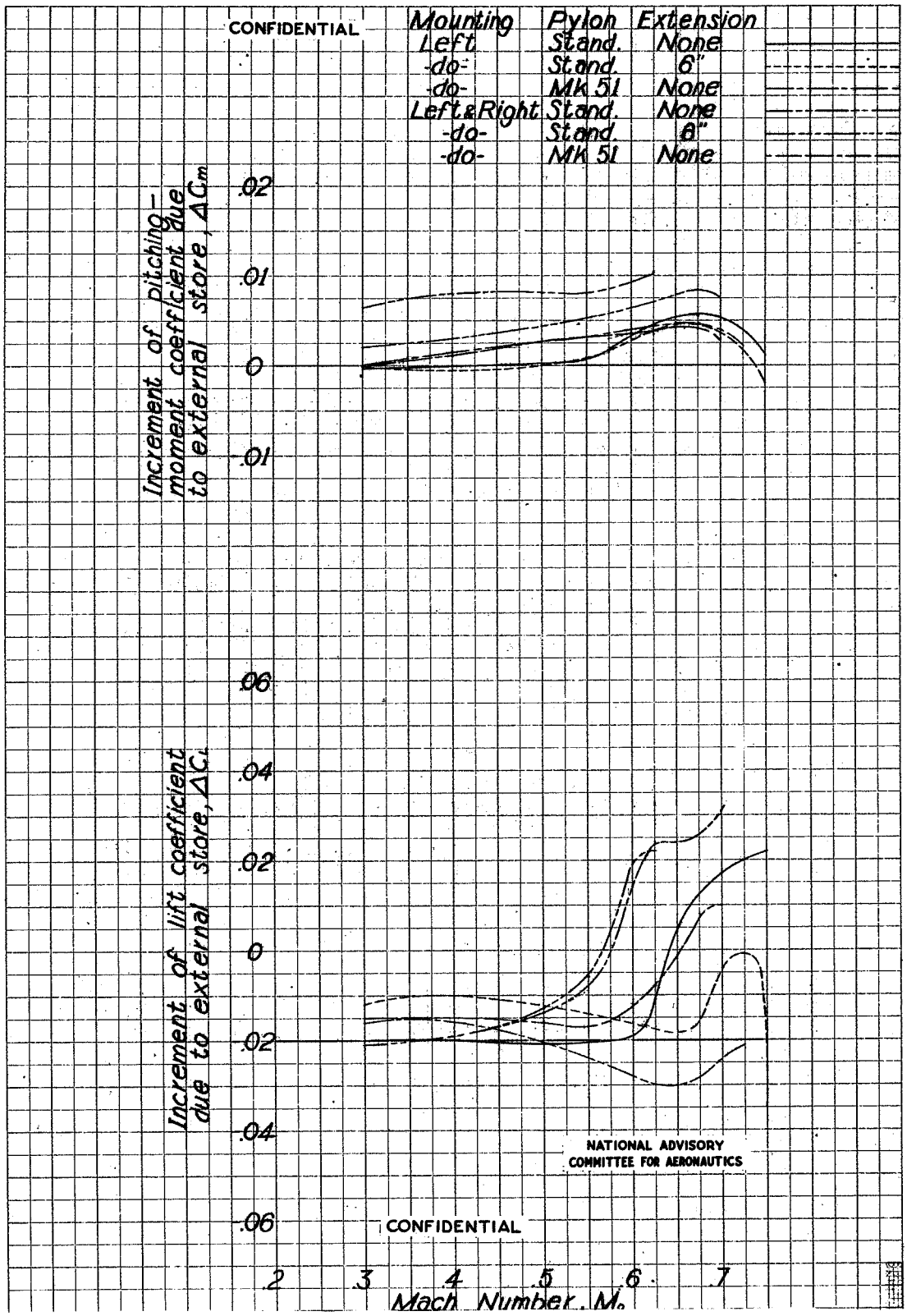
(b) Concluded.

Figure 13. - Continued.



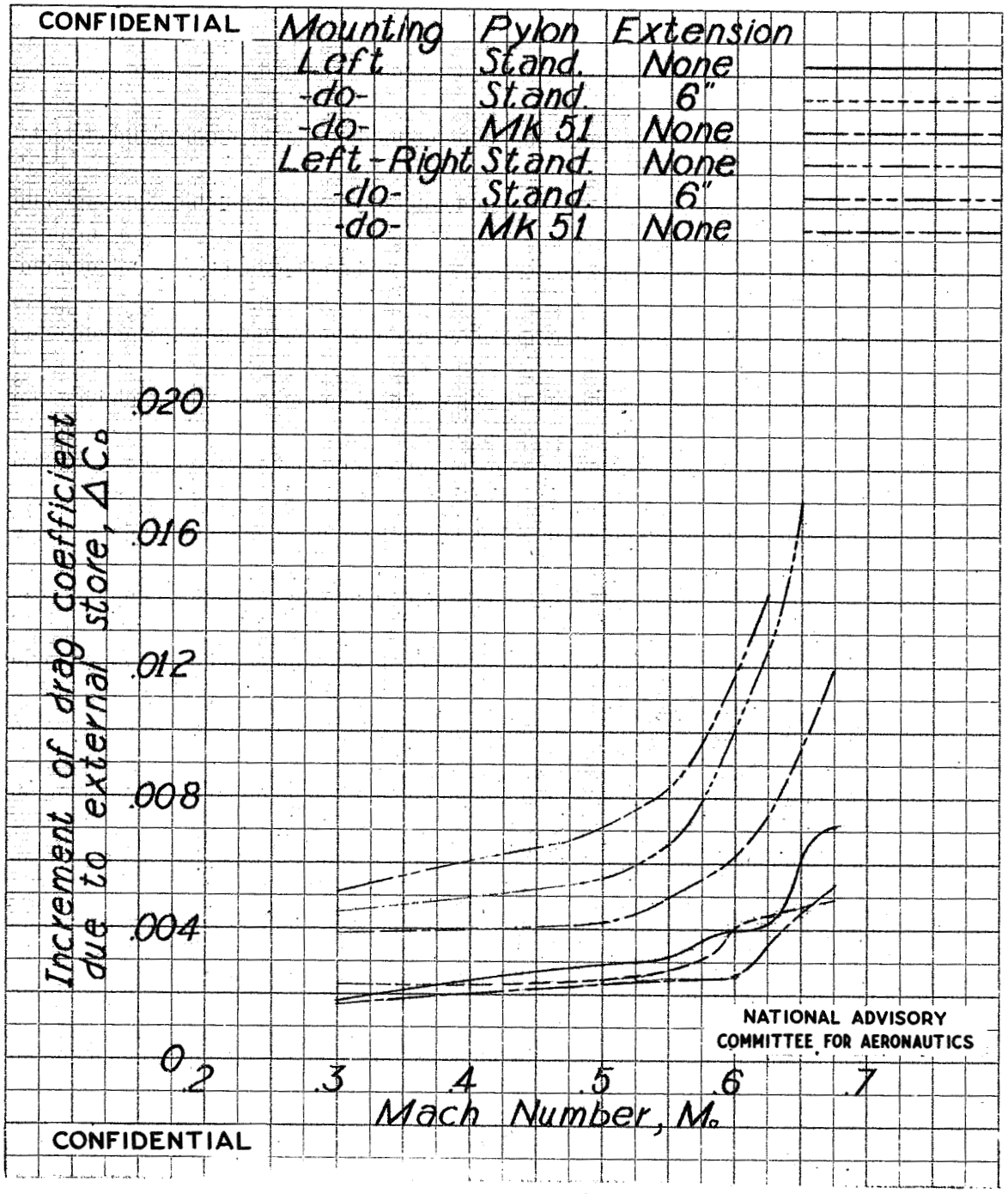
(c) $\alpha = -1.5^\circ$

Figure 13. - Continued.



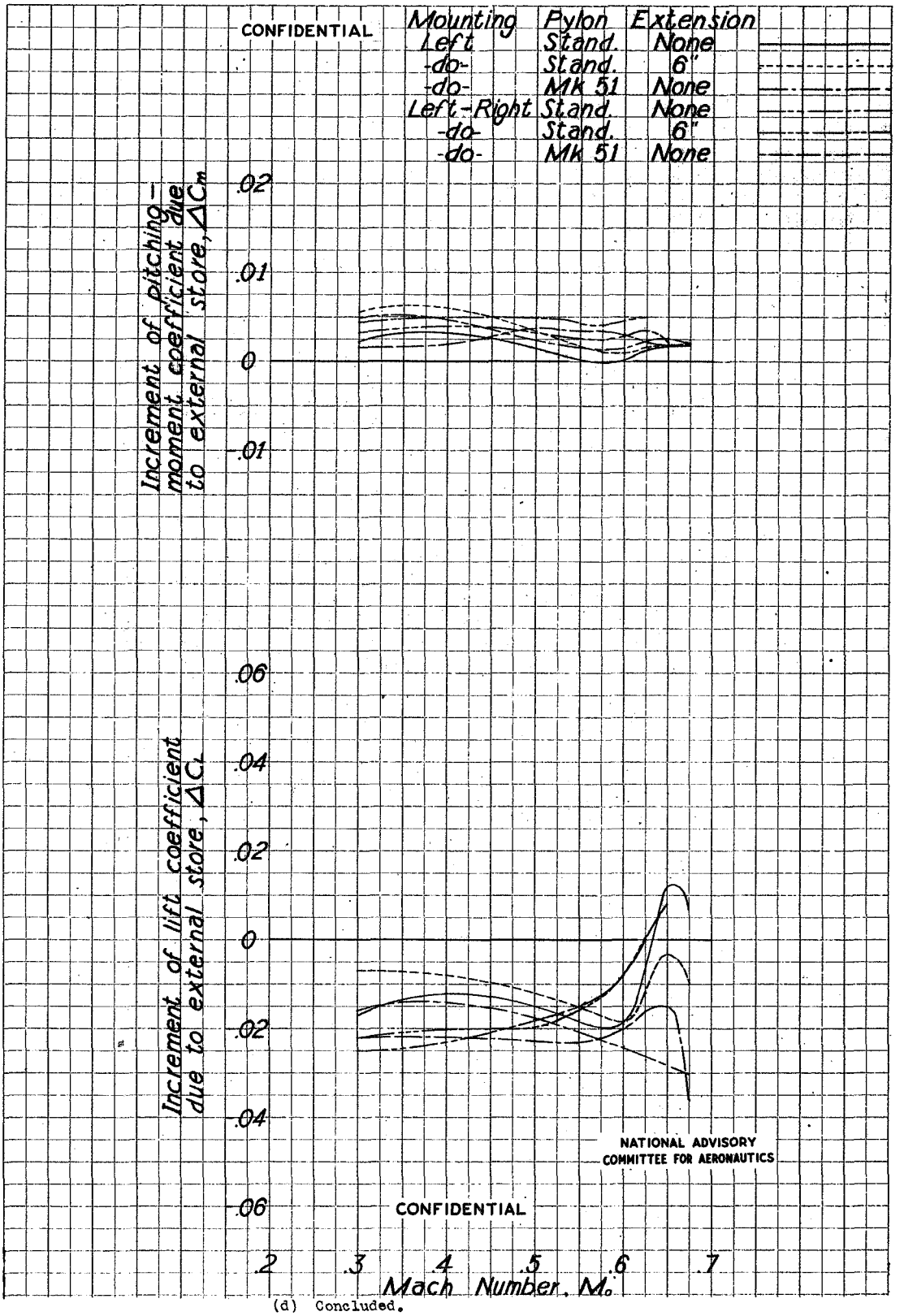
(c) Concluded.

Figure 13. - Continued



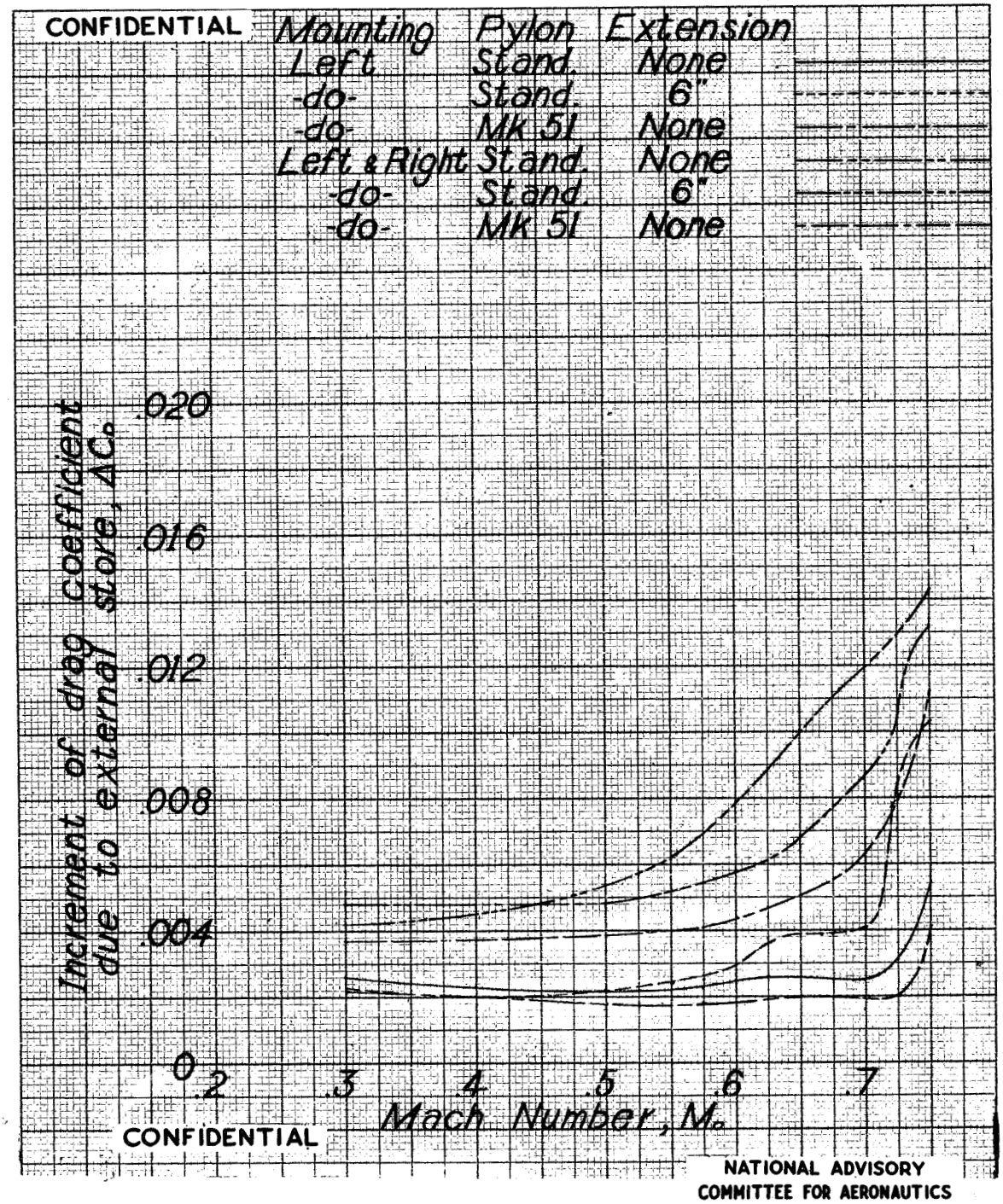
(d) $\alpha = .25^{\circ}$

Figure 13. - Continued.



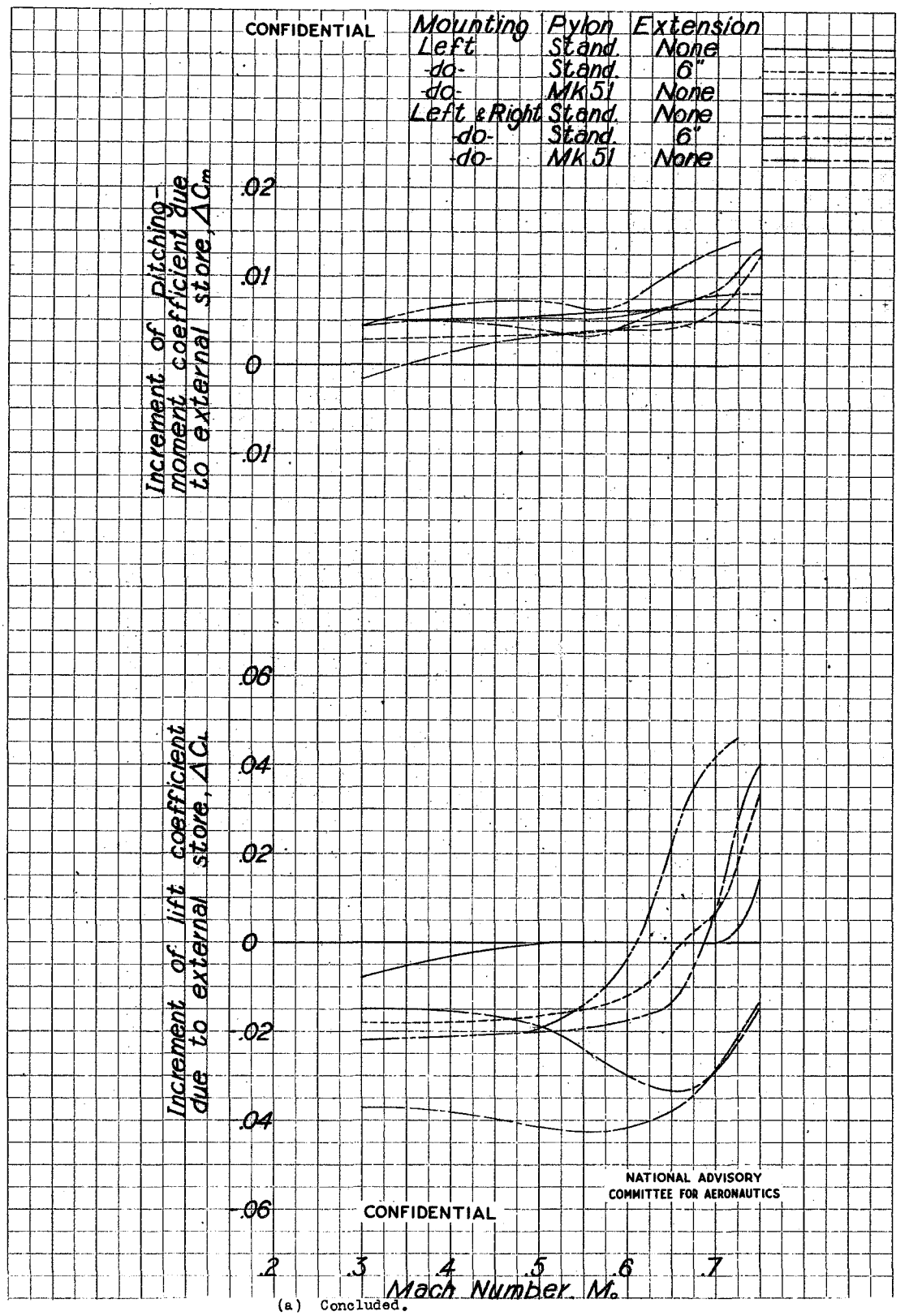
(d) Concluded.

Figure 13. - Concluded.



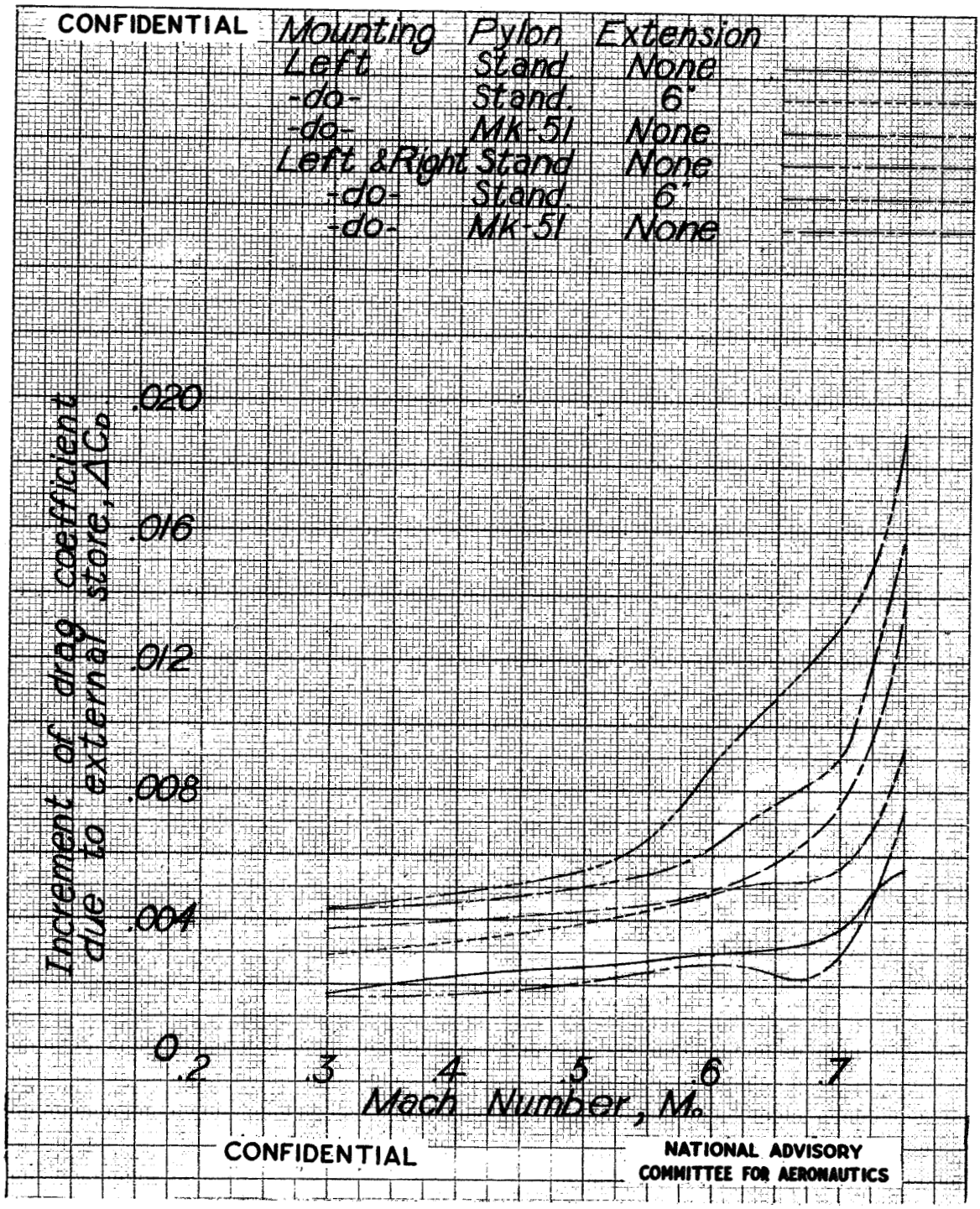
(a) $\alpha = -3.5^{\circ}$

Figure 14. - Effect of various pylon configurations on the aerodynamic characteristics of a 0.182-scale model of an F4U-1 airplane with Universal drop tank.



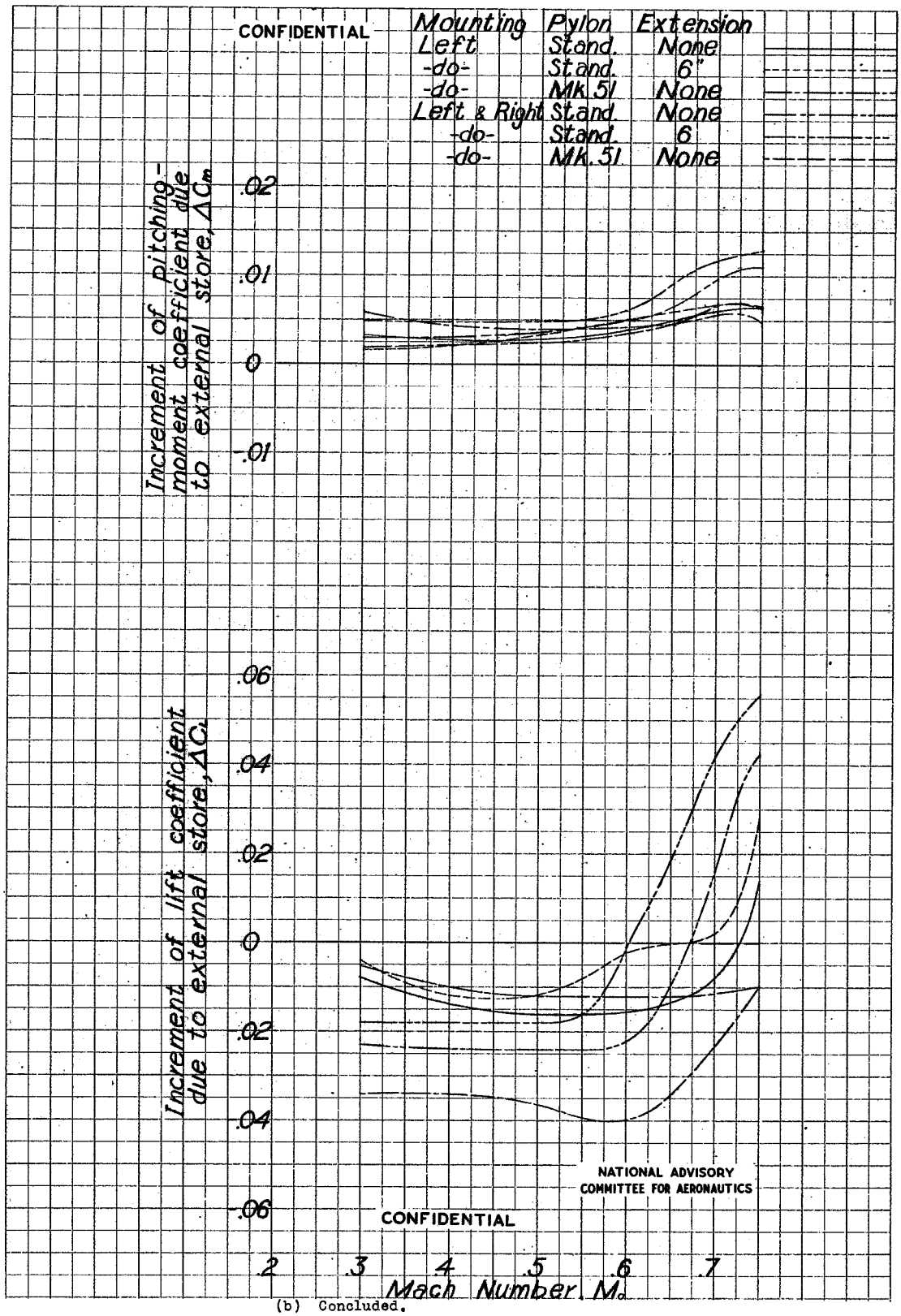
(a) Concluded.

Figure 14. - Continued.



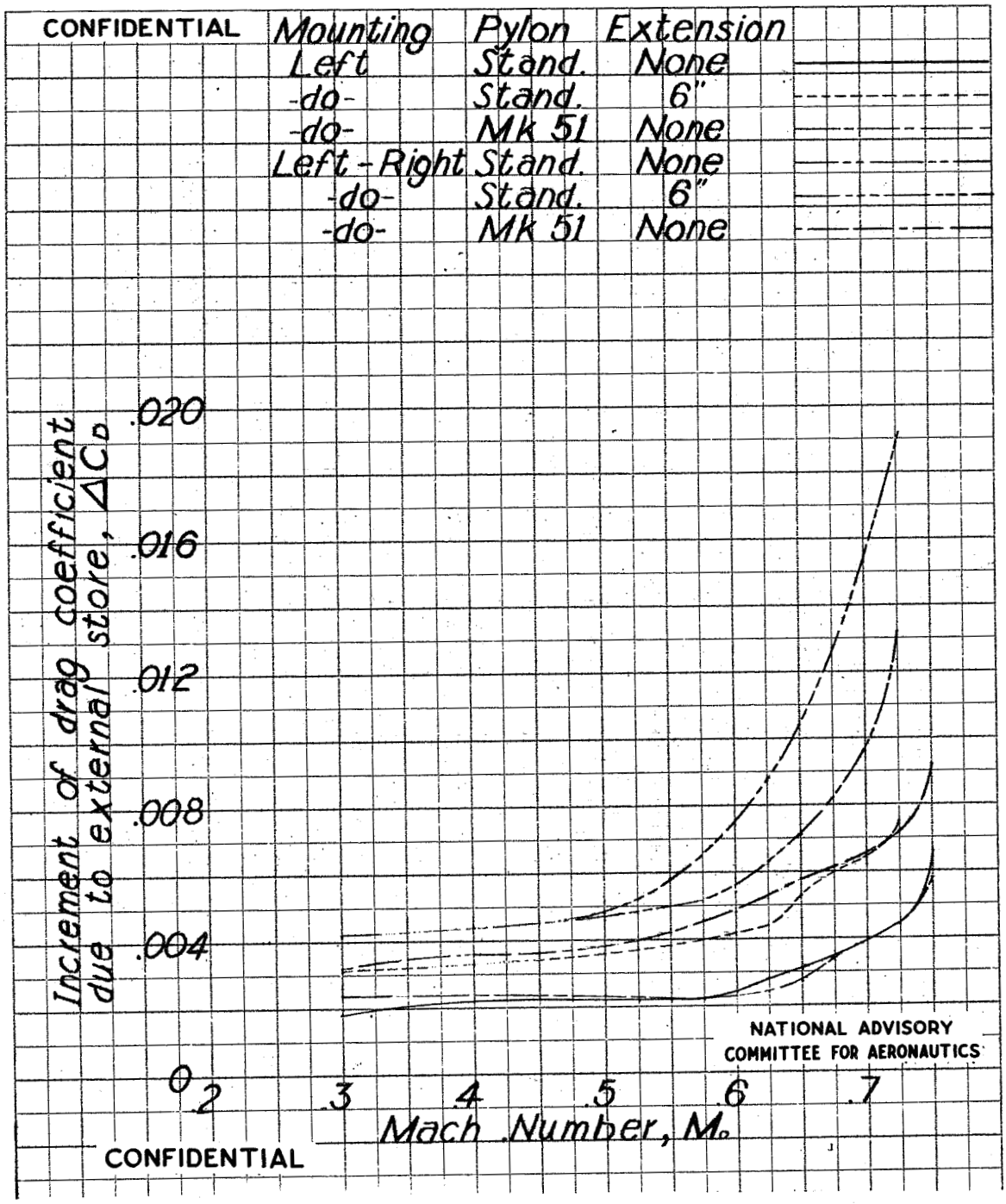
(b) $\alpha = -2.75^{\circ}$

Figure 14. - Continued.



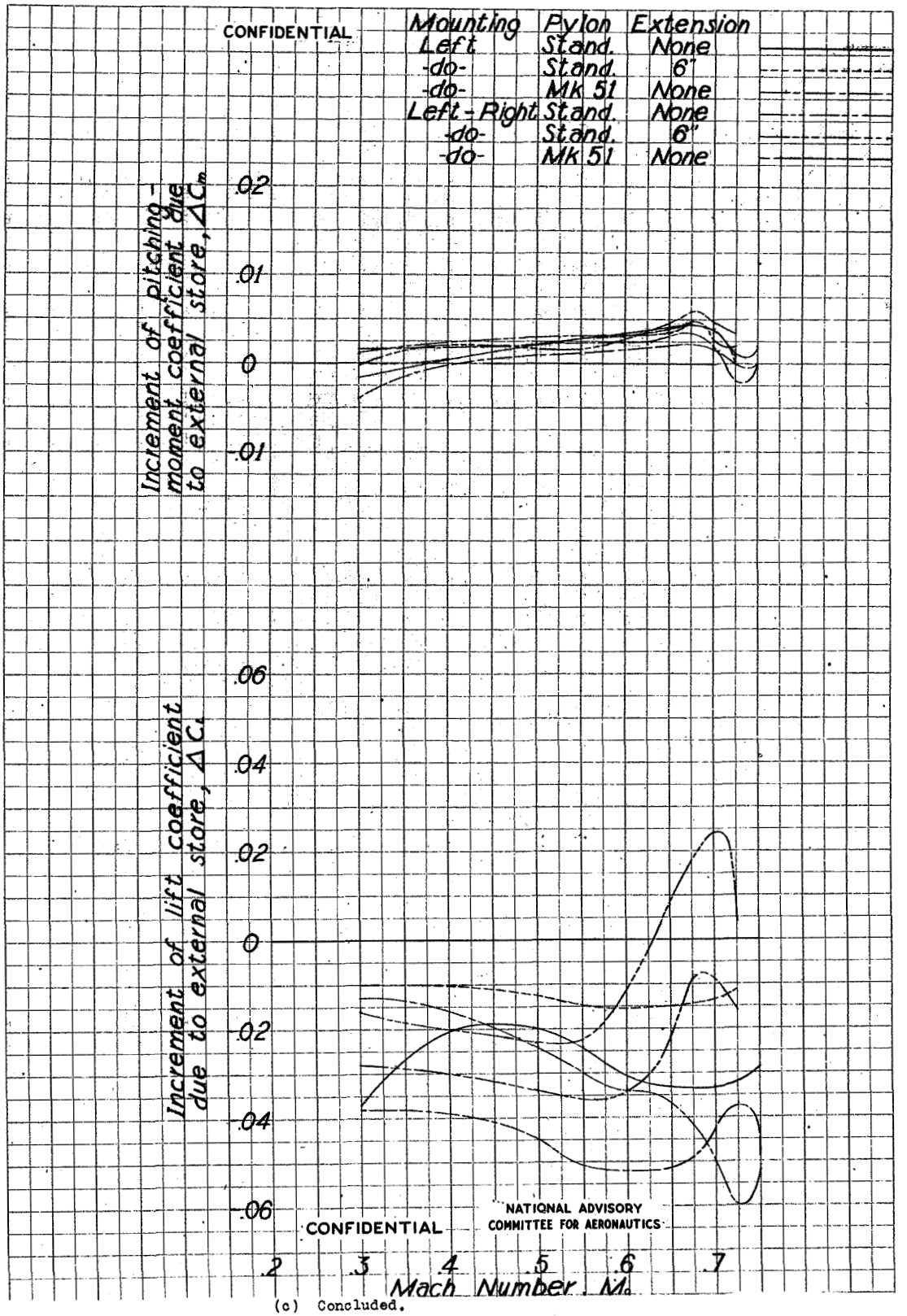
(b) Concluded.

Figure 14. - Continued.



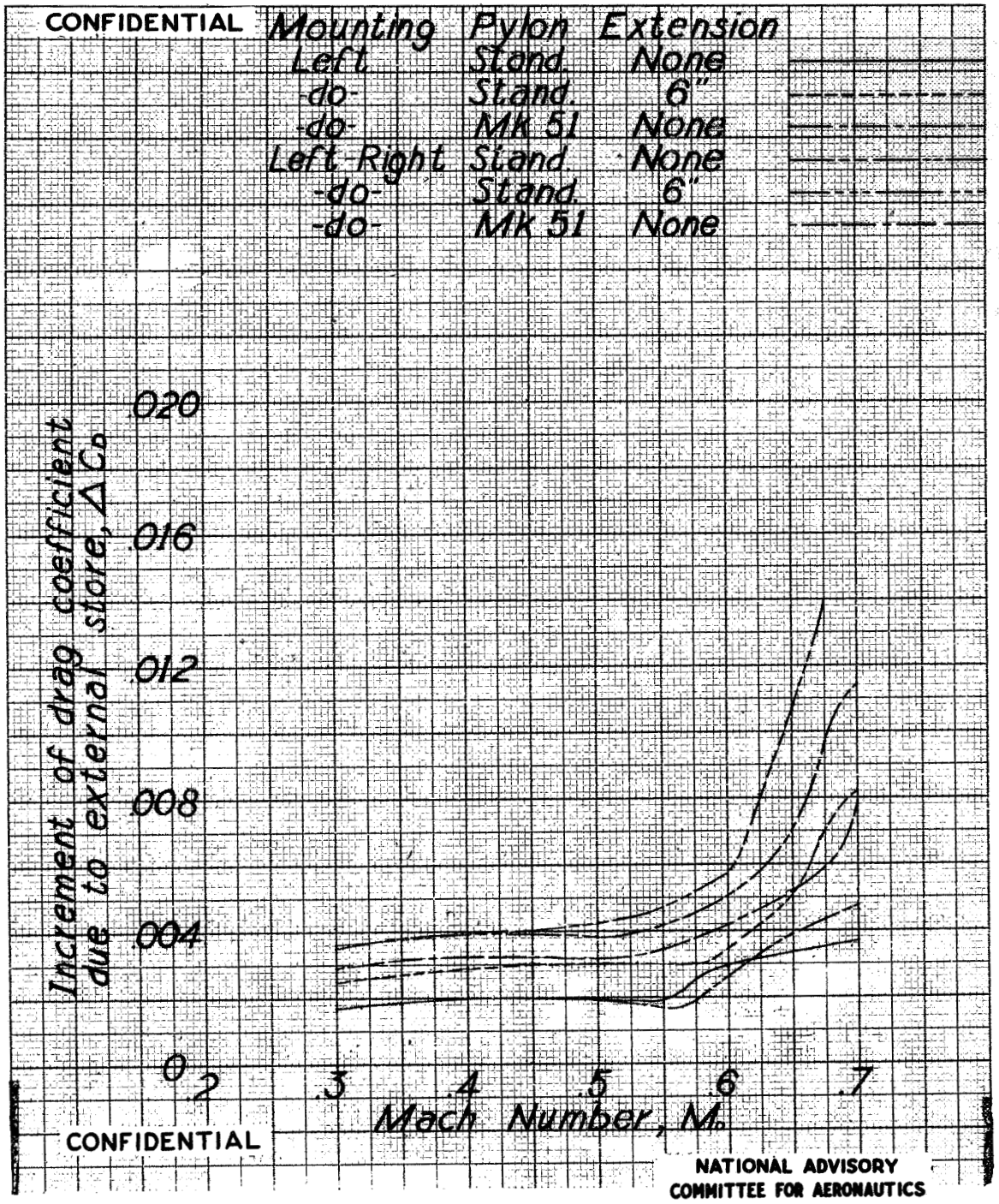
(c) $\alpha = -1.5^\circ$

Figure 14. - Continued.



(c) Concluded.

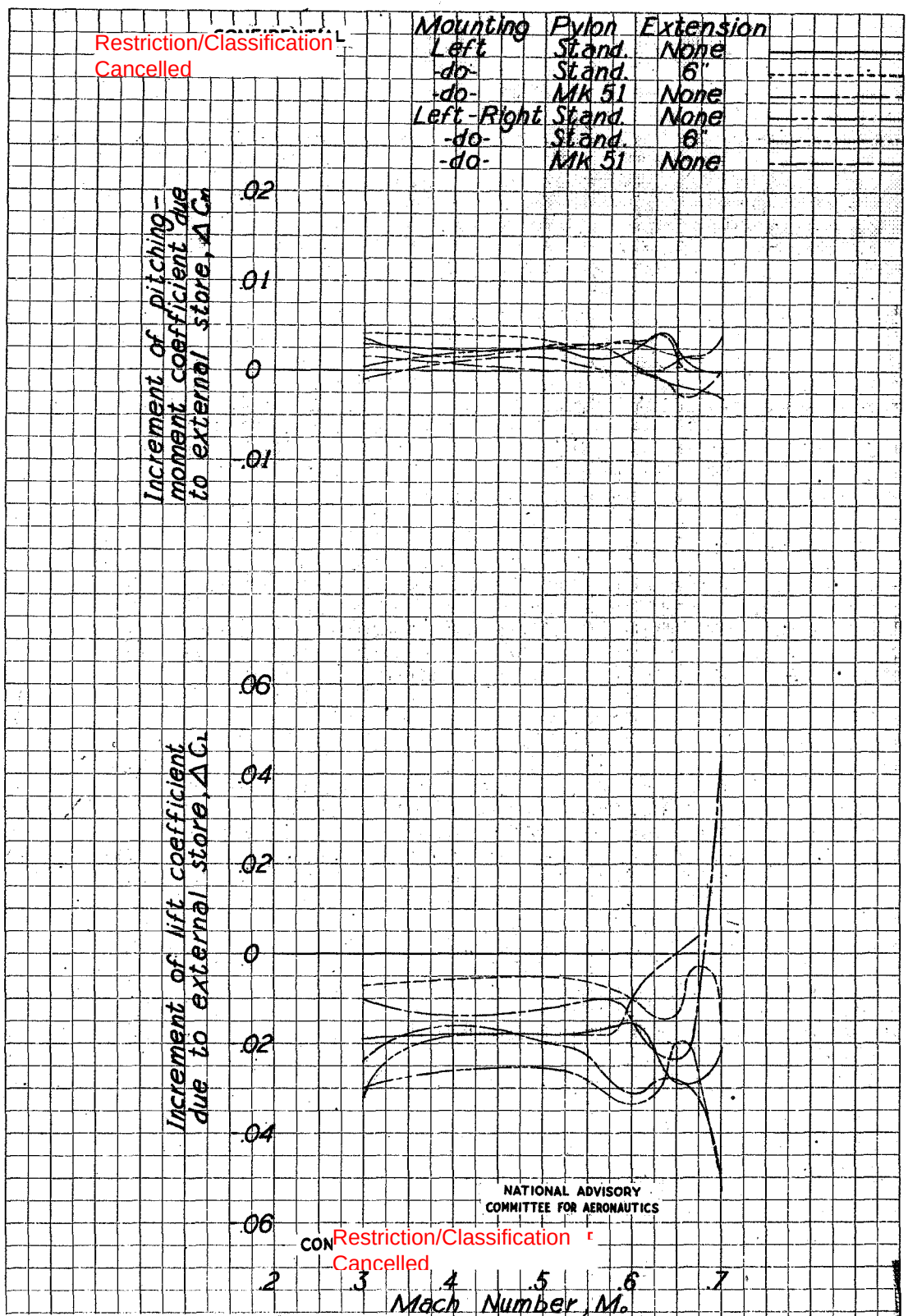
Figure 14. - Continued.



(d) $\alpha = .25^{\circ}$

Figure 14. - Continued.

Restriction/Classification Cancelled



CONFIDENTIAL

Restriction/Classification Cancelled

(d) Concluded.

Figure 14. - Concluded.