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An Experimental Investigation of Thrust Vectoring Two-Dimensional Covergent-Divergent Nozzles Installed in a Twin-Engine Fighter Model at High Angles of Attack

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Summary

This paper presents results from an investigation to determine the thrust vectoring capability of subscale, two-dimensional convergent-divergent exhaust nozzles installed on a twin-engine general research fighter model at angles of attack from -2° to 35°. Pitch thrust vectoring was accomplished by downward rotation of nozzle upper and lower flaps. The effects of nozzle sidewall cutback were studied for both unvectored and pitch-vectored nozzles. A single cutback sidewall was employed for yaw thrust vectoring. This investigation was conducted in the Langley 16-Foot Transonic Tunnel at Mach numbers ranging from 0 to 1.20. High-pressure air was used to simulate the jet exhaust and provide values of nozzle pressure ratio up to 9.

Nozzle sidewall cutback caused little or no effect on peak static nozzle performance for both unvectored and pitch-vectored nozzles. Thrust-minus-drag performance for the unvectored nozzle configurations varied less than 1 percent at subsonic speeds, thus showing the relative insensitivity of installed performance to nozzle sidewall cutback. At static conditions, resultant pitch vector angle was always greater than the geometric pitch vector angle for the three configurations tested. The increment in either the force or moment coefficient that resulted from pitch or yaw vectoring remained essentially constant over the entire angle-of-attack range for all Mach numbers tested. Longitudinal control power was a function of nozzle pressure ratio and Mach number. Powered controls were very effective at low Mach numbers, but their effectiveness decreased as Mach number increased because of a reduction in thrust. Longitudinal control power from thrust vectoring was greater than that provided by aerodynamic controls at low speeds. Negative yaw vector angles were generated at underexpanded nozzle operating conditions, but positive yaw vector angles were found at overexpanded nozzle operating conditions for a nozzle using a single cutback sidewall to produce yaw thrust vectoring.

Introduction

The next generation of fighter aircraft will be a versatile class of vehicles designed for operation over a wide range of flight and combat conditions. Future fighter aircraft requirements will probably include transonic and supersonic cruise capability, short takeoff and landing (STOL) features, high turn rates, and maneuvering at both conventional and high angles of attack. Studies have shown that significant advantages in air combat are gained with the ability to perform transient maneuvers at high angles of attack including brief excursions into post-stall conditions. (See refs. 1 to 5.) Current fighters are somewhat limited in their angle-of-attack envelope because inadequate aerodynamic control power exists at high angles of attack.

Augmenting existing aircraft control systems with multiaxis thrust vectoring could greatly enhance the effectiveness of fighter aircraft and allow them to exploit a much-expanded angle-of-attack envelope. If current flight capabilities are sufficient, augmenting existing fighter aircraft control systems could allow the designer the option of reducing empennage size, thus reducing total airframe drag. In either case, improved low-speed, high-angle-of-attack performance and STOL capability are likely benefits of the use of thrust vectoring (refs. 6 to 8).

A number of investigations conducted at both static (wind-off) and forward speeds have verified the effectiveness of multifunction nozzles for pitch thrust vectoring. (For example, see refs. 9 to 14.) More recent studies have evaluated static and wind-on effects of lateral or yaw thrust vectoring on installed nozzle performance (refs. 9, 10, and 14 to 16).

This paper presents results from an investigation to determine the thrust vectoring capability of subscale, two-dimensional convergent-divergent exhaust nozzles installed on a twin-engine general research fighter model at angles of attack from -2° to 35°. Pitch thrust vectoring was accomplished by downward rotation of nozzle upper and lower flaps. The effects of nozzle sidewall cutback were studied for both unvectored and pitch-vectored nozzles. A single cutback sidewall was employed for yaw thrust vectoring. This investigation was conducted in the Langley 16-Foot Transonic Tunnel at Mach numbers ranging from 0 to 1.20. High-pressure air was used to simulate the jet exhaust and provide values of nozzle pressure ratio up to 9.

Symbols

All model longitudinal forces and moments are referred to the stability axis system, and all lateral forces and moments are referred to the body axis system. The model moment reference center was located 1.75 in. above the model centerline at fuselage station 36.06 in. (FS 36.06) which corresponds to $0.25\bar{c}$. A discussion of the data reduction procedure and definitions of the aerodynamic force and moment terms and the propulsion relationships are presented in the appendix. Further details of the data reduction and calibration procedures used herein can be found in references 7 and 18. The symbols used in the computer-generated tables are given in parentheses.

A_e nozzle exit area, in^2

$A_{\max}$ maximum model cross-sectional area, in^2

$A_{\mathrm{mb},1}$ model cross-sectional area at FS 44.75 and 48.25, in^2

$A_{\mathrm{mb},2}$ model cross-sectional area at FS 66.25, in^2

$A_{\mathrm{seal},1}$ cross-sectional area enclosed by seal strip at FS 44.75 and 48.25, in^2

$A_{\mathrm{seal},2}$ cross-sectional area enclosed by seal strip at FS 66.25, in^2

A_t nozzle throat area, in^2

AR nozzle aspect ratio, ratio of nozzle throat width to height

b wing span, 40.00 in.

b_n maximum nozzle width, in.

C_D (CD) total aft-end drag coefficient, $C_D \equiv C_{D-F}$ at NPR = 1.0 (jet off)

$C_{D,\mathrm{aft}}$ (CDAFT) afterbody drag coefficient

$C_{D,n}$ (CDN) nozzle drag coefficient

C_{D-F} (C(D-F)) drag-minus-thrust coefficient, $\frac{\text{Drag} - \text{Thrust}}{q_\infty S}$

C_L (CL) total aft-end aerodynamic lift coefficient, $C_L \equiv C_{L,t}$ at NPR = 1.0 (jet off)

$C_{L,\mathrm{aft}}$ (CLAFT) afterbody lift coefficient

$C_{L,n}$ (CLN) nozzle lift coefficient

$C_{L,t}$ (CLT) total aft-end lift coefficient, including thrust component, $\frac{\text{Lift}}{q_\infty S}$

$C_{L_{\delta_v}}$ lift effectiveness due to thrust vectoring, per degree

C_l (CROLL) total aft-end rolling-moment coefficient, $C_l \equiv C_{l,t}$ at NPR = 1.0 (jet off)

$C_{l,t}$ (CROLLT) total aft-end rolling-moment coefficient including thrust component, $\frac{\text{Rolling moment}}{q_\infty Sb}$

C_m (CM) total aft-end aerodynamic pitching-moment coefficient, $C_m \equiv C_{m,t}$ at NPR = 1.0 (jet off)

$C_{m,\mathrm{aft}}$ (CMAFT) afterbody pitching-moment coefficient

$C_{m,n}$ (CMN) nozzle pitching-moment coefficient

$C_{m,t}$ (CMT) total aft-end pitching-moment coefficient including thrust component, $\frac{\text{Pitching moment}}{q_\infty S\bar{c}}$

C_{m_δ} longitudinal control power, per degree

$C_{m_{\delta_v}}$ longitudinal control power due to pitch vectoring, per degree

C_n (CN) total aft-end yawing moment, $C_n \equiv C_{n,t}$ at NPR = 1.0 (jet off)

$C_{n,t}$ (CNT) total aft-end yawing moment including thrust component, $\frac{\text{Yawing moment}}{q_\infty Sb}$

C_p pressure coefficient, $(p - p_\infty)/q_\infty$

C_Y (CY) total aft-end side-force coefficient, $C_Y \equiv C_{Y,t}$ at NPR = 1.0 (jet off)

$C_{Y,t}$ (CYT) total aft-end side-force coefficient including thrust coefficient, $\frac{\text{Side force}}{q_\infty S}$

$\bar{c}$ wing mean geometric chord, 17.42 in.

D drag, lbf

D_f friction drag, lbf

F thrust along stability axis, lbf

F_A total aft-end axial force, lbf

$F_{A,\mathrm{Mbal}}$ axial force measured by main balance, lbf

$F_{A,\mathrm{mom}}$		momentum tare axial force due to bellows, lbf
$F_{A,\mathrm{Sbal}}$		axial force measured by afterbody shell balance, lbf
F_{aft}		afterbody axial force, lb
F_G		resultant gross thrust, $\sqrt{F_j^2 + F_N^2 + F_S^2}$, lbf
F_i		ideal isentropic gross thrust, $w_p \left\{ \frac{RT_{t,j}}{g^2} \frac{2\gamma}{\gamma - 1} \left[1 - \left(\frac{1}{\mathrm{NPR}} \right)^{(\gamma-1)/\gamma} \right] \right\}^{1/2}$, lbf
F_j		measured thrust along body axis, lbf
F_N		measured jet normal force, lbf
F_S		measured jet side force, lbf
g		gravitational constant, 32.174 ft/sec^2
L		length from nozzle attachment station (FS 66.30) to nozzle exit, used in coordinate system of figure 6(a)
L_j		length from moment reference center to nozzle throat, in.
L_t		length from moment reference center to quarter-chord of horizontal tail mean geometric chord, in.
l		length from nozzle throat to nozzle exit, used in coordinate system of figure 6(b), in.
M	(MACH)	free-stream Mach number
NPR	(NPR)	nozzle pressure ratio, $p_{t,j}/p_\infty$ or $p_{t,j}/p_a$
$(\mathrm{NPR})_{\mathrm{des}}$		nozzle pressure ratio required for fully expanded flow
p		local static pressure, psi
p_a		ambient pressure, psi
$\overline{p}_{\mathrm{es},1}$		average static pressure at external seal at FS 44.75, psi
$\overline{p}_{\mathrm{es},2}$		average static pressure at external seal at FS 48.25, psi
$\overline{p}_{\mathrm{es},3}$		average static pressure at external seal at FS 66.25, psi
$\overline{p}_i$		average internal static pressure, psi
$p_{t,j}$		average jet total pressure, psi
p_∞		free-stream static pressure, psi
q_∞		free-stream dynamic pressure, psi
R		gas constant, 1716 ft^2/sec^2-°R
S		wing reference area, 664.4 in^2
S_t		horizontal tail area, in^2
$T_{t,j}$		average jet total temperature, °R
$\overline{V}$		volume coefficient (see the appendix)
w_i		ideal weight-flow rate, lbf/sec
w_p		measured weight-flow rate, lbf/sec
X		axial distance measured from nozzle attachment station (FS 66.30), positive downstream, used in coordinate system of figure 6(a), in.
x		axial distance measured from nozzle throat, positive downstream, used in coordinate system of figure 6(b), in.
Y		lateral distance measured from model centerline, positive to left (outboard) looking downstream, used in coordinate system of figure 6(a), in.

y		lateral distance measured from nozzle centerline, positive to left (outboard) looking downstream, used in coordinate system of figure 6(b), in.
α	(ALPHA)	angle of attack, deg
γ		ratio of specific heats, 1.3997 for air
δ_p		resultant pitch vector angle, $\tan^{-1}\frac{F_N}{F_j}$, deg
$\delta_{v,p}$		geometric pitch vector angle measured from nozzle centerline, positive for downward deflection angles, deg
δ_y		resultant yaw vector angle, $\tan^{-1}\frac{F_S}{F_j}$, deg

Abbreviations:

A/B	afterburning
BL	butt line, in.
C-D	convergent-divergent
FS	fuselage station (axial location described by distance in inches from model nose)
STOL	short takeoff and landing
WL	waterline, in.
2-D	two-dimensional

Apparatus and Procedure

Wind Tunnel

This investigation was conducted in the Langley 16-Foot Transonic Tunnel, a single-return atmospheric wind tunnel with a slotted octagonal test section and continuous air exchange. The wind tunnel has variable airspeeds up to a Mach number of 1.30. Test-section plenum suction is used for speeds above a Mach number of 1.05. A complete description of this facility and operating characteristics can be found in reference 17.

Model and Support System

Details of the general research twin-engine fighter model and wingtip-mounted support system used in this investigation are presented in figure 1. A photograph of the model and support system installed in the Langley 16-Foot Transonic Tunnel is shown in figure 2. A sketch of the wing planform geometry is presented in figure 3.

The wingtip model support system shown in figure 1 consisted of three major portions: the twin support booms, the forebody (nose), and the wing/centerbody. These pieces made up the nonmetric portion (that portion of the model not mounted on force balance) of the twin-engine fighter model. The fuselage centerbody was essentially rectangular in cross section and had a constant width and height of 10.00 in. and 5.00 in., respectively. The four corners were rounded by a radius of 1.00 in. The maximum cross-sectional area of the centerbody (fuselage) was 49.14 in^2. The support system forebody (or nose) was typical of a powered model in that the inlets were faired over. The wings were mounted above the model centerline in a high position that is typical of many current fighter designs. The wing had a 45° leading-edge sweep, a taper ratio of 0.5, an aspect ratio of 2.4, and a cranked trailing edge (fig. 3). The NACA 64-series airfoil had an airfoil thickness ratio of 0.067 near the wing root. From BL 11.00 to the support booms, however, wing thickness ratio increased from 0.077 to 0.10 to provide adequate structural support for the model and to permit the transfer of compressed air from the booms to the model propulsion system.

The wingtip support system has the unique feature of being able to rotate the wing with respect to the support booms. This allows testing of models to high angles of attack while keeping the model near the tunnel centerline. A detailed description of the wingtip support system is given in reference 17.

The metric portion of the model aft of FS 44.75, supported by the main force balance, consisted of the internal propulsion system, afterbody, tails, and nozzles. The afterbody lines were chosen to provide a length of constant cross section aft of the nonmetric centerbody and to enclose the force balance and jet simulation system while fairing smoothly downstream into the closely spaced nozzles. The afterbody shell from FS 48.25 to 66.25 was attached to an afterbody force balance that was attached to the main force balance (fig. 1). The main force balance in turn was grounded to the nonmetric wing/centerbody section. The nozzles were attached directly to the main force balance through the propulsion system piping. Three clearance gaps (metric breaks) were provided between the nonmetric and individual metric portions (afterbody and nozzles) of the model at FS 44.75, 48.25, and 66.25 to prevent fouling of the components upon each other. A flexible plastic strip inserted into circumferentially machined grooves in each component impeded flow into or out of the internal model cavity (fig. 1).

In this report, that section of the model aft of FS 48.25 is referred to as the total aft end (which includes afterbody and nozzles). That section of the model from FS 48.25 to 66.25 is referred to as the afterbody, and that section aft of FS 66.25 is considered the nozzles. An adjustment to the drag results of the main balance was made for the section of the model from FS 44.75 to 48.25. (See the appendix.)

Twin-Jet Propulsion Simulation System

The twin-jet propulsion simulation system is shown in figure 1. An external high-pressure air system provided a continuous flow of clean, dry air at a controlled temperature of about 70°F at the nozzles. This high-pressure air was brought into the wind-tunnel main support strut where it was divided into two separate flows and passed through remotely operated flow-control valves. These valves were used to balance the total pressure in each nozzle.

The divided compressed airflows were piped through the wingtip support booms, through the wings, and into the flow-transfer (bellows) assemblies (fig. 1). A sketch of a single flow-transfer bellows assembly is shown in figure 4. The air in each supply pipe was discharged perpendicularly to the model axis through six sonic nozzles equally spaced around the supply pipe. This method was designed to minimize any transfer of axial momentum as the air passed from the nonmetric portion to the metric portion of the model. Two flexible metal bellows were used as seals and served to compensate for the axial forces caused by pressurization. The cavity between the supply pipe and bellows was vented to model internal pressure. The airflow then passed through the tail pipes into the transition sections, through choke plates (30 percent of the tail pipe open area), to the instrumentation or charging sections, and then to the exhaust nozzles. (See fig. 1.)

Exhaust Nozzles

The two-dimensional convergent-divergent (2-D C-D) nozzle is a nonaxisymmetric exhaust system in which a symmetric contraction and expansion process takes place internally in the vertical plane. Basic nozzle components consist of upper and lower flaps to regulate the contraction and expansion process and flat nozzle sidewalls to contain the flow laterally. The flap inner-surface geometry (on full-scale hardware) can be varied or altered by actuators so that (1) the engine power setting can be changed by varying the throat height and (2) the expansion surface angle (the flat surface downstream of the throat) can be varied for optimum expansion of the exhaust flow (ref. 19). The 2-D C-D nozzle can be designed to vector the exhaust flow up or down (in the pitch plane) by rotating the upper and lower flaps independently.

The subscale 2-D C-D nozzle models tested during this investigation are shown in figure 5. These nozzles are fixed-geometry representations of a variable-geometry nozzle at dry power and partial afterburning (A/B) power settings. The nozzle models were sized to the twin-engine wingtip-supported propulsion simulator by selecting values of the ratio of total nozzle throat area to maximum fuselage cross-sectional area ($2A_t/A_{\max}$) that were representative of current twin-engine high-performance aircraft installations. The values of nozzle internal expansion ratio selected for testing were based on typical current, full-scale, mixed-flow turbofan cycles. A summary of important geometric parameters is given in the following table:

Power setting	A_t, in.	A_e/A_t	$2A_t/A_{\max}$	AR	$(\mathrm{NPR})_{\mathrm{des}}$
Dry	2.69	1.16	0.11	3.45	3.46
A/B	3.92	1.24	.16	2.39	4.17

Various combinations of nozzle flap and sidewall geometry were examined as seen in figure 5. Three basic upper and lower flap arrangements were tested: unvectored flaps, pitch-vectored A/B flaps, and unvectored dry power flaps. The pitch vectoring was produced by a simple 15° downward rotation of the unvectored A/B nozzle divergent flaps. The sidewall geometry variations used with each of the upper and lower flap arrangements are indicated in figure 5(b). The A/B sidewalls were designed to fair smoothly with the external lines of the A/B flaps. When paired with the dry power flaps, the A/B sidewalls provide small external flow fences. Conversely, the dry power sidewall (designed to fair with the dry power flaps) allows some internal flow ventilation when combined with the A/B flaps.

The effects of sidewall cutback were investigated on both the unvectored and pitch-vectored A/B flaps as seen in figure 5(b). The baseline or 100-percent A/B sidewall provided full exhaust flow containment over the entire divergent flap of the unvectored nozzle. The 50- and 25-percent sidewall cutbacks provided one-half and one-quarter containment, respectively, of the unvectored A/B divergent flap length.

Because sidewall base areas were held constant, sidewall boattail angle varied with sidewall cutback as shown in the view labeled "Top view."

The sidewall variations discussed in the previous paragraphs refer only to the outboard sidewall of each nozzle. For the closely spaced twin-nozzle arrangement of the present investigation, a common inboard sidewall (splitter plate) is more practical than individual sidewalls. The splitter plate geometry was constant throughout the entire investigation. This splitter plate represented two baseline A/B sidewalls (with 100-percent containment) located back to back. The splitter plate is identified in the sketch of figure 5(a) and the photograph of figure 5(c).

Yaw vectoring was provided by an asymmetric combination of sidewall lengths on the A/B nozzle flaps. A 100-percent A/B sidewall was located outboard on the left nozzle, and a 25-percent A/B sidewall was located outboard on the right nozzle. This combination of sidewall cutback represented a yaw-vectoring concept called the translating sidewall concept. In a full-scale application, a single sidewall would translate, whereas the opposite sidewall remained in the full containment position. This lateral asymmetry would produce a yaw vector angle whose magnitude can be varied by varying the amount of sidewall translation. A more detailed discussion of this yaw-vectoring concept is contained in reference 14.

Instrumentation

Forces and moments on the metric portions of the model were measured by two six-component strain gauge balances. The main balance measured forces and moments resulting from nozzle gross thrust and the external flow field over that portion of the model aft of FS 44.75. The afterbody balance measured forces and moments resulting from the external flow field over the afterbody from FS 48.25 to 66.25. This twin balance arrangement permits the separation of model component forces for data analysis.

External static pressures were measured at eight points in the seal gap at the first metric break (FS 44.75). All orifices were located on the nonmetric centerbody and spaced symmetrically about the model perimeter. An additional five orifices positioned about the right side of the model measured seal gap pressures at the second metric break (FS 48.25). The third and final set of seal pressures was measured by two pairs of surface taps, each an equal distance fore and aft of the third metric break (FS 66.25).

In addition to these external pressures, two internal pressures were measured at each metric seal. These pressure measurements were then used to correct measured axial force and pitching moment for pressure area tares as discussed in the appendix.

Chamber pressure measurements made in each supply pipe, upstream of the six sonic nozzles (fig. 4), were used to compute mass-flow rates for each nozzle and were also used to compute tare forces. Instrumentation in each charging section consisted of a stagnation-temperature probe and a total-pressure rake. Each rake contained four total-pressure probes. (See fig. 5.) Nozzle total pressure was determined from these measurements.

External and internal static pressures were measured on the two A/B power nozzles. The orifice locations are shown in figure 6. External pressures were measured on the right nozzle (looking upstream). The external orifices were arranged in three rows along the top surface of the convergent and divergent flaps of the nozzle. Internal static pressures were measured on the left nozzle (looking upstream). The internal orifices were located only along the divergent flap, starting at the nozzle throat. A single row of orifices was placed along the centerline of the top flap, and three rows of orifices were placed along the surface of the bottom flap. All pressures were measured with individual pressure transducers. Data obtained during each tunnel run were recorded on magnetic tape. Typically, for each data point, 50 frames of data were taken over a period of 5 sec and the average was used for computational purposes.

Tests

This investigation was conducted in the Langley 16-Foot Transonic Tunnel at Mach numbers of 0, 0.15, 0.60, 0.90, and 1.20 and at angles of attack from $-2°$ to $35°$. The nozzle pressure ratio varied from 1.0 (jet off) to 9.0 depending upon Mach number. Most model configurations were tested at angles of attack from $-2°$ to $18°$. Selected configurations were subsequently tested over an angle-of-attack range from about $16.6°$ to $35°$. This was accomplished by presetting wing incidence through rotation of the wings with respect to the wing support booms. Basic data were obtained by varying nozzle pressure ratio at an angle of attack of $0°$ and by varying angle of attack at jet off and at a fixed (different for each Mach number) nozzle pressure ratio. The fixed nozzle pressure ratio tested at each Mach number represented a typical operating pressure ratio for a turbofan engine at that Mach number. The Reynolds number based on the wing mean aerodynamic chord varied from 4.4×10^6 to 5.28×10^6.

All tests were conducted with 0.10-in-wide boundary-layer transition strips consisting of No. 120 silicon carbide grit sparsely distributed in a thin film of lacquer. A single strip was located 1.00 in. from the tip of the forebody nose. Additional transition strips were placed on both upper and lower surfaces of the wings at 5 percent of the root chord to 10 percent of the tip chord.

Presentation of Results

The results of this investigation are presented in both tabular and plotted form. Table 1 is an index to the results contained in tables 2 to 13. The computer symbols appearing in these tables are defined in the Symbols section of the paper with their corresponding mathematical symbols. Only data for the A/B powered nozzle are presented in plotted form in this report. However, all data are tabulated.

Discussion

Pitch Thrust Vectoring

Static performance. The effect of cutback sidewalls on nozzle static performance for the afterburner power nozzles with geometric pitch vector angles of 0° and 15° is presented in figures 7 and 8, respectively. Static nozzle performance is presented as internal thrust ratio F/F_i, internal gross thrust ratio F_G/F_i, resultant pitch vector angle δ_p, and nozzle discharge coefficient w_p/w_i. Both cutback sidewall nozzle configurations at $\delta_{v,p} = 0°$ had higher thrust performance than the full sidewall configuration at overexpanded conditions (NPR less than design NPR). Similar effects were found for the dry power nozzle (ref. 20).

Peak nozzle performance occurred between nozzle pressure ratios of 4 and 5. Typically, the peak nozzle performance is obtained at the jet nozzle pressure ratio required for fully expanded flow (the design pressure ratio), which for the current nozzles is 4.17. There is no effect of sidewall cutback on internal gross thrust ratio at peak nozzle performance conditions (fig. 7). Thus, there is no indication that cutback sidewalls caused a decrease in the effective expansion ratio of the nozzle that would have resulted in peak performance occurring at a lower nozzle pressure ratio. Earlier investigations showed that a reduction in effective nozzle expansion ratio would be expected with cutback sidewalls (refs. 12 and 20).

The effect of cutback sidewalls on nozzle performance for the nozzle with a pitch vector angle of 15° is presented in figure 8. As was the case for the unvectored nozzle, both cutback sidewall nozzle configurations had a higher thrust performance than the nozzle with full sidewalls at overexpanded conditions. Differences in peak nozzle performance were less than 1 percent of the internal gross thrust ratio. A comparison between the unvectored and vectored nozzles shows similar gross thrust ratios indicating little or no losses due to flow turning. The pitch-vectoring concept was very effective in that resultant pitch vector angles were produced that were greater than the geometric pitch angle of 15° at all nozzle pressure ratios tested. Such large pitch vector angles, typical of pitch vectoring by differential flap deflection (refs. 9 to 13), are caused in part by local overexpansion at the nozzle throat on the lower flaps of the nozzle. This very localized region of overexpanded flow forms immediately downstream of the throat and forces the exhaust flow to overturn before expanding onto the lower flap.

Basic aeropropulsive performance. The effect of cutback sidewalls on basic aeropropulsive performance with the nozzle at zero pitch vector angle is presented in figure 9. The variation of the aeropropulsive parameter $(F - D)/F_i$ and total aft-end drag coefficient with nozzle pressure ratio is presented for Mach numbers from 0.60 to 1.20. As expected, because of increased drag, the aeropropulsive performance of all configurations decreased with increasing Mach number. Consistent trends with a cutback sidewall are not evident at subsonic Mach numbers (fig. 9(a)). However, differences in aeropropulsive performance of less than 1 percent occurred at typical operational pressure ratios. At $M = 1.20$, the nozzle configuration with the 100-percent sidewalls had the highest aeropropulsive performance over the entire NPR range tested.

At subsonic speeds, there are no consistent trends in aft-end drag as the nozzle sidewall is cut back (fig. 9(b)). However, the configuration with the 100-percent sidewalls had the lowest jet-off drag coefficient at all Mach numbers tested, and the configuration with the 25-percent sidewalls had the highest drag. This probably results from the cutback sidewalls having a steeper boattail angle than that of the full sidewall (fig. 5(b)).

Pitch vectoring at forward speeds. The effect of cutback sidewalls on total longitudinal characteristics for the nozzles with geometric pitch vector angles of 0° and 15° at $\alpha = 0°$ is presented in figures 10 and 11, respectively. Generally, the effect of cutback sidewalls was small. Similar results (not shown in the figure) were found at $\alpha = 20°$ between the 100-percent and 25-percent sidewalls at $M = 0.15$ and 0.60. (See tables 2 and 4.)

The increment in C_L or C_m between $\delta_{v,p} = 0°$ (fig. 10) and $\delta_{v,p} = 15°$ (fig. 11) at jet-off conditions (NPR = 1.0) results from the aerodynamic flap effect of the deflected nozzle divergent flaps. (See fig. 5.) As nozzle pressure ratio increases, C_L increases and C_m becomes more negative for the pitch-vectored configuration. The increase in lift coefficient with increasing NPR is due primarily to the jet lift component of the nozzle gross thrust and some jet-induced lift. Jet-induced lift can be determined from the total aft-end aerodynamic lift coefficient C_L presented in tables 7 to 9. For this configuration with the 100-percent sidewalls, jet-induced lift varied from about 20 to 30 percent of the total aft-end aerodynamic lift coefficient C_L at Mach numbers from 0.60 to 1.20. Similar results were obtained in reference 13.

The drag-minus-thrust coefficient varies nearly linearly with nozzle pressure ratio regardless of pitch thrust vector angle. The differences between C_{D-F} for $\delta_{v,p} = 0°$ and C_{D-F} for $\delta_{v,p} = 15°$ result both from thrust losses caused by turning the exhaust vector away from the axial direction and from generally higher drag on the $\delta_{v,p} = 15°$ configuration. (See table 7.) Increasing the magnitude of negative numbers for C_{D-F} indicates improved performance from either higher thrust or lower drag.

The effect of angle of attack on the total aft-end longitudinal aerodynamic characteristics for the nozzle with 100-percent and 25-percent sidewalls is presented in figures 12 and 13, respectively. The increment in lift or pitching-moment coefficient that results from changing the nozzle pitch vector angle from 0° to 15°, at either jet-off or jet-on conditions, remains essentially constant over the entire angle-of-attack range for all Mach numbers tested. Thus, there is also no effect of pitch thrust vectoring on lift-curve slope and longitudinal stability characteristics. Similar results are reported in references 9 and 10.

Longitudinal control power. Longitudinal control power and lift effectiveness due to thrust vectoring are presented in figure 14. These parameters at a constant Mach number are only a function of nozzle pressure ratio because the aerodynamic increments that resulted from thrust vectoring were independent of angle of attack. The decrease in control power that occurs as Mach number increases is the result of a decrease in thrust (at constant NPR). The decrease in thrust is caused primarily by the decrease in free-stream static pressure as Mach number increases and, to a lesser extent, by free-stream dynamic pressure effects.

A comparison of longitudinal control power C_{m_δ} from powered and aerodynamic controls is presented in figure 15 as a function of Mach number at $\alpha = 0°$. Longitudinal control power from pitch vectoring was obtained for each Mach number shown at a typical operating pressure ratio. These operating pressure ratios are indicated in the keys of figure 12. Longitudinal control power from pitch vectoring 2-D C-D nozzles on an F-18 aircraft model (ref. 13) and a supersonic cruise fighter (ref. 10) is shown in figure 15. Longitudinal control power generated by the horizontal tail for the current configuration (ref. 21), for the F-18 aircraft model (ref. 13), and by a canard (ref. 10) is also presented in this figure. Note that symbols are used to distinguish longitudinal control power from pitch vectoring and that lines are used to denote aerodynamic controls.

At low speed, pitch vectoring provided a significant increase in longitudinal control power when compared with the horizontal tail (fig. 15). Similar results for the other configurations are presented in reference 9. The decrease in value of the powered controls with increasing Mach number is caused by the decrease in thrust discussed previously. Because aerodynamic controls are usually sized for low speed, they are generally more effective than is required at high speeds. Thus, thrust vectoring could be used to augment the control power provided by aerodynamic controls, particularly at low speeds. For an aircraft design utilizing pitch thrust vectoring to augment aircraft control, the size of the aerodynamic surfaces could be reduced, and this reduction would likely reduce the drag.

Yaw Thrust Vectoring

Static performance. The effect of yaw thrust vectoring utilizing asymmetric sidewall cutback (translating sidewall concept) at static conditions is presented in figure 16. This yaw-vectoring concept produced rather small (less than 3°) values of resultant yaw vector angles. At overexpanded nozzle operating conditions (NPR < $(\text{NPR})_{\text{des}}$), the measured yaw vector angles were positive; at underexpanded nozzle operating conditions (NPR > 4.2), the yaw vector angles were negative. This effect of thrust direction varying with pressure ratio is common in nonaxisymmetric nozzles whenever one flap is longer than the other relative to the exhaust flow centerline. It occurs for both unvectored and vectored single-expansion-ramp nozzles (see, for example, refs. 13 and 22) and some vectored 2-D C-D nozzles where rotation of the individual flaps takes place about axes near the throat. This type of nozzle geometry presents expansion surfaces of unequal length for the flow to work against; thus, one side of the exhaust flow is contained longer by a flap (in this investigation, by the inboard sidewall) while the other side of the exhaust flow is unbounded. The change in the direction of the resultant yaw vector angles as nozzle operation changes from overexpanded to underexpanded indicates that the translating sidewall concept may not be feasible in generating directional control at transient engine operating conditions. This trend in yaw vector angle with increasing NPR was reported as a result of an earlier static study (ref. 15). However, the magnitude of the resultant yaw angles is so small (see fig. 16) that little useful directional control could be provided over the range of NPR's tested. Larger yaw vector angles at higher nozzle pressure ratios would result from translating the sidewall up to or past the nozzle throat, but such sidewall translation would probably decrease F_G/F_i. (See ref. 15.)

Yaw vectoring at forward speeds. The effect of yaw thrust vectoring on the total aft-end lateral aerodynamic characteristics is presented in figures 17 and 18. The variation of the lateral characteristics with NPR at $\alpha = 0°$ is shown in figure 17, whereas the effect of angle of attack with jet off and constant NPR is shown in figure 18.

The variations in wind-on lateral characteristics with NPR shown in figure 17 would be expected from the static results discussed previously. (See fig. 16.) The changes in direction of both $C_{n,t}$ and $C_{Y,t}$ are caused by the change in directions of δ_y as the nozzle operation changes from overexpanded to underexpanded conditions. Thus, as discussed earlier, yaw vectoring by truncated sidewalls may not be feasible in producing positive yaw control over the operational NPR range without further nozzle geometry variations. As shown in figure 18, yawing moment and the increment in C_n resulting from sidewall translation were essentially independent of angle of attack. The insensitivity of the C_n increment to α is identical to the results discussed previously for pitch thrust vectoring on the longitudinal characteristics.

Internal Static Pressure Distributions

Internal static pressure distributions for the A/B power nozzle with 100-percent sidewalls and $\delta_{v,p} = 0°$ are presented in figure 19. As shown in figure 6(b), pressures were measured along the centerline of the top and bottom divergent flap as well as outboard and inboard locations on the bottom divergent flap. In general, the measured internal static pressure distributions are similar to those measured in conventional round nozzles. For NPR = 2.0 at $M = 0$, for example, the static pressures on the nozzle (fig. 19(a)) show a typical sudden pressure rise across the exhaust-flow normal shock. As expected, there was little or no effect of external flow on the internal pressure distributions at constant NPR.

The effect of nozzle pressure ratio on the internal static distributions for the A/B power nozzle with the 100-percent sidewalls and $\delta_{v,p} = 15°$ is presented in figure 20. The results indicate a highly inclined throat at static conditions as the flow becomes sonic ($p/p_{t,j} = 0.528$) on the top flap at $x/l = 0.67$. There is little or no effect of Mach number on these internal static pressure distributions at constant NPR (fig. 20).

The effect of 50- and 25-percent-cutback sidewalls on internal nozzle pressure characteristics is shown in figures 21 and 22, respectively. As shown, the initial 50-percent-cutback sidewall produces flow separation along the outboard portion of the bottom flap (fig. 21(a)). Additional truncation of the sidewall enlarges the separation region and begins to affect the nozzle centerline pressures along the bottom flap (fig. 22(a)). As would be expected, the separated region on the nozzle flap decreases as nozzle pressure ratio is increased. Similar effects due to cutback sidewalls would be expected to occur for the unvectored nozzle and are typical for this type of nozzle (refs. 20 and 22). There was little or no effect of external flow on the internal static pressure distribution at constant NPR.

External Static Pressure Distributions

Afterbody/nozzle pressure distributions for the model with a nozzle pitch vector angle of 0° and 100-percent sidewalls are presented in figure 23. Pressures were measured only on the top surface of the afterbody/nozzle as shown in figure 6(a). These pressure distributions show typical results of a large expansion at the start of the afterbody boattail and a recompression along the afterbody and nozzle. At subsonic speeds, pressure recovery to positive values of pressure coefficient on the nozzle with the 100-percent sidewalls (fig. 23) can produce negative values of nozzle drag as previously reported in reference 23 for the configuration with the nozzle in the dry power mode. Figures 24 and 25 present similar afterbody/nozzle pressure distributions for the nozzles with 50- and 25-percent-cutback sidewalls and show essentially no effect of cutback sidewall.

The effect of nozzle pressure ratio on afterbody/nozzle pressure distributions for the model with a nozzle pitch vector angle of 15° and 100-percent sidewalls is presented in figure 26. Thrust vectoring reduces the recompression of the flow on the afterbody/nozzle upper surfaces. In general, vectoring tends to increase pressures on the lower surface of the configuration which generally results in some induced lift being generated.

The effect of cutback sidewall on the afterbody/nozzle pressure distributions is presented in figures 27 to 30 for the pitch-vectored nozzle. At NPR < 3.5, pressures are more positive as the nozzle sidewalls are cut back, whereas at NPR = 6.0, pressures are more negative. The largest effect of the cutback sidewall occurs on the outboard portion of the surface of the afterbody/nozzle. As nozzle pressure ratio increases, jet entrainment effects probably dominate the flow field and more negative pressures result from the pumping action of the vectored exhaust. However, there is probably a pressurization of the lower surface under these conditions because cutback sidewalls had little or no effect on the afterbody forces and moments (fig. 11).

Conclusions

An investigation has been conducted in the Langley 16-Foot Transonic Tunnel to determine the thrust vectoring capability of two-dimensional convergent-divergent nozzles installed on a twin-engine general research fighter model. Pitch vectoring was accomplished by differential deflection of the nozzle upper and lower divergent flaps. The effects of nozzle sidewall cutback were studied for both unvectored and pitch-vectored nozzles. A single cutback sidewall was employed for yaw thrust vectoring. This investigation was conducted at Mach numbers from 0 to 1.20, at angles of attack from -2° to 35°, and at nozzle pressure ratios up to 9. An analysis of the results of this investigation indicates the following conclusions:

1. Nozzle sidewall cutback caused little or no effect on peak static nozzle performance for both unvectored and pitch-vectored nozzles.

2. Thrust-minus-drag performance for the unvectored nozzle configurations varied less than 1 percent at subsonic speeds, thus showing the relative insensitivity of installed performance to nozzle sidewall cutback.

3. At static conditions, resultant pitch vector angle was always greater than the geometric pitch vector angle.

4. The increment in either the force or moment coefficient that resulted from pitch or yaw vectoring remained essentially constant over the entire angle-of-attack range for all Mach numbers tested.

5. Longitudinal control power was a function of nozzle pressure ratio and Mach number. Powered controls were very effective at low Mach numbers, but their effectiveness decreased as Mach number increased because of a reduction in thrust.

6. Longitudinal control power from thrust vectoring was greater than that provided by aerodynamic controls at low speeds.

7. The yaw vectoring configuration tested was ineffective at producing yaw vectoring at nozzle pressure ratios typical for operation at subsonic Mach numbers. Negative yaw vector angles were generated at underexpanded nozzle operating conditions, but positive yaw vector angles were found at overexpanded nozzle operating conditions for a nozzle using a single cutback sidewall to produce yaw thrust vectoring.

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Appendix

Data Reduction and Calibration Procedure

Calibration Procedure

The main balance measured the combined forces and moments due to nozzle gross thrust and the external flow field of that portion of the model aft of FS 44.75. The afterbody balance measured the forces and moments due to the external flow field exerted over the afterbody between FS 48.25 and 66.25.

Force and moment interactions exist between the bellows-flow transfer system (fig. 4) and the main force balance because the centerline of this balance is below the jet centerline (fig. 1). Consequently, single and combined loadings of normal force, axial force, and pitching moment were made with and without the jets operating with Stratford calibration nozzles (ref. 17). These calibrations are performed with the jets operating because this condition gives a more realistic effect of pressurizing the bellows than does capping off the nozzles and pressurizing the flow system. Thus, in addition to the usual balance-interaction corrections applied for a single force balance under combined loads, another set of interactions was applied to the data from this investigation to account for the combined loading effect of the main balance with the bellows system. These calibrations were performed over a range of expected normal forces and pitching moments. Note that this procedure is not necessary for the afterbody balance because the balance is not bridged by the flow system.

Data Corrections

In order to achieve desired axial-force terms, the axial forces measured by both force balances must also be corrected for pressure-area tare forces acting on the model, and the main balance must be corrected for momentum tare forces caused by flow in the bellows. The external seal and internal pressure forces on the model were obtained by multiplying the difference between the average pressure (external seal or internal pressures) and free-stream static pressure by the affected projected area normal to the model axis. The momentum tare force was determined from calibrations using the Stratford choke nozzles prior to the wind-tunnel investigation.

Axial force minus thrust was computed from the main balance axial force from the following relationship:

$$F_A - F_j = F_{A,\mathrm{Mbal}} + (\overline{p}_{\mathrm{es},1} - p_\infty)(A_{\mathrm{mb},1} - A_{\mathrm{seal},1}) + (\overline{p}_i - p_\infty)A_{\mathrm{seal},1} - F_{A,\mathrm{mom}} - D_f \qquad \text{(A1)}$$

where the first term $F_{A,\mathrm{Mbal}}$ includes all pressure and viscous forces (internal and external on both the afterbody and thrust system). The second and third terms account for the forward seal rim and interior pressure forces, respectively. In terms of an axial-force coefficient, the second term ranges from -0.0001 to -0.0007 and the third term varies ± 0.0075 depending upon Mach number and pressure ratio. The internal pressure at any given set of test conditions was uniform throughout the inside of the model, thus indicating no cavity flow. The momentum tare force $F_{A,\mathrm{mom}}$ is a momentum tare correction with jets operating and is a function of the average bellows internal pressure, which is a function of the internal chamber pressure in the supply pipes just ahead of the sonic nozzles (fig. 5). Although the bellows were designed to minimize momentum and pressurization tares, small bellows tares still exist with the jet on. These tares result from small pressure differences between the ends of the bellows when internal velocities are high and also from small differences in the spring constants of the forward and aft bellows when the bellows are pressurized. The last term D_f is the friction drag of the section from FS 44.75 to 48.25. A friction drag coefficient of 0.0004 was applied at all Mach numbers. No corrections were applied to the forces and moments for the effects of angle of attack on this section.

The afterbody axial force is computed from a similar relationship:

$$F_{\mathrm{aft}} = F_{A,\mathrm{Sbal}} + \left(\overline{p}_{\mathrm{es},2} - p_\infty\right)(A_{\mathrm{mb},1} - A_{\mathrm{seal},1}) + (\overline{p}_i - p_\infty)A_{\mathrm{seal},2} + (\overline{p}_{\mathrm{es},3} - p_\infty) + (A_{\mathrm{mb},2} - A_{\mathrm{seal},2}) \qquad \text{(A2)}$$

Since both balances are offset from the model centerline, similar adjustments are made to the pitching moments measured by both balances. These adjustments are necessary because both the pressure area and bellows momentum tare forces are assumed to act along the model centerline. The pitching-moment tare is determined by multiplying the tare force by the appropriate moment arm and subtracting the value from the measured pitching moments.

Model Attitude

The adjusted forces and moments measured by both balances are transferred from the body axis of the metric portion of the model to the stability axis. The attitude of the nonmetric forebody relative to gravity was determined from a calibrated attitude indicator located in the model nose. The angle of attack α, which is the angle between the afterbody centerline and the relative wind, was determined by applying terms for afterbody deflection (caused when the model and balance bend under aerodynamic load) and a flow angularity term to the angle measured by the attitude indicator. The flow angularity correction was 0.1°, which is the average angle measured in the Langley 16-Foot Transonic Tunnel.

Thrust-Removed Data

The resulting external and internal thrust force and moment coefficients from the main balance include total lift coefficient $C_{L,t}$, drag minus thrust coefficient C_{D-F}, total pitching-moment coefficient $C_{m,t}$, total rolling-moment coefficient $C_{l,t}$, total-yawing-moment coefficient $C_{n,t}$, and total side-force coefficient $C_{Y,t}$. Force and moment coefficients from the afterbody balance are afterbody lift coefficient $C_{L,\mathrm{aft}}$, afterbody drag coefficient $C_{D,\mathrm{aft}}$, and afterbody pitching-moment coefficient $C_{m,\mathrm{aft}}$.

The thrust-removed aerodynamic force and moment coefficients for the entire model were obtained by determining the components of thrust in axial force, normal force, pitching moment, rolling moment, yawing moment, and side force, and then by subtracting these values from the measured total (aerodynamic plus thrust) forces and moments. These thrust components at forward speeds were determined from measured static data and were a function of the free-stream static and dynamic pressures. The thrust-removed aerodynamic coefficients are given as follows:

$$C_L = C_{L,t} - \text{Jet lift coefficient} \qquad \text{(A3)}$$

$$C_D = C_{D-F} + \text{Thrust coefficient} \qquad \text{(A4)}$$

$$C_m = C_{m,t} - \text{Jet pitching-moment coefficient} \qquad \text{(A5)}$$

$$C_l = C_{l,t} - \text{Jet rolling-moment coefficient} \qquad \text{(A6)}$$

$$C_n = C_{n,t} - \text{Jet yawing-moment coefficient} \qquad \text{(A7)}$$

$$C_Y = C_{Y,t} - \text{Jet side-force coefficient} \qquad \text{(A8)}$$

The nozzle coefficients are obtained by simply combining the measured results from both force balances as follows:

$$C_{L,n} = C_L - C_{L,\mathrm{aft}} \qquad \text{(A9)}$$

$$C_{D,n} = C_D - C_{D,\mathrm{aft}} \qquad \text{(A10)}$$

$$C_{m,n} = C_m - C_{m,\mathrm{aft}} \qquad \text{(A11)}$$

Volume Coefficients

To facilitate the analysis of control-power characteristics, a powered volume coefficient is defined. (See ref. 9.) The volume coefficient of the horizontal tail is

$$\overline{V} = \frac{S_t}{S}\frac{L_t}{\bar{c}}$$

where S_t is the horizontal tail area and L_t is the distance from the moment reference center to the quarter-chord of the tail. The pitch vectoring powered-volume coefficient is defined as

$$\overline{V} = \frac{2A_t}{S}\frac{L_j}{\bar{c}}$$

where A_t is the nozzle throat area and L_j is the distance from the moment reference center to the nozzle throat. The throat area is multiplied by 2 because the configuration reported on herein is a twin-engine model.

References

1. Herbst, W. B.: Future Fighter Technologies. *J. Aircr.*, vol. 17, no. 8, Aug. 1980, pp. 561–566.
2. Gallaway, C. R.; and Osborn, R. F.: Aerodynamics Perspective of Supermaneuverability. AIAA-85-4068, Oct. 1985.
3. Hienz, Egon; and Vedova, Ralph: Requirements, Definition and Preliminary Design for an Axisymmetric Vectoring Nozzle, To Enhance Aircraft Maneuverability. AIAA-84-1212, June 1984.
4. Skow, Andrew M.; Hamilton, William L.; and Taylor, John H.: Advanced Fighter Agility Metrics. AIAA-85-1779, Aug. 1985.
5. Miller, L. Earl: *Post Stall Maneuvers and Thrust Vectoring Performance Analysis.* AFWAL-TR-84-3109, U.S. Air Force, July 1984. (Available from DTIC as AD A158 100.)
6. Richey, G. K.; Surber, L. E.; and Berrier, B. L.: Airframe-Propulsion Integration for Fighter Aircraft. AIAA-83-0084, Jan. 1983.
7. Nelson, B. D.; and Nicolai, L. M.: Application of Multi-Function Nozzles to Advanced Fighters. AIAA-81-2618, Dec. 1981.
8. Mello, J. F.; and Kotansky, D. R.: Aero/Propulsion Technology for STOL and Maneuver. AIAA-85-4013, Oct. 1985.
9. Capone, Francis J.; and Mason, Mary L.: *Multiaxis Aircraft Control Power From Thrust Vectoring at High Angles of Attack.* NASA TM-87741, 1986.
10. Capone, Francis J.; and Bare, E. Ann: *Multiaxis Control Power From Thrust Vectoring for a Supersonic Fighter Aircraft Model at Mach 0.20 to 2.47.* NASA TP-2712, 1987.
11. Capone, Francis J.: *Static Performance of Five Twin-Engine Nonaxisymmetric Nozzles With Vectoring and Reversing Capability.* NASA TP-1224, 1978.
12. Capone, Francis J.; and Reubush, David E.: *Effects of Varying Podded Nacelle-Nozzle Installations on Transonic Aeropropulsive Characteristics of a Supersonic Fighter Aircraft.* NASA TP-2120, 1983.
13. Capone, Francis J.; and Berrier, Bobby L.: *Investigation of Axisymmetric and Nonaxisymmetric Nozzles Installed on a 0.10-Scale F-18 Prototype Airplane Model.* NASA TP-1638, 1980.
14. Mason, Mary L.; and Berrier, Bobby L.: *Static Investigation of Several Yaw Vectoring Concepts on Nonaxisymmetric Nozzles.* NASA TP-2432, 1985.
15. Mason, Mary L.; and Berrier, Bobby L.: *Static Performance of Nonaxisymmetric Nozzles With Yaw Thrust-Vectoring Vanes.* NASA TP-2813, 1988.
16. Taylor, John G.: A Static Investigation of a Simultaneous Pitch and Yaw Vectoring 2-D C-D Nozzle. AIAA-88-2998, July 1988.
17. Peddrew, Kathryn H., compiler: *A User's Guide to the Langley 16-Foot Transonic Tunnel.* NASA TM-83186, 1981.
18. Mercer, Charles E.; Berrier, Bobby L.; Capone, Francis J.; Grayston, Alan M.; and Sherman, C. D.: *Computations for the 16-Foot Transonic Tunnel—NASA, Langley Research Center, Revision 1.* NASA TM-86319, 1987. (Supersedes NASA TM-86319, 1984.)
19. Stevens, H. L.; Thayer, E. B.; and Fullerton, J. F.: Development of the Multi-Function 2-D/C-D Nozzle. AIAA-81-1491, July 1981.
20. Yetter, Jeffery A.; and Leavitt, Laurence D.: *Effects of Sidewall Geometry on the Installed Performance of Nonaxisymmetric Convergent-Divergent Exhaust Nozzles.* NASA TP-1771, 1980.
21. Capone, Francis J.; and Mason, Mary L.: *Interference Effects of Thrust Reversing on Horizontal Tail Effectiveness of a Twin-Engine Fighter Aircraft at Mach Numbers From 0.15 to 0.90.* NASA TP-2350, 1984.
22. Re, Richard J.; and Leavitt, Laurence D.: *Static Internal Performance Including Thrust Vectoring and Reversing of Two-Dimensional Convergent-Divergent Nozzles.* NASA TP-2253, 1984.
23. Capone, Francis J.; and Carson, George T., Jr.: *Effects of Empennage Surface Location on Aerodynamic Characteristics of a Twin-Engine Afterbody Model With Nonaxisymmetric Nozzles.* NASA TP-2392, 1985.

Table 1. Index to Data in Tables 2 to 13

Table	Power setting	Sidewall, left/right	$\delta_{v,p}$, deg
2, 3	Afterburner	100/100 A/B	0
4		50/50 A/B	
5		25/25 A/B	
6		100/100 dry	
7		100/100 A/B	15
8		50/50 A/B	15
9		25/25 A/B	15
10, 11		100/25 A/B	0
12, 13	Dry	100/25 A/B	0

Table 2. Longitudinal Aerodynamic Characteristics for A/B Nozzle With 100/100 A/B Sidewalls and $\delta_{v,p} = 0°$

(a) Total aft end

MACH	NPR	ALPHA	CLT	C(D-F)	CMT	CL	CD	CM
1.201	.99	.00	-.0098	.0166	.0031	-.0098	.0166	.0031
1.202	3.01	.02	-.0100	-.0151	.0069	-.0100	.0158	.0041
1.202	4.96	.04	-.0109	-.0450	.0117	-.0109	.0153	.0060
1.203	6.99	.04	-.0114	-.0773	.0156	-.0115	.0136	.0069
1.202	8.97	.03	-.0111	-.1087	.0183	-.0112	.0121	.0066
1.199	.99	-2.02	-.0224	.0178	.0137	-.0224	.0178	.0137
1.202	.98	.01	-.0091	.0165	.0026	-.0091	.0165	.0026
1.201	.93	3.01	.0063	.0178	-.0083	.0063	.0178	-.0083
1.198	.90	5.98	.0223	.0212	-.0201	.0223	.0212	-.0201
1.200	.88	9.03	.0358	.0271	-.0294	.0359	.0271	-.0294
1.198	.80	12.02	.0486	.0371	-.0455	.0487	.0371	-.0455
1.200	.70	16.01	.0655	.0479	-.0634	.0656	.0479	-.0634
1.202	.67	18.01	.0747	.0542	-.0738	.0748	.0542	-.0738
1.199	7.03	-2.01	-.0218	-.0764	.0203	-.0186	.0155	.0114
1.201	7.00	-.02	-.0093	-.0769	.0147	-.0093	.0144	.0060
1.201	6.96	3.02	.0083	-.0755	.0083	.0036	.0149	-.0005
1.203	7.02	6.01	.0287	-.0732	-.0024	.0192	.0175	-.0112
1.201	7.05	8.98	.0479	-.0679	-.0144	.0337	.0229	-.0233
1.199	6.99	11.99	.0660	-.0590	-.0289	.0471	.0304	-.0376
1.200	7.00	16.02	.0896	-.0476	-.0473	.0645	.0402	-.0561
1.199	6.99	17.98	.1008	-.0417	-.0558	.0726	.0453	-.0646
.903	1.10	-.01	-.0107	.0033	.0059	-.0107	.0033	.0059
.900	1.98	-.02	-.0088	-.0245	.0066	-.0088	.0034	.0042
.901	3.01	.00	-.0097	-.0511	.0110	-.0097	.0040	.0059
.898	4.99	.02	-.0097	-.1054	.0168	-.0097	.0033	.0065
.900	7.00	.00	-.0101	-.1605	.0224	-.0101	.0020	.0068
.899	1.10	-2.01	-.0086	.0033	.0038	-.0086	.0033	.0038
.902	1.10	-.02	-.0090	.0034	.0054	-.0090	.0034	.0054
.899	1.09	2.99	-.0044	.0029	.0056	-.0044	.0029	.0056
.901	1.10	6.01	-.0062	.0022	.0075	-.0062	.0022	.0075
.901	1.10	8.99	-.0021	.0029	.0064	-.0020	.0029	.0064
.902	1.10	12.01	.0141	.0074	-.0033	.0142	.0074	-.0033
.899	1.09	16.01	.0299	.0173	-.0152	.0300	.0173	-.0152
.899	1.07	18.02	.0382	.0248	-.0225	.0384	.0248	-.0225
.900	5.01	-1.99	-.0125	-.1052	.0152	-.0088	.0033	.0049
.901	5.00	.00	-.0098	-.1055	.0169	-.0098	.0029	.0066
.901	5.01	3.03	.0003	-.1060	.0167	-.0054	.0023	.0063
.899	4.99	5.99	.0037	-.1064	.0190	-.0076	.0016	.0087
.901	5.00	9.00	.0141	-.1050	.0175	-.0028	.0022	.0072
.903	5.01	12.01	.0356	-.0992	.0075	.0131	.0066	-.0028
.900	4.99	16.02	.0605	-.0874	-.0066	.0307	.0168	-.0170
.901	5.00	18.01	.0734	-.0785	-.0151	.0401	.0245	-.0254

Table 2. Continued

(a) Continued

MACH	NPR	ALPHA	CLT	C(D–F)	CMT	CL	CD	CM
.601	1.03	.01	–.0111	.0037	.0055	–.0111	.0037	.0055
.599	1.99	.02	–.0090	–.0609	.0101	–.0090	.0032	.0046
.601	3.00	–.02	–.0096	–.1194	.0171	–.0096	.0043	.0056
.602	3.52	–.02	–.0092	–.1501	.0199	–.0092	.0034	.0054
.603	5.01	–.02	–.0087	–.2386	.0283	–.0087	.0038	.0052
.604	1.03	–1.94	–.0065	.0052	.0033	–.0065	.0052	.0033
.600	1.03	.00	–.0045	.0043	.0031	–.0045	.0043	.0031
.602	1.03	3.01	–.0023	.0040	.0032	–.0023	.0040	.0032
.603	1.03	6.00	.0013	.0042	.0016	.0013	.0042	.0016
.601	1.03	9.00	.0052	.0052	–.0013	.0052	.0052	–.0013
.600	1.03	12.02	.0099	.0068	–.0059	.0100	.0068	–.0059
.600	1.02	16.00	.0255	.0127	–.0182	.0256	.0127	–.0182
.598	1.02	18.03	.0340	.0176	–.0241	.0341	.0176	–.0241
.599	3.51	–1.85	–.0118	–.1504	.0195	–.0068	.0040	.0050
.600	3.52	.01	–.0050	–.1509	.0187	–.0050	.0037	.0042
.602	3.51	3.00	.0062	–.1490	.0176	–.0018	.0037	.0032
.599	3.50	5.97	.0172	–.1490	.0165	.0012	.0039	.0021
.598	3.49	8.99	.0296	–.1471	.0131	.0056	.0049	–.0013
.599	3.49	12.00	.0429	–.1437	.0079	.0110	.0067	–.0066
.600	3.49	15.99	.0692	–.1346	–.0055	.0272	.0125	–.0198
.601	3.50	18.00	.0827	–.1279	–.0119	.0356	.0174	–.0262
.597	1.02	20.01	.0413	.0234	–.0293	.0415	.0234	–.0293
.602	2.02	20.01	.0633	–.0393	–.0236	.0412	.0218	–.0292
.602	3.05	20.01	.0843	–.0958	–.0189	.0415	.0223	–.0306
.602	3.51	20.00	.0938	–.1220	–.0166	.0416	.0220	–.0310
.601	5.01	20.02	.1251	–.2085	–.0086	.0415	.0213	–.0320
.600	1.02	16.63	.0267	.0144	–.0196	.0268	.0144	–.0196
.599	1.02	17.99	.0321	.0173	–.0232	.0322	.0173	–.0232
.599	1.02	19.98	.0396	.0225	–.0292	.0398	.0226	–.0292
.600	1.00	23.97	.0572	.0375	–.0463	.0573	.0375	–.0463
.600	.99	27.98	.0769	.0584	–.0714	.0771	.0585	–.0714
.598	.96	31.99	.0921	.0831	–.1010	.0923	.0832	–.1010
.599	3.53	16.79	.0710	–.1360	–.0057	.0262	.0129	–.0203
.599	3.46	17.99	.0785	–.1281	–.0098	.0318	.0162	–.0240
.598	3.49	19.98	.0925	–.1231	–.0160	.0402	.0213	–.0304
.596	3.48	23.96	.1216	–.1047	–.0354	.0591	.0364	–.0499
.600	3.50	27.97	.1542	–.0771	–.0661	.0825	.0583	–.0805
.600	3.50	31.98	.1822	–.0455	–.1007	.1013	.0844	–.1151

Table 2. Continued

(a) Concluded

MACH	NPR	ALPHA	CLT	C(D-F)	CMT	CL	CD	CM
.152	1.00	.00	.0073	.0085	-.0060	.0073	.0085	-.0060
.153	2.02	-.01	.0193	-1.0161	.0737	.0194	-.0036	-.0135
.153	2.60	.00	.0102	-1.5133	.1304	.0102	.0141	-.0083
.153	3.00	.00	.0056	-1.8833	.1798	.0055	.0122	.0044
.154	3.81	.00	.0041	-2.6051	.2522	.0040	.0018	.0059
.151	1.00	-1.53	.0062	-.0033	-.0012	.0062	-.0033	-.0012
.151	1.00	-.01	.0097	.0017	-.0018	.0097	.0017	-.0018
.152	1.00	2.98	.0121	-.0016	-.0018	.0121	-.0016	-.0018
.152	1.00	6.02	.0157	-.0034	-.0009	.0157	-.0034	-.0009
.152	1.00	8.98	.0247	-.0005	-.0065	.0247	-.0005	-.0065
.152	1.00	11.99	.0276	.0049	-.0104	.0276	.0049	-.0104
.151	1.00	16.02	.0403	.0076	-.0207	.0404	.0076	-.0207
.151	1.00	17.99	.0469	.0104	-.0261	.0471	.0104	-.0261
.153	2.63	-1.54	-.0412	-1.5609	.1499	.0011	.0087	.0071
.153	2.65	.04	-.0012	-1.5664	.1529	-.0024	.0101	.0094
.154	2.62	3.02	.0846	-1.5270	.1432	.0035	.0100	.0033
.154	2.62	6.00	.1648	-1.5273	.1447	.0034	.0084	.0043
.154	2.63	9.00	.2496	-1.5146	.1416	.0083	.0090	.0013
.151	2.62	12.00	.3478	-1.5540	.1422	.0159	.0076	-.0030
.151	2.62	16.01	.4743	-1.5296	.1286	.0313	.0147	-.0175
.150	2.62	18.00	.5389	-1.5157	.1235	.0409	.0175	-.0231
.152	1.00	19.99	.0330	.0228	-.0294	.0331	.0228	-.0294
.151	2.03	19.98	.3900	-.9462	.0594	.0377	.0236	-.0295
.152	2.58	19.98	.5604	-1.4225	.1153	.0327	.0289	-.0247
.152	3.01	19.99	.6946	-1.7909	.1581	.0334	.0274	-.0210
.145	3.83	19.98	1.0548	-2.7861	.2645	.0357	.0168	-.0174
.149	3.83	19.99	.9980	-2.6255	.2477	.0363	.0191	-.0184
.151	1.00	15.98	.0310	.0116	-.0179	.0311	.0116	-.0179
.151	1.00	17.98	.0507	.0171	-.0305	.0508	.0172	-.0305
.151	1.00	19.98	.0573	.0249	-.0360	.0574	.0250	-.0360
.151	1.00	23.98	.0685	.0354	-.0446	.0687	.0354	-.0446
.151	1.00	27.98	.0937	.0586	-.0655	.0939	.0587	-.0655
.151	1.00	31.99	.1085	.0800	-.0874	.1087	.0801	-.0874
.150	1.00	35.18	.1125	.0977	-.1028	.1127	.0978	-.1028
.152	2.58	15.97	.4668	-1.4334	.1159	.0458	.0385	-.0229
.152	2.64	17.97	.5467	-1.4758	.1162	.0547	.0413	-.0290
.152	2.63	19.97	.5949	-1.4438	.1143	.0551	.0420	-.0295
.152	2.63	23.97	.7119	-1.4010	.1055	.0670	.0496	-.0389
.152	2.63	27.97	.8189	-1.3410	.0903	.0742	.0617	-.0542
.152	2.63	31.97	.9369	-1.2771	.0695	.0915	.0777	-.0758
.151	2.63	34.98	1.0213	-1.2245	.0503	.0984	.0948	-.0962

Table 2. Continued

(b) Afterbody and nozzle

MACH	NPR	ALPHA	CLAFT	CDAFT	CMAFT	CLN	CDN	CMN
1.201	.99	.00	-.0081	.0084	.0077	-.0017	.0082	-.0046
1.202	3.01	.02	-.0079	.0084	.0075	-.0021	.0074	-.0034
1.202	4.96	.04	-.0078	.0084	.0075	-.0031	.0069	-.0015
1.203	6.99	.04	-.0080	.0085	.0075	-.0035	.0051	-.0007
1.202	8.97	.03	-.0078	.0085	.0074	-.0034	.0036	-.0008
1.199	.99	-2.02	-.0163	.0091	.0145	-.0060	.0086	-.0008
1.202	.98	.01	-.0078	.0086	.0073	-.0013	.0080	-.0047
1.201	.93	3.01	.0036	.0092	-.0022	.0027	.0086	-.0061
1.198	.90	5.98	.0174	.0114	-.0153	.0050	.0098	-.0048
1.200	.88	9.03	.0301	.0150	-.0284	.0058	.0121	-.0010
1.198	.80	12.02	.0405	.0199	-.0418	.0082	.0172	-.0037
1.200	.70	16.01	.0534	.0266	-.0562	.0122	.0213	-.0071
1.202	.67	18.01	.0594	.0305	-.0632	.0154	.0237	-.0106
1.199	7.03	-2.01	-.0164	.0093	.0144	-.0022	.0063	-.0030
1.201	7.00	-.02	-.0084	.0087	.0078	-.0009	.0057	-.0018
1.201	6.96	3.02	.0036	.0093	-.0025	.0000	.0056	.0020
1.203	7.02	6.01	.0182	.0116	-.0163	.0011	.0059	.0051
1.201	7.05	8.98	.0300	.0152	-.0289	.0037	.0077	.0057
1.199	6.99	11.99	.0408	.0199	-.0421	.0063	.0105	.0044
1.200	7.00	16.02	.0536	.0269	-.0569	.0110	.0133	.0007
1.199	6.99	17.98	.0589	.0305	-.0626	.0138	.0149	-.0020
.903	1.10	-.01	-.0033	.0060	.0028	-.0075	-.0027	.0031
.900	1.98	-.02	-.0032	.0055	.0027	-.0056	-.0020	.0015
.901	3.01	.00	-.0033	.0055	.0028	-.0064	-.0016	.0030
.898	4.99	.02	-.0034	.0054	.0029	-.0063	-.0021	.0035
.900	7.00	.00	-.0034	.0052	.0028	-.0067	-.0032	.0040
.899	1.10	-2.01	-.0018	.0059	.0010	-.0069	-.0026	.0028
.902	1.10	-.02	-.0032	.0060	.0026	-.0059	-.0027	.0028
.899	1.09	2.99	-.0049	.0059	.0051	.0005	-.0030	.0005
.901	1.10	6.01	-.0060	.0056	.0066	-.0002	-.0034	.0009
.901	1.10	8.99	-.0047	.0058	.0070	.0027	-.0029	-.0005
.902	1.10	12.01	-.0005	.0073	.0051	.0147	.0000	-.0084
.899	1.09	16.01	.0138	.0142	-.0055	.0162	.0031	-.0097
.899	1.07	18.02	.0189	.0188	-.0093	.0195	.0061	-.0132
.900	5.01	-1.99	-.0017	.0053	.0009	-.0071	-.0020	.0039
.901	5.00	.00	-.0032	.0054	.0027	-.0066	-.0024	.0039
.901	5.01	3.03	-.0050	.0053	.0054	-.0004	-.0030	.0009
.899	4.99	5.99	-.0055	.0050	.0063	-.0021	-.0034	.0023
.901	5.00	9.00	-.0043	.0052	.0067	.0015	-.0031	.0005
.903	5.01	12.01	.0003	.0070	.0044	.0129	-.0003	-.0072
.900	4.99	16.02	.0151	.0141	-.0071	.0156	.0027	-.0099
.901	5.00	18.01	.0203	.0187	-.0112	.0198	.0058	-.0142

Table 2. Continued

(b) Continued

MACH	NPR	ALPHA	CLAFT	CDAFT	CMAFT	CLN	CDN	CMN
.601	1.03	.01	-.0032	.0055	.0029	-.0079	-.0018	.0026
.599	1.99	.02	-.0031	.0052	.0026	-.0059	-.0020	.0020
.601	3.00	-.02	-.0031	.0052	.0027	-.0065	-.0009	.0029
.602	3.52	-.02	-.0029	.0052	.0025	-.0062	-.0018	.0029
.603	5.01	-.02	-.0031	.0051	.0027	-.0056	-.0013	.0025
.604	1.03	-1.94	-.0041	.0056	.0032	-.0025	-.0004	.0002
.600	1.03	.00	-.0028	.0054	.0024	-.0017	-.0011	.0007
.602	1.03	3.01	-.0019	.0054	.0024	-.0004	-.0015	.0007
.603	1.03	6.00	-.0004	.0056	.0014	.0017	-.0014	.0002
.601	1.03	9.00	.0019	.0061	-.0007	.0033	-.0009	-.0006
.600	1.03	12.02	.0050	.0072	-.0042	.0050	-.0003	-.0017
.600	1.02	16.00	.0148	.0108	-.0137	.0108	.0019	-.0045
.598	1.02	18.03	.0197	.0133	-.0177	.0144	.0043	-.0064
.599	3.51	-1.85	-.0035	.0052	.0026	-.0033	-.0011	.0024
.600	3.52	.01	-.0025	.0051	.0022	-.0025	-.0013	.0020
.602	3.51	3.00	-.0016	.0051	.0022	-.0002	-.0014	.0010
.599	3.50	5.97	-.0002	.0053	.0014	.0015	-.0014	.0007
.598	3.49	8.99	.0021	.0058	-.0008	.0035	-.0009	-.0005
.599	3.49	12.00	.0055	.0069	-.0046	.0055	-.0002	-.0019
.600	3.49	15.99	.0154	.0105	-.0142	.0118	.0020	-.0057
.601	3.50	18.00	.0206	.0133	-.0186	.0150	.0041	-.0076
.597	1.02	20.01	.0224	.0156	-.0215	.0190	.0079	-.0078
.602	2.02	20.01	.0230	.0156	-.0221	.0182	.0062	-.0070
.602	3.05	20.01	.0231	.0156	-.0224	.0183	.0067	-.0082
.602	3.51	20.00	.0233	.0157	-.0226	.0183	.0063	-.0084
.601	5.01	20.02	.0234	.0157	-.0229	.0181	.0056	-.0091
.600	1.02	16.63	.0149	.0109	-.0148	.0119	.0034	-.0048
.599	1.02	17.99	.0177	.0125	-.0171	.0145	.0048	-.0062
.599	1.02	19.98	.0223	.0156	-.0215	.0174	.0070	-.0077
.600	1.00	23.97	.0363	.0255	-.0370	.0210	.0121	-.0093
.600	.99	27.98	.0510	.0389	-.0573	.0261	.0196	-.0141
.598	.96	31.99	.0665	.0566	-.0835	.0258	.0266	-.0175
.599	3.53	16.79	.0156	.0109	-.0156	.0106	.0020	-.0046
.599	3.46	17.99	.0181	.0123	-.0176	.0137	.0038	-.0064
.598	3.49	19.98	.0228	.0155	-.0221	.0174	.0059	-.0083
.596	3.48	23.96	.0372	.0256	-.0382	.0219	.0107	-.0117
.600	3.50	27.97	.0530	.0398	-.0603	.0295	.0185	-.0202
.600	3.50	31.98	.0699	.0586	-.0886	.0314	.0258	-.0264

Table 2. Concluded

(b) Concluded

MACH	NPR	ALPHA	CLAFT	CDAFT	CMAFT	CLN	CDN	CMN
.152	1.00	.00	-.0016	.0064	.0006	.0088	.0022	-.0065
.153	2.02	-.01	-.0032	.0071	.0026	.0226	-.0106	-.0161
.153	2.60	.00	-.0032	.0071	.0034	.0134	.0070	-.0117
.153	3.00	.00	-.0031	.0076	.0035	.0086	.0047	.0010
.154	3.81	.00	-.0043	.0077	.0047	.0083	-.0059	.0012
.151	1.00	-1.53	-.0020	.0058	.0014	.0082	-.0091	-.0026
.151	1.00	-.01	-.0016	.0057	.0011	.0113	-.0040	-.0030
.152	1.00	2.98	-.0017	.0058	.0028	.0138	-.0075	-.0047
.152	1.00	6.02	-.0002	.0059	.0017	.0159	-.0093	-.0026
.152	1.00	8.98	.0024	.0066	-.0008	.0224	-.0071	-.0056
.152	1.00	11.99	.0070	.0081	-.0062	.0206	-.0032	-.0041
.151	1.00	16.02	.0135	.0107	-.0127	.0269	-.0030	-.0079
.151	1.00	17.99	.0183	.0132	-.0174	.0288	-.0028	-.0087
.153	2.63	-1.54	-.0021	.0069	.0024	.0032	.0018	.0047
.153	2.65	.04	-.0025	.0067	.0033	.0001	.0034	.0061
.154	2.62	3.02	.0011	.0070	-.0004	.0024	.0030	.0037
.154	2.62	6.00	.0008	.0070	.0001	.0026	.0014	.0042
.154	2.63	9.00	.0010	.0074	.0007	.0073	.0015	.0006
.151	2.62	12.00	.0048	.0087	-.0043	.0110	-.0011	.0014
.151	2.62	16.01	.0132	.0120	-.0134	.0180	.0026	-.0041
.150	2.62	18.00	.0191	.0147	-.0197	.0219	.0028	-.0034
.152	1.00	19.99	.0175	.0137	-.0199	.0156	.0091	-.0094
.151	2.03	19.98	.0181	.0141	-.0211	.0195	.0095	-.0084
.152	2.58	19.98	.0181	.0140	-.0207	.0146	.0150	-.0040
.152	3.01	19.99	.0181	.0142	-.0208	.0153	.0132	-.0001
.145	3.83	19.98	.0167	.0142	-.0191	.0190	.0026	.0017
.149	3.83	19.99	.0184	.0147	-.0210	.0179	.0044	.0026
.151	1.00	15.98	.0103	.0086	-.0104	.0208	.0030	-.0075
.151	1.00	17.98	.0165	.0108	-.0172	.0343	.0064	-.0133
.151	1.00	19.98	.0206	.0130	-.0214	.0368	.0120	-.0146
.151	1.00	23.98	.0272	.0185	-.0270	.0415	.0169	-.0177
.151	1.00	27.98	.0392	.0288	-.0419	.0546	.0299	-.0236
.151	1.00	31.99	.0522	.0428	-.0611	.0565	.0373	-.0262
.150	1.00	35.18	.0575	.0521	-.0715	.0552	.0457	-.0312
.152	2.58	15.97	.0102	.0095	-.0094	.0357	.0289	-.0135
.152	2.64	17.97	.0175	.0122	-.0188	.0372	.0290	-.0101
.152	2.63	19.97	.0209	.0144	-.0218	.0342	.0277	-.0077
.152	2.63	23.97	.0271	.0195	-.0283	.0399	.0301	-.0106
.152	2.63	27.97	.0390	.0299	-.0426	.0352	.0319	-.0116
.152	2.63	31.97	.0522	.0440	-.0617	.0394	.0337	-.0141
.151	2.63	34.98	.0620	.0566	-.0783	.0364	.0382	-.0179

Table 3. Lateral Aerodynamic Characteristics for A/B Nozzle With 100/100 A/B Sidewalls and $\delta_{v,p} = 0°$

MACH	NPR	ALPHA	CROLLT	CNT	CYT	CROLL	CN	CY
1.201	.99	.00	.0000	.0002	-.0007	.0000	.0002	-.0007
1.202	3.01	.02	.0000	.0003	-.0011	.0000	.0003	-.0011
1.202	4.96	.04	.0001	.0003	-.0012	.0001	.0003	-.0012
1.203	6.99	.04	.0001	.0003	-.0014	.0001	.0003	-.0014
1.202	8.97	.03	.0001	.0003	-.0015	.0001	.0003	-.0015
1.199	.99	-2.02	.0001	.0001	-.0007	.0001	.0001	-.0007
1.202	.98	.01	.0001	.0003	-.0008	.0001	.0003	-.0008
1.201	.93	3.01	.0001	.0004	-.0013	.0001	.0004	-.0013
1.198	.90	5.98	.0001	.0004	-.0015	.0001	.0004	-.0015
1.200	.88	9.03	.0002	.0005	-.0019	.0002	.0005	-.0019
1.198	.80	12.02	.0001	.0003	-.0018	.0001	.0003	-.0018
1.200	.70	16.01	.0001	.0003	-.0015	.0001	.0003	-.0015
1.202	.67	18.01	.0002	.0003	-.0013	.0002	.0003	-.0013
1.199	7.03	-2.01	.0002	.0004	-.0022	.0002	.0004	-.0022
1.201	7.00	-.02	.0002	.0005	-.0025	.0002	.0005	-.0025
1.201	6.96	3.02	.0002	.0006	-.0028	.0002	.0006	-.0028
1.203	7.02	6.01	.0002	.0007	-.0030	.0002	.0007	-.0030
1.201	7.05	8.98	.0003	.0011	-.0034	.0003	.0011	-.0034
1.199	6.99	11.99	.0002	.0004	-.0031	.0002	.0004	-.0031
1.200	7.00	16.02	.0002	.0001	-.0022	.0002	.0001	-.0022
1.199	6.99	17.98	.0002	.0000	-.0018	.0002	.0000	-.0018
.903	1.10	-.01	.0003	.0005	-.0024	.0003	.0005	-.0024
.900	1.98	-.02	.0003	.0006	-.0028	.0003	.0006	-.0028
.901	3.01	.00	.0003	.0005	-.0029	.0003	.0005	-.0029
.898	4.99	.02	.0003	.0005	-.0032	.0003	.0005	-.0032
.900	7.00	.00	.0003	.0005	-.0036	.0003	.0005	-.0036
.899	1.10	-2.01	.0002	.0004	-.0023	.0002	.0004	-.0023
.902	1.10	-.02	.0003	.0005	-.0025	.0003	.0005	-.0025
.899	1.09	2.99	.0002	.0005	-.0025	.0002	.0005	-.0025
.901	1.10	6.01	.0002	.0005	-.0023	.0002	.0005	-.0023
.901	1.10	8.99	.0002	.0004	-.0022	.0002	.0004	-.0022
.902	1.10	12.01	.0002	.0003	-.0021	.0002	.0003	-.0021
.899	1.09	16.01	.0002	.0002	-.0018	.0002	.0002	-.0018
.899	1.07	18.02	.0002	.0003	-.0021	.0002	.0003	-.0021
.900	5.01	-1.99	.0002	.0004	-.0029	.0002	.0004	-.0029
.901	5.00	.00	.0002	.0005	-.0030	.0002	.0005	-.0030
.901	5.01	3.03	.0002	.0005	-.0029	.0002	.0005	-.0029
.899	4.99	5.99	.0002	.0005	-.0029	.0002	.0005	-.0029
.901	5.00	9.00	.0002	.0005	-.0029	.0002	.0005	-.0029
.903	5.01	12.01	.0002	.0003	-.0025	.0002	.0003	-.0025
.900	4.99	16.02	.0002	.0002	-.0024	.0002	.0002	-.0024
.901	5.00	18.01	.0002	.0003	-.0026	.0002	.0003	-.0026

Table 3. Continued

MACH	NPR	ALPHA	CROLLT	CNT	CYT	CROLL	CN	CY
.601	1.03	.01	.0002	.0002	-.0015	.0002	.0002	-.0015
.599	1.99	.02	.0002	.0006	-.0024	.0002	.0006	-.0024
.601	3.00	-.02	.0002	.0003	-.0026	.0002	.0003	-.0026
.602	3.52	-.02	.0002	.0004	-.0028	.0002	.0004	-.0028
.603	5.01	-.02	.0002	.0004	-.0033	.0002	.0004	-.0033
.604	1.03	-1.94	.0003	.0005	-.0029	.0003	.0005	-.0029
.600	1.03	.00	.0004	.0004	-.0028	.0004	.0004	-.0028
.602	1.03	3.01	.0004	.0005	-.0028	.0004	.0005	-.0028
.603	1.03	6.00	.0004	.0005	-.0028	.0004	.0005	-.0028
.601	1.03	9.00	.0003	.0005	-.0028	.0003	.0005	-.0028
.600	1.03	12.02	.0003	.0006	-.0028	.0003	.0006	-.0028
.600	1.02	16.00	.0003	.0005	-.0026	.0003	.0005	-.0026
.598	1.02	18.03	.0003	.0006	-.0028	.0003	.0006	-.0028
.599	3.51	-1.85	.0002	.0004	-.0032	.0002	.0004	-.0032
.600	3.52	.01	.0002	.0004	-.0029	.0002	.0004	-.0029
.602	3.51	3.00	.0002	.0004	-.0032	.0002	.0004	-.0032
.599	3.50	5.97	.0002	.0004	-.0032	.0002	.0004	-.0032
.598	3.49	8.99	.0002	.0004	-.0032	.0002	.0004	-.0032
.599	3.49	12.00	.0003	.0006	-.0035	.0003	.0006	-.0035
.600	3.49	15.99	.0002	.0005	-.0032	.0002	.0005	-.0032
.601	3.50	18.00	.0003	.0007	-.0040	.0003	.0007	-.0040
.597	1.02	20.01	.0001	.0006	-.0020	.0001	.0006	-.0020
.602	2.02	20.01	.0002	.0011	-.0035	.0002	.0011	-.0035
.602	3.05	20.01	.0002	.0011	-.0039	.0002	.0011	-.0039
.602	3.51	20.00	.0002	.0010	-.0041	.0002	.0010	-.0041
.601	5.01	20.02	.0002	.0012	-.0050	.0002	.0012	-.0050
.600	1.02	16.63	.0000	.0002	-.0011	.0000	.0002	-.0011
.599	1.02	17.99	.0000	.0002	-.0012	.0000	.0002	-.0012
.599	1.02	19.98	.0001	.0007	-.0025	.0001	.0007	-.0025
.600	1.00	23.97	.0011	.0078	-.0188	.0011	.0078	-.0188
.600	.99	27.98	.0018	.0128	-.0275	.0018	.0128	-.0275
.598	.96	31.99	.0016	.0127	-.0266	.0016	.0127	-.0266
.599	3.53	16.79	.0001	.0004	-.0021	.0001	.0004	-.0021
.599	3.46	17.99	.0001	.0005	-.0025	.0001	.0005	-.0025
.598	3.49	19.98	.0002	.0012	-.0045	.0002	.0012	-.0045
.596	3.48	23.96	.0012	.0082	-.0206	.0012	.0082	-.0206
.600	3.50	27.97	.0019	.0133	-.0298	.0019	.0133	-.0298
.600	3.50	31.98	.0018	.0141	-.0304	.0018	.0141	-.0304

Table 3. Concluded

MACH	NPR	ALPHA	CROLLT	CNT	CYT	CROLL	CN	CY
.152	1.00	.00	.0029	.0037	-.0222	.0029	.0037	-.0222
.153	2.02	-.01	.0032	.0093	-.0376	.0032	.0093	-.0376
.153	2.60	.00	.0028	.0062	-.0352	.0028	.0062	-.0352
.153	3.00	.00	.0020	.0043	-.0352	.0020	.0043	-.0352
.154	3.81	.00	.0016	.0030	-.0365	.0016	.0030	-.0365
.151	1.00	-1.53	.0020	.0029	-.0174	.0020	.0029	-.0174
.151	1.00	-.01	.0018	.0033	-.0188	.0018	.0033	-.0188
.152	1.00	2.98	.0018	.0033	-.0170	.0018	.0033	-.0170
.152	1.00	6.02	.0018	.0037	-.0170	.0018	.0037	-.0170
.152	1.00	8.98	.0015	.0043	-.0170	.0015	.0043	-.0170
.152	1.00	11.99	.0014	.0037	-.0135	.0014	.0037	-.0135
.151	1.00	16.02	.0011	.0043	-.0134	.0011	.0043	-.0134
.151	1.00	17.99	.0011	.0049	-.0152	.0011	.0049	-.0152
.153	2.63	-1.54	.0005	.0029	-.0228	.0005	.0029	-.0228
.153	2.65	.04	.0007	.0028	-.0197	.0007	.0028	-.0197
.154	2.62	3.02	.0010	.0041	-.0245	.0010	.0041	-.0245
.154	2.62	6.00	.0006	.0039	-.0212	.0006	.0039	-.0212
.154	2.63	9.00	.0009	.0047	-.0243	.0009	.0047	-.0243
.151	2.62	12.00	.0007	.0047	-.0218	.0007	.0047	-.0218
.151	2.62	16.01	.0004	.0043	-.0197	.0004	.0043	-.0197
.150	2.62	18.00	.0003	.0051	-.0201	.0003	.0051	-.0201
.152	1.00	19.99	.0020	.0010	-.0041	.0020	.0010	-.0041
.151	2.03	19.98	.0016	.0085	-.0251	.0016	.0085	-.0251
.152	2.58	19.98	.0009	.0071	-.0253	.0009	.0071	-.0253
.152	3.01	19.99	.0007	.0050	-.0237	.0007	.0050	-.0237
.145	3.83	19.98	.0006	.0056	-.0305	.0006	.0056	-.0305
.149	3.83	19.99	.0005	.0052	-.0287	.0005	.0052	-.0287
.151	1.00	15.98	.0015	.0017	-.0075	.0015	.0017	-.0075
.151	1.00	17.98	.0014	.0016	-.0059	.0014	.0016	-.0059
.151	1.00	19.98	.0014	.0017	-.0058	.0014	.0017	-.0058
.151	1.00	23.98	.0010	.0011	-.0037	.0010	.0011	-.0037
.151	1.00	27.98	.0012	.0020	-.0042	.0012	.0020	-.0042
.151	1.00	31.99	.0006	-.0023	.0061	.0006	-.0023	.0061
.150	1.00	35.18	.0009	-.0023	.0048	.0009	-.0023	.0048
.152	2.58	15.97	.0013	.0066	-.0252	.0013	.0066	-.0252
.152	2.64	17.97	.0010	.0064	-.0250	.0010	.0064	-.0250
.152	2.63	19.97	.0009	.0062	-.0232	.0009	.0062	-.0232
.152	2.63	23.97	.0006	.0051	-.0209	.0006	.0051	-.0209
.152	2.63	27.97	.0006	.0072	-.0233	.0006	.0072	-.0233
.152	2.63	31.97	-.0005	.0016	-.0078	-.0005	.0016	-.0078
.151	2.63	34.98	-.0006	.0010	-.0073	-.0006	.0010	-.0073

Table 4. Longitudinal Aerodynamic Characteristics for A/B Nozzle With 50/50 A/B Sidewalls and $\delta_{v,p} = 0°$

(a) Total aft end

MACH	NPR	ALPHA	CLT	C(D-F)	CMT	CL	CD	CM
1.201	.97	.01	-.0096	.0173	.0045	-.0096	.0173	.0045
1.201	3.01	.02	-.0086	-.0150	.0064	-.0086	.0161	.0035
1.200	5.00	.02	-.0104	-.0452	.0120	-.0104	.0158	.0062
1.201	7.06	.02	-.0108	-.0774	.0158	-.0109	.0147	.0069
1.201	9.03	.02	-.0111	-.1084	.0189	-.0112	.0134	.0071
.902	1.10	.00	-.0108	.0033	.0065	-.0108	.0033	.0065
.901	2.02	.02	-.0108	-.0264	.0098	-.0108	.0026	.0073
.900	3.00	.02	-.0111	-.0518	.0127	-.0112	.0033	.0076
.897	4.99	.01	-.0109	-.1058	.0179	-.0109	.0033	.0075
.900	7.01	.02	-.0108	-.1599	.0231	-.0109	.0028	.0075
.598	1.03	.01	-.0085	.0039	.0049	-.0085	.0039	.0049
.598	2.02	.02	-.0069	-.0626	.0110	-.0070	.0031	.0054
.600	3.01	.01	-.0068	-.1197	.0171	-.0068	.0045	.0056
.600	3.58	.02	-.0067	-.1542	.0205	-.0067	.0040	.0056
.602	5.09	.02	-.0061	-.2454	.0292	-.0062	.0027	.0055

(b) Afterbody and nozzle

MACH	NPR	ALPHA	CLAFT	CDAFT	CMAFT	CLN	CDN	CMN
1.201	.97	.01	-.0084	.0083	.0082	-.0012	.0090	-.0037
1.201	3.01	.02	-.0081	.0084	.0079	-.0005	.0078	-.0044
1.200	5.00	.02	-.0084	.0085	.0081	-.0021	.0073	-.0019
1.201	7.06	.02	-.0083	.0085	.0080	-.0026	.0062	-.0011
1.201	9.03	.02	-.0083	.0085	.0079	-.0029	.0049	-.0008
.902	1.10	.00	-.0035	.0060	.0032	-.0073	-.0028	.0033
.901	2.02	.02	-.0036	.0055	.0034	-.0072	-.0028	.0040
.900	3.00	.02	-.0037	.0055	.0034	-.0075	-.0022	.0042
.897	4.99	.01	-.0037	.0054	.0034	-.0072	-.0021	.0040
.900	7.01	.02	-.0036	.0052	.0032	-.0073	-.0024	.0042
.598	1.03	.01	-.0032	.0054	.0030	-.0053	-.0015	.0019
.598	2.02	.02	-.0031	.0051	.0030	-.0039	-.0020	.0024
.600	3.01	.01	-.0036	.0051	.0036	-.0033	-.0006	.0021
.600	3.58	.02	-.0031	.0051	.0029	-.0037	-.0011	.0027
.602	5.09	.02	-.0028	.0050	.0027	-.0034	-.0024	.0028

Table 5. Longitudinal Aerodynamic Characteristics for A/B Nozzle With 25/25 A/B Sidewalls and $\delta_{v,p} = 0°$

(a) Total aft end

MACH	NPR	ALPHA	CLT	C(D-F)	CMT	CL	CD	CM
1.200	.92	.02	-.0104	.0184	.0054	-.0104	.0184	.0054
1.200	3.03	.02	-.0092	-.0152	.0063	-.0093	.0162	.0034
1.202	5.01	.01	-.0101	-.0448	.0106	-.0101	.0161	.0048
1.202	7.00	.02	-.0102	-.0760	.0137	-.0102	.0150	.0050
1.201	8.97	.03	-.0105	-.1075	.0174	-.0106	.0136	.0057
1.200	.95	-2.04	-.0222	.0196	.0131	-.0222	.0196	.0131
1.203	.91	.01	-.0109	.0184	.0052	-.0109	.0184	.0052
1.204	.90	2.99	.0039	.0186	-.0048	.0039	.0186	-.0048
1.200	.88	5.98	.0197	.0218	-.0176	.0198	.0218	-.0176
1.201	.85	8.99	.0337	.0294	-.0302	.0338	.0294	-.0302
1.204	.81	12.01	.0498	.0375	-.0469	.0499	.0375	-.0469
1.200	.74	16.03	.0660	.0487	-.0643	.0661	.0487	-.0643
1.200	.70	17.99	.0752	.0550	-.0745	.0753	.0551	-.0745
1.200	6.98	-1.99	-.0210	-.0742	.0193	-.0178	.0169	.0105
1.202	7.00	-.01	-.0079	-.0752	.0128	-.0079	.0159	.0041
1.201	6.99	3.01	.0097	-.0746	.0065	.0049	.0164	-.0022
1.201	7.00	6.01	.0291	-.0717	-.0035	.0196	.0190	-.0123
1.199	7.00	9.01	.0491	-.0664	-.0159	.0348	.0239	-.0247
1.199	6.99	11.98	.0670	-.0576	-.0315	.0481	.0318	-.0402
1.203	7.04	15.99	.0919	-.0460	-.0514	.0668	.0418	-.0602
1.200	7.01	18.01	.1035	-.0392	-.0607	.0754	.0478	-.0695
.901	1.09	-.02	-.0092	.0042	.0046	-.0092	.0042	.0046
.903	2.03	-.01	-.0089	-.0261	.0079	-.0089	.0032	.0054
.898	3.01	-.02	-.0077	-.0513	.0091	-.0077	.0041	.0040
.903	5.03	.00	-.0082	-.1044	.0147	-.0082	.0040	.0044
.899	7.02	.00	-.0078	-.1601	.0197	-.0079	.0032	.0040
.902	1.10	-2.05	-.0080	.0038	.0030	-.0080	.0038	.0030
.901	1.09	-.01	-.0079	.0038	.0043	-.0079	.0038	.0043
.902	1.09	3.02	-.0031	.0033	.0044	-.0031	.0033	.0044
.897	1.09	6.02	-.0053	.0027	.0063	-.0052	.0027	.0063
.901	1.09	9.03	-.0027	.0032	.0065	-.0027	.0032	.0065
.902	1.09	12.01	.0140	.0077	-.0032	.0141	.0077	-.0032
.901	1.09	16.00	.0290	.0174	-.0144	.0291	.0174	-.0144
.899	1.08	18.01	.0376	.0249	-.0221	.0378	.0250	-.0221
.901	5.02	-2.05	-.0113	-.1051	.0131	-.0074	.0037	.0027
.899	5.02	.01	-.0077	-.1054	.0146	-.0077	.0038	.0042
.900	5.02	2.99	.0022	-.1055	.0144	-.0035	.0035	.0040
.901	5.02	6.00	.0056	-.1057	.0170	-.0058	.0028	.0066
.901	5.02	9.00	.0146	-.1043	.0162	-.0024	.0033	.0058
.902	5.02	12.02	.0367	-.0986	.0061	.0141	.0078	-.0042
.903	5.03	16.04	.0612	-.0862	-.0081	.0313	.0183	-.0185
.899	5.01	18.01	.0738	-.0783	-.0172	.0402	.0255	-.0277

Table 5. Continued

(a) Continued

MACH	NPR	ALPHA	CLT	C(D-F)	CMT	CL	CD	CM
.602	1.03	.03	-.0102	.0048	.0048	-.0102	.0048	.0048
.599	1.99	.02	-.0079	-.0610	.0097	-.0079	.0029	.0042
.604	3.00	.02	-.0070	-.1177	.0146	-.0070	.0044	.0033
.597	3.54	.01	-.0065	-.1523	.0179	-.0065	.0047	.0031
.598	4.97	.01	-.0050	-.2385	.0249	-.0050	.0054	.0017
.602	1.03	-1.74	-.0057	.0049	.0030	-.0058	.0049	.0030
.599	1.03	.03	-.0041	.0048	.0028	-.0041	.0048	.0028
.601	1.03	2.99	-.0020	.0041	.0030	-.0020	.0041	.0030
.600	1.03	6.00	.0015	.0046	.0014	.0016	.0047	.0014
.602	1.03	8.99	.0051	.0052	-.0009	.0052	.0052	-.0009
.600	1.03	12.00	.0098	.0068	-.0052	.0099	.0069	-.0052
.598	1.03	15.99	.0258	.0132	-.0180	.0259	.0132	-.0180
.599	1.02	17.98	.0334	.0180	-.0233	.0336	.0180	-.0233
.600	3.49	-1.67	-.0096	-.1493	.0175	-.0052	.0039	.0031
.599	3.50	.01	-.0033	-.1495	.0167	-.0033	.0040	.0023
.602	3.50	3.00	.0069	-.1487	.0162	-.0010	.0040	.0018
.600	3.50	6.01	.0186	-.1480	.0146	.0026	.0046	.0002
.599	3.50	9.00	.0308	-.1461	.0115	.0068	.0056	-.0029
.599	3.50	12.00	.0440	-.1425	.0064	.0121	.0077	-.0080
.598	3.49	16.00	.0703	-.1343	-.0074	.0279	.0138	-.0218
.600	3.50	17.99	.0838	-.1269	-.0141	.0366	.0188	-.0285
.598	1.02	20.02	.0410	.0232	-.0288	.0412	.0233	-.0288
.600	1.97	20.01	.0624	-.0374	-.0236	.0413	.0211	-.0289
.599	3.01	19.99	.0843	-.0944	-.0205	.0419	.0226	-.0320
.600	3.55	20.00	.0957	-.1248	-.0184	.0422	.0226	-.0331
.599	4.98	20.00	.1263	-.2052	-.0125	.0431	.0237	-.0358
.600	1.03	16.59	.0268	.0142	-.0190	.0269	.0142	-.0190
.601	1.03	17.96	.0318	.0175	-.0225	.0319	.0175	-.0225
.600	1.02	19.98	.0397	.0229	-.0288	.0398	.0229	-.0288
.601	1.00	23.98	.0569	.0382	-.0460	.0571	.0383	-.0460
.598	.98	27.98	.0773	.0596	-.0728	.0775	.0597	-.0728
.601	.96	31.96	.0932	.0849	-.1036	.0934	.0850	-.1036
.599	3.49	16.78	.0710	-.1327	-.0075	.0269	.0140	-.0219
.601	3.51	17.99	.0804	-.1292	-.0117	.0331	.0169	-.0261
.600	3.51	19.99	.0937	-.1229	-.0181	.0412	.0221	-.0325
.598	3.51	23.99	.1229	-.1045	-.0375	.0601	.0371	-.0520
.600	3.52	27.99	.1551	-.0768	-.0681	.0829	.0594	-.0826
.599	3.51	31.98	.1834	-.0459	-.1029	.1017	.0854	-.1174

Table 5. Continued

(a) Concluded

MACH	NPR	ALPHA	CLT	C(D-F)	CMT	CL	CD	CM
.151	1.00	.02	.0108	.0098	-.0077	.0108	.0098	-.0077
.149	2.00	.01	.0270	-1.0416	.0749	.0268	-.0057	-.0140
.151	2.59	.00	.0297	-1.5589	.1185	.0296	.0092	-.0239
.151	3.00	.01	.0288	-1.9362	.1658	.0285	.0101	-.0142
.150	3.78	.00	.0322	-2.7005	.2354	.0320	.0086	-.0205
.149	1.00	-1.36	.0100	.0003	-.0031	.0100	.0003	-.0031
.150	1.00	.00	.0274	-.0007	-.0094	.0274	-.0007	-.0094
.149	1.00	2.99	.0333	-.0018	-.0095	.0333	-.0018	-.0095
.151	1.00	5.98	.0363	.0003	-.0099	.0363	.0003	-.0099
.151	1.00	9.01	.0347	.0049	-.0108	.0347	.0049	-.0108
.150	1.00	12.00	.0343	.0110	-.0117	.0344	.0110	-.0117
.148	1.00	15.99	.0516	.0174	-.0244	.0517	.0174	-.0244
.151	1.00	17.98	.0550	.0231	-.0296	.0551	.0231	-.0296
.150	2.59	-1.39	-.0127	-1.5848	.1245	.0259	.0036	-.0196
.150	2.59	-.02	.0257	-1.5878	.1239	.0262	.0069	-.0208
.151	2.60	3.02	.1076	-1.5731	.1258	.0243	.0078	-.0179
.151	2.60	5.98	.1877	-1.5526	.1249	.0243	.0088	-.0177
.148	2.60	9.00	.2891	-1.5993	.1254	.0341	.0116	-.0226
.151	2.60	11.99	.3614	-1.5196	.1182	.0354	.0155	-.0243
.150	2.60	15.99	.4850	-1.5058	.1096	.0471	.0232	-.0348
.148	2.60	17.98	.5675	-1.5380	.1040	.0588	.0298	-.0456
.151	1.00	19.99	.0349	.0254	-.0269	.0350	.0254	-.0269
.150	2.01	19.97	.3839	-.9574	.0770	.0310	.0139	-.0120
.150	2.60	19.98	.5841	-1.4836	.1187	.0360	.0240	-.0270
.150	3.01	19.98	.7095	-1.8380	.1607	.0317	.0262	-.0228
.150	3.84	19.98	.9838	-2.5838	.2355	.0359	.0231	-.0268
.149	1.00	15.98	.0092	.0158	-.0119	.0093	.0158	-.0119
.152	1.00	17.97	.0252	.0182	-.0229	.0253	.0182	-.0229
.149	1.00	19.98	.0390	.0280	-.0298	.0392	.0280	-.0298
.149	1.00	23.99	.0640	.0414	-.0448	.0642	.0414	-.0448
.149	1.00	27.98	.0728	.0574	-.0592	.0730	.0575	-.0592
.149	1.00	31.98	.0978	.0821	-.0846	.0980	.0822	-.0846
.149	1.00	34.98	.1066	.1011	-.1024	.1068	.1012	-.1024
.151	2.61	15.98	.4786	-1.5053	.1249	.0393	.0293	-.0202
.151	2.61	17.97	.5438	-1.4827	.1140	.0518	.0341	-.0309
.151	2.61	19.97	.6012	-1.4631	.1095	.0558	.0381	-.0356
.151	2.61	23.97	.7145	-1.4181	.1031	.0651	.0431	-.0422
.150	2.61	27.99	.8347	-1.3635	.0862	.0795	.0582	-.0601
.150	2.61	31.98	.9509	-1.2870	.0630	.0988	.0783	-.0832
.150	2.61	34.97	1.0279	-1.2299	.0453	.1024	.0936	-.1015

Table 5. Continued

(b) Afterbody and nozzle

MACH	NPR	ALPHA	CLAFT	CDAFT	CMAFT	CLN	CDN	CMN
1.200	.92	.02	-.0087	.0083	.0084	-.0017	.0101	-.0030
1.200	3.03	.02	-.0085	.0083	.0082	-.0007	.0079	-.0048
1.202	5.01	.01	-.0084	.0084	.0080	-.0017	.0077	-.0032
1.202	7.00	.02	-.0086	.0084	.0082	-.0017	.0066	-.0032
1.201	8.97	.03	-.0083	.0084	.0079	-.0023	.0051	-.0022
1.200	.95	-2.04	-.0171	.0091	.0153	-.0051	.0105	-.0022
1.203	.91	.01	-.0087	.0085	.0082	-.0023	.0099	-.0031
1.204	.90	2.99	.0031	.0090	-.0017	.0008	.0095	-.0031
1.200	.88	5.98	.0166	.0112	-.0144	.0032	.0105	-.0032
1.201	.85	8.99	.0284	.0148	-.0272	.0054	.0146	-.0030
1.204	.81	12.01	.0406	.0196	-.0418	.0093	.0179	-.0051
1.200	.74	16.03	.0535	.0266	-.0560	.0126	.0221	-.0083
1.200	.70	17.99	.0594	.0305	-.0629	.0159	.0246	-.0116
1.200	6.98	-1.99	-.0170	.0093	.0150	-.0008	.0076	-.0045
1.202	7.00	-.01	-.0088	.0087	.0081	.0008	.0072	-.0041
1.201	6.99	3.01	.0031	.0092	-.0020	.0018	.0072	-.0003
1.201	7.00	6.01	.0174	.0114	-.0155	.0022	.0076	.0032
1.199	7.00	9.01	.0303	.0150	-.0287	.0045	.0089	.0040
1.199	6.99	11.98	.0406	.0198	-.0419	.0075	.0120	.0016
1.203	7.04	15.99	.0538	.0268	-.0569	.0130	.0151	-.0033
1.200	7.01	18.01	.0602	.0309	-.0640	.0151	.0169	-.0055
.901	1.09	-.02	-.0034	.0060	.0028	-.0058	-.0018	.0018
.903	2.03	-.01	-.0035	.0055	.0030	-.0054	-.0023	.0024
.898	3.01	-.02	-.0035	.0055	.0029	-.0042	-.0014	.0010
.903	5.03	.00	-.0033	.0054	.0027	-.0049	-.0014	.0017
.899	7.02	.00	-.0034	.0052	.0028	-.0045	-.0021	.0012
.902	1.10	-2.05	-.0017	.0059	.0010	-.0063	-.0021	.0020
.901	1.09	-.01	-.0032	.0059	.0026	-.0047	-.0022	.0017
.902	1.09	3.02	-.0050	.0059	.0052	.0019	-.0025	-.0009
.897	1.09	6.02	-.0054	.0056	.0061	.0002	-.0030	.0003
.901	1.09	9.03	-.0049	.0058	.0070	.0022	-.0026	-.0004
.902	1.09	12.01	-.0005	.0072	.0053	.0146	.0005	-.0085
.901	1.09	16.00	.0130	.0139	-.0044	.0161	.0034	-.0100
.899	1.08	18.01	.0184	.0184	-.0089	.0194	.0065	-.0132
.901	5.02	-2.05	-.0017	.0053	.0009	-.0058	-.0016	.0018
.899	5.02	.01	-.0033	.0054	.0027	-.0045	-.0016	.0015
.900	5.02	2.99	-.0047	.0053	.0051	.0012	-.0019	-.0011
.901	5.02	6.00	-.0056	.0050	.0063	-.0002	-.0023	.0003
.901	5.02	9.00	-.0045	.0052	.0067	.0021	-.0019	-.0009
.902	5.02	12.02	-.0003	.0067	.0048	.0144	.0012	-.0090
.903	5.03	16.04	.0145	.0139	-.0062	.0168	.0043	-.0123
.899	5.01	18.01	.0203	.0184	-.0119	.0200	.0071	-.0157

Table 5. Continued

(b) Continued

MACH	NPR	ALPHA	CLAFT	CDAFT	CMAFT	CLN	CDN	CMN
.602	1.03	.03	-.0038	.0055	.0034	-.0064	-.0007	.0014
.599	1.99	.02	-.0036	.0051	.0032	-.0043	-.0022	.0010
.604	3.00	.02	-.0033	.0051	.0028	-.0037	-.0007	.0005
.597	3.54	.01	-.0033	.0052	.0029	-.0032	-.0005	.0002
.598	4.97	.01	-.0033	.0051	.0030	-.0017	.0003	-.0013
.602	1.03	-1.74	-.0036	.0056	.0027	-.0021	-.0006	.0002
.599	1.03	.03	-.0031	.0055	.0027	-.0011	-.0007	.0000
.601	1.03	2.99	-.0020	.0054	.0025	.0000	-.0013	.0005
.600	1.03	6.00	-.0005	.0056	.0016	.0021	-.0010	-.0002
.602	1.03	8.99	.0017	.0061	-.0004	.0035	-.0009	-.0005
.600	1.03	12.00	.0044	.0070	-.0034	.0055	-.0001	-.0018
.598	1.03	15.99	.0142	.0105	-.0129	.0117	.0027	-.0051
.599	1.02	17.98	.0190	.0130	-.0169	.0146	.0050	-.0065
.600	3.49	-1.67	-.0036	.0051	.0028	-.0016	-.0013	.0003
.599	3.50	.01	-.0030	.0051	.0027	-.0003	-.0011	-.0004
.602	3.50	3.00	-.0018	.0051	.0024	.0008	-.0011	-.0006
.600	3.50	6.01	-.0003	.0053	.0014	.0028	-.0007	-.0012
.599	3.50	9.00	.0020	.0058	-.0007	.0048	-.0002	-.0022
.599	3.50	12.00	.0049	.0067	-.0039	.0072	.0009	-.0040
.598	3.49	16.00	.0150	.0104	-.0138	.0130	.0033	-.0081
.600	3.50	17.99	.0199	.0130	-.0179	.0167	.0058	-.0106
.598	1.02	20.02	.0223	.0156	-.0213	.0188	.0077	-.0075
.600	1.97	20.01	.0227	.0155	-.0217	.0185	.0056	-.0071
.599	3.01	19.99	.0229	.0156	-.0220	.0190	.0070	-.0100
.600	3.55	20.00	.0232	.0157	-.0226	.0190	.0069	-.0105
.599	4.98	20.00	.0239	.0160	-.0236	.0192	.0077	-.0122
.600	1.03	16.59	.0146	.0109	-.0145	.0123	.0033	-.0045
.601	1.03	17.96	.0175	.0126	-.0168	.0144	.0049	-.0057
.600	1.02	19.98	.0223	.0156	-.0214	.0176	.0073	-.0074
.601	1.00	23.98	.0361	.0255	-.0367	.0210	.0128	-.0093
.598	.98	27.98	.0515	.0392	-.0580	.0260	.0205	-.0149
.601	.96	31.96	.0669	.0568	-.0841	.0265	.0281	-.0195
.599	3.49	16.78	.0157	.0110	-.0158	.0112	.0029	-.0061
.601	3.51	17.99	.0183	.0125	-.0178	.0148	.0044	-.0083
.600	3.51	19.99	.0231	.0157	-.0224	.0181	.0064	-.0101
.598	3.51	23.99	.0372	.0257	-.0383	.0229	.0114	-.0137
.600	3.52	27.99	.0531	.0400	-.0604	.0298	.0194	-.0221
.599	3.51	31.98	.0696	.0585	-.0881	.0321	.0269	-.0293

Table 5. Concluded

(b) Concluded

MACH	NPR	ALPHA	CLAFT	CDAFT	CMAFT	CLN	CDN	CMN
.151	1.00	.02	-.0004	.0059	-.0010	.0111	.0038	-.0067
.149	2.00	.01	-.0009	.0068	.0003	.0277	-.0125	-.0143
.151	2.59	.00	-.0006	.0068	.0006	.0302	.0023	-.0244
.151	3.00	.01	-.0007	.0068	.0009	.0293	.0033	-.0151
.150	3.78	.00	-.0005	.0070	.0009	.0325	.0017	-.0214
.149	1.00	-1.36	-.0006	.0049	.0007	.0106	-.0046	-.0038
.150	1.00	.00	-.0004	.0047	-.0004	.0278	-.0054	-.0091
.149	1.00	2.99	-.0005	.0046	.0013	.0338	-.0064	-.0108
.151	1.00	5.98	.0004	.0048	.0016	.0360	-.0045	-.0115
.151	1.00	9.01	.0050	.0055	-.0031	.0298	-.0006	-.0077
.150	1.00	12.00	.0089	.0073	-.0075	.0255	.0037	-.0042
.148	1.00	15.99	.0136	.0095	-.0123	.0381	.0078	-.0121
.151	1.00	17.98	.0193	.0121	-.0178	.0359	.0110	-.0118
.150	2.59	-1.39	-.0030	.0063	.0038	.0289	-.0027	-.0234
.150	2.59	-.02	-.0020	.0062	.0030	.0283	.0007	-.0238
.151	2.60	3.02	-.0017	.0062	.0031	.0259	.0016	-.0211
.151	2.60	5.98	.0007	.0064	.0012	.0236	.0024	-.0188
.148	2.60	9.00	.0028	.0069	-.0008	.0313	.0047	-.0219
.151	2.60	11.99	.0038	.0076	-.0014	.0316	.0079	-.0228
.150	2.60	15.99	.0106	.0103	-.0091	.0365	.0129	-.0256
.148	2.60	17.98	.0160	.0128	-.0146	.0428	.0169	-.0310
.151	1.00	19.99	.0196	.0144	-.0219	.0154	.0109	-.0049
.150	2.01	19.97	.0176	.0144	-.0202	.0134	-.0005	.0082
.150	2.60	19.98	.0188	.0148	-.0216	.0172	.0092	-.0053
.150	3.01	19.98	.0185	.0149	-.0215	.0132	.0114	-.0013
.150	3.84	19.98	.0190	.0156	-.0225	.0169	.0076	-.0043
.149	1.00	15.98	.0119	.0109	-.0152	-.0027	.0049	.0033
.152	1.00	17.97	.0160	.0124	-.0188	.0092	.0059	-.0041
.149	1.00	19.98	.0191	.0142	-.0208	.0200	.0138	-.0090
.149	1.00	23.99	.0285	.0207	-.0300	.0357	.0207	-.0148
.149	1.00	27.98	.0392	.0303	-.0432	.0337	.0272	-.0160
.149	1.00	31.98	.0527	.0441	-.0627	.0453	.0380	-.0219
.149	1.00	34.98	.0590	.0534	-.0742	.0479	.0477	-.0283
.151	2.61	15.98	.0111	.0104	-.0111	.0281	.0189	-.0090
.151	2.61	17.97	.0169	.0124	-.0182	.0350	.0217	-.0127
.151	2.61	19.97	.0212	.0149	-.0222	.0346	.0232	-.0134
.151	2.61	23.97	.0281	.0205	-.0287	.0371	.0226	-.0135
.150	2.61	27.99	.0383	.0300	-.0407	.0412	.0282	-.0194
.150	2.61	31.98	.0518	.0441	-.0610	.0470	.0342	-.0222
.150	2.61	34.97	.0575	.0533	-.0714	.0449	.0403	-.0301

Table 6. Longitudinal Aerodynamic Characteristics for A/B Nozzle With 100/100 Dry Sidewalls and $\delta_{v,p} = 0°$

(a) Total aft end

MACH	NPR	ALPHA	CLT	C(D-F)	CMT	CL	CD	CM
1.202	.97	.00	-.0091	.0168	.0039	-.0091	.0168	.0039
1.201	3.01	.01	-.0094	-.0151	.0069	-.0095	.0161	.0038
1.200	4.94	.02	-.0113	-.0445	.0122	-.0113	.0158	.0063
1.200	7.01	.03	-.0121	-.0774	.0164	-.0122	.0137	.0075
1.201	9.04	.02	-.0116	-.1089	.0192	-.0117	.0123	.0073
.904	1.10	-.02	-.0106	.0033	.0063	-.0106	.0033	.0063
.896	2.01	.02	-.0095	-.0263	.0086	-.0095	.0031	.0057
.897	3.00	.02	-.0102	-.0520	.0124	-.0102	.0039	.0069
.900	5.00	.01	-.0099	-.1056	.0175	-.0099	.0030	.0068
.902	7.01	.02	-.0099	-.1596	.0228	-.0099	.0014	.0071
.601	1.03	-.03	-.0056	.0038	.0041	-.0056	.0038	.0041
.600	1.99	.01	-.0038	-.0605	.0091	-.0039	.0037	.0027
.600	3.03	.01	-.0046	-.1211	.0163	-.0046	.0050	.0038
.601	3.50	.01	-.0045	-.1496	.0190	-.0045	.0048	.0038
.599	4.99	.00	-.0037	-.2406	.0275	-.0037	.0041	.0036
.601	1.03	-1.81	-.0051	.0042	.0036	-.0052	.0042	.0036
.600	1.03	2.02	-.0017	.0038	.0032	-.0017	.0038	.0032
.599	1.03	-.01	-.0038	.0037	.0036	-.0038	.0037	.0036
.598	1.03	6.00	.0010	.0039	.0022	.0010	.0039	.0022
.601	1.03	8.97	.0054	.0049	-.0009	.0055	.0049	-.0009
.602	1.03	11.98	.0109	.0067	-.0060	.0110	.0067	-.0060

Table 6. Concluded

(b) Afterbody and nozzle

MACH	NPR	ALPHA	CLAFT	CDAFT	CMAFT	CLN	CDN	CMN
1.202	.97	.00	-.0084	.0084	.0081	-.0007	.0085	-.0042
1.201	3.01	.01	-.0083	.0084	.0080	-.0011	.0077	-.0042
1.200	4.94	.02	-.0084	.0085	.0080	-.0029	.0074	-.0017
1.200	7.01	.03	-.0085	.0085	.0080	-.0037	.0052	-.0005
1.201	9.04	.02	-.0084	.0085	.0080	-.0033	.0038	-.0006
.904	1.10	-.02	-.0036	.0060	.0032	-.0071	-.0027	.0031
.896	2.01	.02	-.0038	.0054	.0035	-.0056	-.0023	.0022
.897	3.00	.02	-.0038	.0055	.0034	-.0064	-.0016	.0035
.900	5.00	.01	-.0037	.0054	.0033	-.0062	-.0023	.0035
.902	7.01	.02	-.0036	.0051	.0032	-.0064	-.0037	.0039
.601	1.03	-.03	-.0033	.0053	.0031	-.0023	-.0015	.0010
.600	1.99	.01	-.0031	.0050	.0028	-.0008	-.0012	-.0002
.600	3.03	.01	-.0031	.0050	.0030	-.0015	.0000	.0008
.601	3.50	.01	-.0031	.0050	.0029	-.0015	-.0002	.0009
.599	4.99	.00	-.0025	.0050	.0022	-.0012	-.0009	.0013
.601	1.03	-1.81	-.0035	.0053	.0028	-.0016	-.0011	.0009
.600	1.03	2.02	-.0023	.0052	.0027	.0006	-.0014	.0005
.599	1.03	-.01	-.0031	.0052	.0029	-.0007	-.0015	.0007
.598	1.03	6.00	-.0003	.0054	.0015	.0013	-.0016	.0007
.601	1.03	8.97	.0019	.0059	-.0005	.0036	-.0010	-.0004
.602	1.03	11.98	.0048	.0068	-.0038	.0062	-.0001	-.0022

Table 7. Longitudinal Aerodynamic Characteristics for A/B Nozzle With 100/100 A/B Sidewalls and $\delta_{v,p} = 15°$

MACH	NPR	ALPHA	CLT	C(D-F)	CMT	CL	CD	CM
1.205	.93	.03	-.0065	.0161	.0007	-.0065	.0161	.0007
1.199	3.00	.02	.0086	-.0121	-.0245	-.0009	.0163	-.0101
1.197	5.00	.00	.0214	-.0404	-.0439	.0045	.0164	-.0195
1.197	6.98	-.03	.0312	-.0693	-.0583	.0071	.0158	-.0239
1.202	8.91	-.01	.0385	-.0970	-.0682	.0074	.0146	-.0244
1.197	.96	-2.01	-.0187	.0173	.0083	-.0187	.0173	.0083
1.195	.91	-.03	-.0080	.0169	.0012	-.0080	.0169	.0012
1.200	.89	3.03	.0081	.0190	-.0116	.0081	.0190	-.0116
1.198	.85	5.99	.0260	.0242	-.0288	.0260	.0242	-.0288
1.197	.80	9.02	.0397	.0317	-.0423	.0397	.0317	-.0423
1.201	.73	12.00	.0575	.0417	-.0635	.0576	.0417	-.0635
1.199	.66	16.00	.0740	.0537	-.0844	.0741	.0537	-.0844
1.202	.62	17.99	.0851	.0609	-.0979	.0853	.0610	-.0979
1.200	7.01	-1.98	.0202	-.0700	-.0533	-.0010	.0158	-.0189
1.202	7.04	.03	.0333	-.0694	-.0593	.0090	.0158	-.0249
1.200	6.98	2.99	.0506	-.0656	-.0668	.0222	.0176	-.0326
1.200	6.99	8.99	.0853	-.0517	-.0885	.0484	.0282	-.0542
1.199	7.06	11.98	.1024	-.0435	-.1023	.0608	.0355	-.0676
.900	1.06	-.02	.0021	.0049	-.0133	.0021	.0049	-.0133
.900	2.00	.01	.0185	-.0208	-.0390	.0089	.0050	-.0242
.900	3.01	-.01	.0275	-.0448	-.0532	.0107	.0057	-.0276
.899	5.01	-.03	.0448	-.0953	-.0788	.0149	.0057	-.0354
.899	6.98	-.04	.0600	-.1452	-.1000	.0173	.0056	-.0389
.901	1.07	-2.01	.0024	.0045	-.0142	.0024	.0045	-.0142
.901	1.06	.00	.0035	.0050	-.0140	.0035	.0050	-.0140
.899	1.06	3.02	.0073	.0052	-.0142	.0073	.0052	-.0142
.899	1.06	6.03	.0053	.0055	-.0131	.0054	.0055	-.0131
.899	1.06	9.02	.0104	.0073	-.0175	.0104	.0073	-.0175
.903	1.06	12.00	.0262	.0128	-.0278	.0263	.0128	-.0278
.898	1.03	16.01	.0437	.0251	-.0437	.0439	.0251	-.0437
.902	1.01	18.00	.0504	.0328	-.0487	.0505	.0328	-.0487
.902	5.02	-2.02	.0399	-.0961	-.0788	.0136	.0053	-.0356
.898	4.99	.00	.0446	-.0950	-.0786	.0148	.0057	-.0353
.902	5.01	3.00	.0542	-.0920	-.0795	.0193	.0067	-.0364
.899	4.99	6.00	.0575	-.0892	-.0785	.0174	.0077	-.0352
.898	4.98	8.98	.0701	-.0845	-.0831	.0249	.0103	-.0397
.900	5.01	12.00	.0880	-.0761	-.0928	.0379	.0163	-.0494
.902	5.02	16.00	.1153	-.0581	-.1109	.0589	.0304	-.0676
.896	4.99	17.97	.1250	-.0498	-.1199	.0654	.0372	-.0763

Table 7. Continued

MACH	NPR	ALPHA	CLT	C(D-F)	CMT	CL	CD	CM
.600	1.02	.02	.0063	.0059	-.0195	.0063	.0059	-.0195
.602	1.99	.01	.0395	-.0506	-.0684	.0183	.0066	-.0354
.601	2.99	-.04	.0567	-.1054	-.0928	.0193	.0069	-.0360
.601	3.52	-.05	.0659	-.1353	-.1061	.0208	.0068	-.0385
.600	5.02	-.05	.0905	-.2203	-.1419	.0233	.0071	-.0442
.597	1.04	-2.12	.0066	.0049	-.0200	.0066	.0049	-.0200
.600	1.02	-.03	.0101	.0055	-.0211	.0101	.0055	-.0211
.601	1.02	3.01	.0140	.0067	-.0228	.0140	.0067	-.0228
.602	1.01	6.02	.0186	.0090	-.0262	.0186	.0090	-.0262
.600	1.01	8.97	.0224	.0114	-.0301	.0225	.0114	-.0301
.602	1.01	12.01	.0283	.0147	-.0362	.0284	.0147	-.0362
.601	1.00	16.02	.0439	.0230	-.0499	.0440	.0230	-.0499
.599	.99	17.98	.0521	.0287	-.0563	.0522	.0287	-.0563
.602	3.54	-2.04	.0613	-.1383	-.1059	.0209	.0061	-.0381
.601	3.50	.02	.0678	-.1339	-.1065	.0228	.0069	-.0394
.602	3.50	3.02	.0786	-.1289	-.1087	.0266	.0086	-.0419
.602	3.50	5.98	.0899	-.1235	-.1125	.0308	.0111	-.0457
.602	3.49	8.99	.1017	-.1171	-.1173	.0357	.0140	-.0506
.601	3.49	12.00	.1136	-.1098	-.1236	.0407	.0180	-.0567
.602	3.49	16.01	.1391	-.0946	-.1393	.0577	.0275	-.0725
.601	.99	18.01	.0477	.0268	-.0549	.0478	.0268	-.0549
.599	.98	20.01	.0567	.0336	-.0615	.0568	.0336	-.0615
.599	2.02	19.97	.1082	-.0110	-.1160	.0673	.0374	-.0818
.599	3.00	19.98	.1425	-.0565	-.1403	.0681	.0376	-.0828
.598	3.54	19.99	.1617	-.0821	-.1546	.0694	.0378	-.0861
.599	5.03	19.97	.2143	-.1521	-.1915	.0727	.0395	-.0933
.599	3.48	18.01	.1531	-.0860	-.1478	.0668	.0341	-.0805
.601	1.00	16.49	.0423	.0229	-.0507	.0424	.0229	-.0507
.601	.98	19.98	.0560	.0333	-.0620	.0561	.0333	-.0620
.598	.97	23.97	.0722	.0498	-.0795	.0724	.0499	-.0795
.600	.95	27.99	.0904	.0700	-.1014	.0906	.0700	-.1014
.600	.93	31.98	.1055	.0958	-.1316	.1058	.0959	-.1316
.598	3.53	16.10	.1376	-.1006	-.1413	.0535	.0255	-.0727
.602	3.54	17.98	.1494	-.0900	-.1470	.0624	.0317	-.0793
.600	3.54	19.98	.1615	-.0809	-.1544	.0699	.0382	-.0864
.599	3.53	23.96	.1897	-.0562	-.1764	.0896	.0566	-.1081
.600	3.54	27.98	.2113	-.0295	-.1961	.1038	.0759	-.1280
.599	3.54	31.97	.2362	.0072	-.2330	.1213	.1052	-.1646

Table 7. Concluded

MACH	NPR	ALPHA	CLT	C(D-F)	CMT	CL	CD	CM
.152	1.00	-.02	-.0225	-.0116	-.0065	-.0225	-.0116	-.0065
.153	2.01	-.03	.3415	-.9091	-.5587	.0078	-.0074	-.0388
.150	2.60	-.02	.5170	-1.4535	-.8291	.0075	.0060	-.0399
.150	2.98	-.02	.5951	-1.7745	-.9299	-.0011	.0150	-.0229
.149	1.00	-1.90	.0272	-.0023	-.0255	.0272	-.0023	-.0255
.152	1.00	.01	.0167	-.0029	-.0205	.0167	-.0029	-.0205
.152	1.00	3.00	.0225	-.0019	-.0219	.0225	-.0019	-.0219
.153	1.00	6.03	.0201	-.0016	-.0219	.0201	-.0016	-.0219
.152	1.00	8.99	.0289	.0039	-.0279	.0289	.0039	-.0279
.152	1.00	11.99	.0315	.0106	-.0316	.0316	.0107	-.0316
.152	1.00	16.02	.0407	.0166	-.0451	.0408	.0166	-.0451
.151	1.00	17.93	.0406	.0201	-.0495	.0407	.0201	-.0495
.154	2.59	-2.03	.4535	-1.3913	-.7918	.0182	.0094	-.0418
.153	2.60	-.01	.5103	-1.3795	-.7968	.0244	.0098	-.0447
.152	2.60	2.98	.5946	-1.3851	-.8158	.0234	.0106	-.0454
.152	2.60	5.98	.6703	-1.3490	-.8186	.0269	.0143	-.0484
.152	2.60	9.03	.7468	-1.3106	-.8232	.0316	.0174	-.0527
.151	2.60	11.95	.8229	-1.2705	-.8336	.0379	.0244	-.0600
.151	2.60	15.92	.9291	-1.2101	-.8516	.0526	.0325	-.0747
.151	2.60	17.55	.9714	-1.1832	-.8622	.0561	.0392	-.0821
.155	1.00	20.01	.0528	.0283	-.0520	.0530	.0283	-.0520
.151	2.02	19.97	.7021	-.7146	-.6093	.0619	.0405	-.0743
.152	2.61	19.96	1.0236	-1.1245	-.8559	.0632	.0525	-.0813
.152	2.99	19.98	1.2146	-1.4097	-.9647	.0610	.0456	-.0730
.152	3.83	19.96	1.6433	-2.0324	-1.2419	.0638	.0415	-.0922
.152	1.00	15.98	.0259	.0236	-.0428	.0260	.0237	-.0428
.152	1.00	17.98	.0435	.0325	-.0553	.0436	.0325	-.0553
.152	1.00	19.98	.0560	.0412	-.0630	.0561	.0412	-.0630
.152	1.00	23.98	.0711	.0564	-.0738	.0713	.0564	-.0738
.150	1.00	27.99	.0942	.0799	-.0964	.0944	.0799	-.0964
.149	1.00	31.98	.1157	.1085	-.1212	.1160	.1086	-.1212
.149	1.00	35.18	.1164	.1231	-.1340	.1166	.1232	-.1340
.151	2.62	15.97	.9573	-1.2009	-.8685	.0657	.0640	-.0816
.151	2.60	17.99	.9989	-1.1471	-.8727	.0744	.0684	-.0929
.150	2.59	19.96	1.0530	-1.1068	-.8830	.0860	.0762	-.1011
.151	2.59	23.97	1.1293	-1.0273	-.8827	.0840	.0831	-.1027
.150	2.59	27.97	1.2273	-.9397	-.9049	.1027	.0995	-.1220
.150	2.59	31.97	1.3133	-.8512	-.9325	.1069	.1169	-.1419
.150	2.59	34.98	1.3705	-.7700	-.9499	.1160	.1328	-.1598

Table 8. Longitudinal Aerodynamic Characteristics for A/B Nozzle With 50/50 A/B Sidewalls and $\delta_{v,p} = 15°$

(a) Total aft end

MACH	NPR	ALPHA	CLT	C(D-F)	CMT	CL	CD	CM
1.199	.91	.02	-.0076	.0181	.0030	-.0076	.0181	.0030
1.200	3.02	-.02	.0084	-.0110	-.0227	-.0010	.0177	-.0087
1.200	4.97	-.02	.0217	-.0379	-.0433	.0052	.0181	-.0194
1.194	6.96	-.02	.0331	-.0673	-.0599	.0090	.0175	-.0254
1.200	9.02	-.03	.0411	-.0963	-.0708	.0098	.0165	-.0263
.899	1.06	-.03	-.0003	.0059	-.0099	-.0003	.0059	-.0099
.904	2.04	.01	.0135	-.0215	-.0311	.0050	.0054	-.0186
.901	2.99	-.02	.0250	-.0438	-.0488	.0086	.0061	-.0243
.899	5.04	-.04	.0451	-.0945	-.0782	.0153	.0068	-.0350
.901	7.02	-.04	.0604	-.1437	-.1002	.0178	.0068	-.0392
.601	1.02	.03	.0079	.0067	-.0180	.0079	.0067	-.0180
.601	2.00	-.03	.0344	-.0520	-.0573	.0159	.0067	-.0305
.601	3.04	-.03	.0564	-.1075	-.0904	.0187	.0077	-.0343
.601	3.52	-.03	.0655	-.1338	-.1032	.0207	.0081	-.0373
.601	5.05	-.03	.0919	-.2186	-.1418	.0250	.0089	-.0449

(b) Afterbody and nozzle

MACH	NPR	ALPHA	CLAFT	CDAFT	CMAFT	CLN	CDN	CMN
1.199	.91	.02	-.0080	.0086	.0078	.0004	.0094	-.0047
1.200	3.02	-.02	-.0067	.0087	.0064	.0057	.0089	-.0152
1.200	4.97	-.02	-.0055	.0087	.0053	.0107	.0094	-.0246
1.194	6.96	-.02	-.0044	.0087	.0041	.0134	.0088	-.0295
1.200	9.02	-.03	-.0035	.0086	.0030	.0133	.0079	-.0293
.899	1.06	-.03	-.0011	.0056	-.0007	.0008	.0003	-.0092
.904	2.04	.01	.0006	.0050	-.0032	.0044	.0004	-.0154
.901	2.99	-.02	.0014	.0049	-.0044	.0072	.0011	-.0199
.899	5.04	-.04	.0030	.0048	-.0066	.0123	.0020	-.0284
.901	7.02	-.04	.0040	.0046	-.0081	.0138	.0022	-.0311
.601	1.02	.03	.0015	.0051	-.0040	.0064	.0016	-.0140
.601	2.00	-.03	.0039	.0048	-.0073	.0120	.0020	-.0232
.601	3.04	-.03	.0049	.0048	-.0087	.0138	.0029	-.0256
.601	3.52	-.03	.0055	.0048	-.0096	.0152	.0033	-.0277
.601	5.05	-.03	.0071	.0048	-.0117	.0179	.0040	-.0332

Table 9. Longitudinal Aerodynamic Characteristics for A/B Nozzle With 25/25 A/B Sidewalls and $\delta_{v,p} = 15°$

(a) Total aft end

MACH	NPR	ALPHA	CLT	C(D-F)	CMT	CL	CD	CM
1.200	.91	.00	-.0060	.0168	.0003	-.0060	.0168	.0003
1.200	3.02	.00	.0079	-.0119	-.0217	-.0010	.0168	-.0089
1.201	5.04	-.02	.0219	-.0396	-.0439	.0055	.0174	-.0201
1.201	7.04	-.04	.0334	-.0681	-.0615	.0096	.0170	-.0269
1.200	9.01	-.03	.0420	-.0971	-.0735	.0107	.0157	-.0282
1.199	.93	-2.02	-.0178	.0174	.0083	-.0178	.0174	.0083
1.202	.90	-.03	-.0070	.0171	.0007	-.0070	.0171	.0007
1.200	.88	3.01	.0091	.0195	-.0116	.0092	.0195	-.0116
1.198	.86	6.00	.0275	.0240	-.0276	.0276	.0240	-.0276
1.201	.80	9.02	.0412	.0317	-.0401	.0413	.0317	-.0401
1.203	.74	12.02	.0589	.0413	-.0610	.0590	.0413	-.0610
1.200	.64	16.01	.0780	.0543	-.0834	.0781	.0543	-.0834
1.203	.61	18.00	.0894	.0621	-.0976	.0895	.0622	-.0976
1.200	7.02	-2.02	.0208	-.0684	-.0561	-.0001	.0173	-.0216
1.198	7.00	.00	.0337	-.0674	-.0620	.0099	.0174	-.0275
1.199	7.01	3.02	.0519	-.0646	-.0695	.0237	.0188	-.0349
1.200	7.02	6.00	.0727	-.0591	-.0817	.0401	.0229	-.0471
1.199	7.02	8.98	.0888	-.0501	-.0921	.0520	.0301	-.0575
1.199	7.02	11.99	.1070	-.0403	-.1073	.0660	.0379	-.0727
.901	1.07	-.02	.0018	.0051	-.0090	.0018	.0051	-.0090
.898	2.03	-.02	.0120	-.0230	-.0243	.0039	.0044	-.0129
.901	3.00	-.03	.0256	-.0447	-.0462	.0100	.0057	-.0238
.901	5.01	-.03	.0463	-.0936	-.0782	.0174	.0070	-.0362
.900	7.04	-.04	.0639	-.1444	-.1040	.0214	.0071	-.0424
.899	1.07	-2.01	.0009	.0048	-.0096	.0008	.0048	-.0096
.902	1.07	.02	.0003	.0051	-.0086	.0003	.0051	-.0086
.899	1.06	3.01	.0062	.0052	-.0103	.0062	.0052	-.0103
.902	1.06	6.00	.0040	.0051	-.0081	.0040	.0051	-.0081
.903	1.07	8.99	.0098	.0069	-.0136	.0099	.0069	-.0136
.900	1.06	12.02	.0258	.0127	-.0240	.0259	.0127	-.0240
.899	1.03	16.03	.0436	.0254	-.0393	.0437	.0254	-.0393
.898	1.01	18.00	.0521	.0332	-.0463	.0522	.0333	-.0463
.901	5.03	-2.04	.0406	-.0958	-.0784	.0151	.0061	-.0363
.900	5.01	.01	.0449	-.0941	-.0778	.0159	.0066	-.0358
.900	5.00	2.97	.0546	-.0913	-.0790	.0204	.0075	-.0371
.900	5.00	5.99	.0569	-.0888	-.0768	.0177	.0081	-.0349
.898	4.99	8.99	.0701	-.0840	-.0818	.0257	.0109	-.0398
.898	4.99	11.99	.0891	-.0752	-.0927	.0399	.0172	-.0507
.898	4.99	15.98	.1179	-.0572	-.1126	.0623	.0316	-.0706
.899	5.00	18.00	.1284	-.0472	-.1210	.0699	.0395	-.0790

Table 9. Continued

(a) Continued

MACH	NPR	ALPHA	CLT	C(D-F)	CMT	CL	CD	CM
.600	1.02	.01	.0067	.0057	-.0167	.0067	.0057	-.0167
.601	1.99	-.04	.0273	-.0544	-.0448	.0101	.0045	-.0209
.600	3.00	-.03	.0528	-.1076	-.0838	.0176	.0067	-.0329
.600	3.50	-.04	.0623	-.1344	-.0982	.0198	.0065	-.0366
.601	5.01	-.04	.0911	-.2165	-.1409	.0263	.0088	-.0469
.600	1.03	-2.02	.0060	.0053	-.0163	.0060	.0053	-.0163
.598	1.02	-.02	.0097	.0056	-.0177	.0097	.0056	-.0177
.600	1.02	2.99	.0121	.0067	-.0185	.0121	.0067	-.0185
.600	1.02	5.99	.0165	.0085	-.0218	.0166	.0085	-.0218
.603	1.01	9.02	.0215	.0109	-.0261	.0216	.0109	-.0261
.600	1.01	12.00	.0266	.0137	-.0315	.0267	.0137	-.0315
.599	1.00	15.99	.0420	.0221	-.0447	.0421	.0221	-.0447
.601	.99	18.01	.0502	.0280	-.0512	.0503	.0280	-.0512
.598	3.49	-2.04	.0572	-.1366	-.0976	.0194	.0064	-.0357
.600	3.52	-.02	.0644	-.1351	-.0994	.0215	.0075	-.0374
.603	3.52	3.00	.0748	-.1302	-.1010	.0249	.0088	-.0395
.601	3.51	6.01	.0862	-.1257	-.1047	.0290	.0108	-.0431
.601	3.51	8.98	.0981	-.1200	-.1096	.0339	.0134	-.0479
.600	3.51	12.00	.1105	-.1126	-.1160	.0392	.0174	-.0542
.600	3.51	15.99	.1371	-.0978	-.1326	.0570	.0268	-.0708
.597	3.50	17.96	.1514	-.0896	-.1413	.0665	.0328	-.0790
.601	.98	20.00	.0543	.0326	-.0557	.0544	.0326	-.0557
.599	2.03	19.97	.0989	-.0179	-.0960	.0611	.0334	-.0707
.600	3.01	19.95	.1370	-.0596	-.1293	.0648	.0361	-.0783
.600	3.51	19.96	.1565	-.0820	-.1456	.0676	.0374	-.0836
.599	5.00	19.95	.2120	-.1488	-.1902	.0734	.0420	-.0956
.600	1.00	16.52	.0392	.0219	-.0452	.0394	.0219	-.0452
.599	.99	17.97	.0446	.0256	-.0492	.0448	.0256	-.0492
.597	.98	19.96	.0519	.0317	-.0555	.0520	.0317	-.0555
.600	.97	23.97	.0701	.0487	-.0752	.0702	.0487	-.0752
.601	.95	27.96	.0885	.0691	-.0995	.0887	.0692	-.0995
.600	.92	31.96	.1065	.0964	-.1343	.1067	.0965	-.1343
.598	3.49	16.15	.1312	-.0999	-.1310	.0506	.0244	-.0690
.601	3.50	17.95	.1431	-.0903	-.1373	.0595	.0303	-.0759
.598	3.49	19.97	.1557	-.0817	-.1453	.0674	.0366	-.0835
.600	3.49	23.98	.1834	-.0564	-.1683	.0875	.0550	-.1068
.600	3.49	27.95	.2075	-.0282	-.1926	.1040	.0763	-.1310
.601	3.50	31.97	.2333	.0098	-.2326	.1231	.1066	-.1712

Table 9. Continued

(a) Concluded

MACH	NPR	ALPHA	CLT	C(D-F)	CMT	CL	CD	CM
.150	1.00	.01	.0381	.0067	-.0327	.0381	.0067	-.0327
.151	2.01	-.03	.3226	-.9357	-.4342	.0426	.0145	-.0446
.151	2.60	-.03	.5032	-1.4329	-.7190	.0416	.0297	-.0520
.151	3.04	-.01	.5978	-1.8054	-.8609	.0340	.0265	-.0462
.150	3.76	.00	.7907	-2.4841	-1.1401	.0446	.0188	-.0615
.152	1.00	-1.59	.0037	.0039	-.0187	.0037	.0039	-.0187
.150	1.00	-.01	.0069	.0021	-.0176	.0069	.0021	-.0176
.151	1.00	3.00	.0094	.0036	-.0196	.0095	.0036	-.0196
.150	1.00	6.00	.0100	.0022	-.0192	.0100	.0022	-.0192
.151	1.00	8.99	.0265	.0204	-.0290	.0265	.0204	-.0290
.151	1.00	11.99	.0318	.0253	-.0333	.0319	.0253	-.0333
.150	1.00	16.01	.0454	.0338	-.0459	.0455	.0339	-.0459
.151	1.00	18.00	.0570	.0415	-.0570	.0572	.0415	-.0570
.150	2.61	-1.96	.4407	-1.4704	-.7199	.0228	.0292	-.0434
.150	2.62	-.03	.4888	-1.4546	-.7189	.0211	.0289	-.0433
.151	2.62	3.00	.5685	-1.4201	-.7168	.0260	.0290	-.0446
.150	2.61	5.99	.6488	-1.3950	-.7221	.0289	.0294	-.0472
.150	2.61	8.99	.7235	-1.3563	-.7258	.0292	.0349	-.0503
.150	2.62	12.00	.8115	-1.3211	-.7373	.0415	.0387	-.0585
.149	2.61	15.98	.9226	-1.2663	-.7595	.0519	.0490	-.0741
.149	2.61	17.86	.9750	-1.2313	-.7691	.0601	.0568	-.0827
.149	1.00	20.02	.0456	.0299	-.0483	.0457	.0300	-.0483
.149	2.01	19.99	.6358	-.7864	-.4466	.0359	.0270	-.0494
.152	2.63	19.97	.9586	-1.1737	-.7178	.0313	.0358	-.0562
.153	3.01	19.96	1.1527	-1.4304	-.8519	.0418	.0385	-.0680
.148	3.80	19.96	1.6637	-2.1388	-1.2027	.0456	.0459	-.0818
.149	1.00	15.98	.0164	.0196	-.0349	.0165	.0197	-.0349
.152	1.00	17.96	.0288	.0227	-.0458	.0289	.0227	-.0458
.149	1.00	19.97	.0395	.0303	-.0512	.0397	.0304	-.0512
.150	1.00	23.98	.0627	.0452	-.0664	.0629	.0453	-.0664
.147	1.00	27.97	.0822	.0643	-.0871	.0824	.0644	-.0871
.148	1.00	31.96	.1044	.0921	-.1149	.1046	.0922	-.1149
.151	1.00	34.98	.1124	.1085	-.1321	.1126	.1086	-.1321
.149	2.59	15.97	.9017	-1.2614	-.7492	.0367	.0444	-.0675
.149	2.59	17.97	.9496	-1.2232	-.7563	.0424	.0474	-.0768
.148	2.59	19.97	1.0036	-1.1961	-.7635	.0459	.0507	-.0791
.151	2.59	23.97	1.0624	-1.0811	-.7481	.0548	.0570	-.0866
.151	2.59	27.98	1.1614	-.9947	-.7687	.0746	.0722	-.1060
.151	2.59	31.97	1.2535	-.8971	-.7965	.0921	.0943	-.1320
.150	2.59	34.96	1.3192	-.8259	-.8207	.0989	.1101	-.1515

Table 9. Continued

(b) Afterbody and nozzle

MACH	NPR	ALPHA	CLAFT	CDAFT	CMAFT	CLN	CDN	CMN
1.200	.91	.00	-.0083	.0084	.0081	.0024	.0084	-.0078
1.200	3.02	.00	-.0071	.0085	.0068	.0061	.0083	-.0157
1.201	5.04	-.02	-.0060	.0085	.0057	.0115	.0088	-.0258
1.201	7.04	-.04	-.0048	.0085	.0045	.0144	.0085	-.0314
1.200	9.01	-.03	-.0037	.0084	.0032	.0144	.0073	-.0314
1.199	.93	-2.02	-.0166	.0092	.0149	-.0012	.0082	-.0067
1.202	.90	-.03	-.0081	.0086	.0077	.0011	.0085	-.0070
1.200	.88	3.01	.0046	.0092	-.0031	.0046	.0103	-.0085
1.198	.86	6.00	.0191	.0115	-.0167	.0085	.0125	-.0109
1.201	.80	9.02	.0303	.0154	-.0298	.0110	.0163	-.0104
1.203	.74	12.02	.0421	.0201	-.0435	.0169	.0212	-.0175
1.200	.64	16.01	.0546	.0269	-.0572	.0236	.0274	-.0262
1.203	.61	18.00	.0617	.0312	-.0660	.0277	.0310	-.0316
1.200	7.02	-2.02	-.0130	.0091	.0113	.0130	.0082	-.0329
1.198	7.00	.00	-.0044	.0087	.0040	.0143	.0087	-.0315
1.199	7.01	3.02	.0081	.0095	-.0067	.0156	.0093	-.0282
1.200	7.02	6.00	.0222	.0119	-.0201	.0179	.0109	-.0269
1.199	7.02	8.98	.0324	.0160	-.0321	.0196	.0141	-.0254
1.199	7.02	11.99	.0434	.0206	-.0446	.0227	.0173	-.0280
.901	1.07	-.02	-.0013	.0055	-.0004	.0031	-.0004	-.0086
.898	2.03	-.02	-.0001	.0050	-.0021	.0040	-.0006	-.0108
.901	3.00	-.03	.0013	.0049	-.0043	.0087	.0008	-.0195
.901	5.01	-.03	.0030	.0047	-.0067	.0144	.0023	-.0295
.900	7.04	-.04	.0042	.0044	-.0084	.0172	.0027	-.0340
.899	1.07	-2.01	.0001	.0054	-.0019	.0008	-.0006	-.0077
.902	1.07	.02	-.0012	.0055	-.0005	.0015	-.0004	-.0080
.899	1.06	3.01	-.0024	.0056	.0012	.0085	-.0004	-.0115
.902	1.06	6.00	-.0036	.0054	.0028	.0076	-.0003	-.0109
.903	1.07	8.99	-.0019	.0057	.0027	.0118	.0012	-.0163
.900	1.06	12.02	.0031	.0076	.0002	.0228	.0051	-.0242
.899	1.03	16.03	.0181	.0151	-.0110	.0256	.0103	-.0283
.898	1.01	18.00	.0227	.0193	-.0150	.0295	.0140	-.0313
.901	5.03	-2.04	.0044	.0045	-.0084	.0106	.0017	-.0279
.900	5.01	.01	.0029	.0048	-.0066	.0129	.0018	-.0292
.900	5.00	2.97	.0020	.0050	-.0052	.0184	.0025	-.0319
.900	5.00	5.99	.0014	.0051	-.0041	.0163	.0030	-.0308
.898	4.99	8.99	.0037	.0058	-.0041	.0220	.0051	-.0357
.898	4.99	11.99	.0097	.0084	-.0081	.0302	.0088	-.0426
.898	4.99	15.98	.0243	.0162	-.0196	.0381	.0154	-.0510
.899	5.00	18.00	.0295	.0209	-.0248	.0404	.0186	-.0542

Table 9. Continued

(b) Continued

MACH	NPR	ALPHA	CLAFT	CDAFT	CMAFT	CLN	CDN	CMN
.600	1.02	.01	.0012	.0052	-.0039	.0055	.0004	-.0129
.601	1.99	-.04	.0028	.0049	-.0060	.0073	-.0004	-.0149
.600	3.00	-.03	.0047	.0049	-.0086	.0129	.0017	-.0243
.600	3.50	-.04	.0053	.0049	-.0095	.0145	.0016	-.0271
.601	5.01	-.04	.0074	.0049	-.0124	.0189	.0039	-.0345
.600	1.03	-2.02	.0000	.0050	-.0030	.0060	.0003	-.0132
.598	1.02	-.02	.0014	.0051	-.0040	.0083	.0006	-.0137
.600	1.02	2.99	.0030	.0054	-.0050	.0091	.0013	-.0135
.600	1.02	5.99	.0048	.0059	-.0064	.0117	.0026	-.0154
.603	1.01	9.02	.0074	.0067	-.0088	.0142	.0042	-.0173
.600	1.01	12.00	.0102	.0079	-.0120	.0165	.0058	-.0196
.599	1.00	15.99	.0199	.0119	-.0214	.0221	.0102	-.0233
.601	.99	18.01	.0251	.0148	-.0258	.0253	.0132	-.0254
.598	3.49	-2.04	.0042	.0046	-.0088	.0152	.0018	-.0269
.600	3.52	-.02	.0054	.0048	-.0096	.0161	.0027	-.0278
.603	3.52	3.00	.0073	.0053	-.0109	.0176	.0034	-.0286
.601	3.51	6.01	.0094	.0061	-.0126	.0196	.0047	-.0305
.601	3.51	8.98	.0120	.0071	-.0153	.0219	.0062	-.0326
.600	3.51	12.00	.0148	.0087	-.0185	.0244	.0087	-.0357
.600	3.51	15.99	.0257	.0134	-.0291	.0313	.0134	-.0417
.597	3.50	17.96	.0310	.0166	-.0339	.0355	.0162	-.0451
.601	.98	20.00	.0275	.0173	-.0292	.0270	.0153	-.0265
.599	2.03	19.97	.0306	.0183	-.0336	.0305	.0151	-.0371
.600	3.01	19.95	.0320	.0189	-.0358	.0328	.0171	-.0425
.600	3.51	19.96	.0331	.0193	-.0373	.0346	.0180	-.0462
.599	5.00	19.95	.0355	.0203	-.0409	.0378	.0216	-.0547
.600	1.00	16.52	.0198	.0123	-.0226	.0196	.0096	-.0226
.599	.99	17.97	.0229	.0141	-.0251	.0218	.0115	-.0241
.597	.98	19.96	.0273	.0173	-.0293	.0247	.0144	-.0262
.600	.97	23.97	.0416	.0277	-.0453	.0286	.0211	-.0299
.601	.95	27.96	.0556	.0409	-.0646	.0332	.0282	-.0349
.600	.92	31.96	.0730	.0600	-.0936	.0337	.0365	-.0407
.598	3.49	16.15	.0242	.0132	-.0290	.0264	.0112	-.0400
.601	3.50	17.95	.0283	.0158	-.0324	.0313	.0145	-.0435
.598	3.49	19.97	.0328	.0192	-.0371	.0346	.0173	-.0463
.600	3.49	23.98	.0485	.0308	-.0550	.0390	.0242	-.0518
.600	3.49	27.95	.0612	.0440	-.0731	.0428	.0324	-.0579
.601	3.50	31.97	.0792	.0644	-.1037	.0439	.0422	-.0675

Table 9. Concluded

(b) Concluded

MACH	NPR	ALPHA	CLAFT	CDAFT	CMAFT	CLN	CDN	CMN
.150	1.00	.01	.0030	.0058	-.0064	.0351	.0008	-.0263
.151	2.01	-.03	.0063	.0067	-.0111	.0363	.0078	-.0335
.151	2.60	-.03	.0094	.0075	-.0150	.0322	.0221	-.0369
.151	3.04	-.01	.0090	.0076	-.0146	.0249	.0188	-.0316
.150	3.76	.00	.0118	.0084	-.0182	.0327	.0104	-.0434
.152	1.00	-1.59	.0019	.0069	-.0068	.0018	-.0030	-.0119
.150	1.00	-.01	.0029	.0066	-.0077	.0039	-.0045	-.0099
.151	1.00	3.00	.0064	.0073	-.0109	.0031	-.0036	-.0087
.150	1.00	6.00	.0050	.0071	-.0077	.0050	-.0048	-.0115
.151	1.00	8.99	.0088	.0082	-.0117	.0177	.0123	-.0173
.151	1.00	11.99	.0126	.0095	-.0160	.0193	.0158	-.0174
.150	1.00	16.01	.0178	.0118	-.0211	.0277	.0221	-.0247
.151	1.00	18.00	.0270	.0160	-.0314	.0301	.0256	-.0256
.150	2.61	-1.96	.0062	.0075	-.0106	.0166	.0216	-.0328
.150	2.62	-.03	.0084	.0076	-.0127	.0127	.0213	-.0306
.151	2.62	3.00	.0067	.0080	-.0096	.0193	.0209	-.0350
.150	2.61	5.99	.0095	.0088	-.0119	.0194	.0206	-.0353
.150	2.61	8.99	.0114	.0097	-.0133	.0179	.0253	-.0369
.150	2.62	12.00	.0152	.0113	-.0178	.0263	.0274	-.0406
.149	2.61	15.98	.0222	.0147	-.0266	.0296	.0344	-.0476
.149	2.61	17.86	.0311	.0190	-.0369	.0290	.0378	-.0458
.149	1.00	20.02	.0247	.0167	-.0282	.0210	.0133	-.0201
.149	2.01	19.99	.0274	.0190	-.0321	.0085	.0080	-.0173
.152	2.63	19.97	.0275	.0200	-.0336	.0038	.0158	-.0226
.153	3.01	19.96	.0276	.0202	-.0344	.0142	.0182	-.0336
.148	3.80	19.96	.0310	.0229	-.0404	.0146	.0230	-.0413
.149	1.00	15.98	.0173	.0126	-.0234	-.0008	.0071	-.0115
.152	1.00	17.96	.0221	.0145	-.0285	.0069	.0082	-.0173
.149	1.00	19.97	.0259	.0169	-.0315	.0138	.0135	-.0197
.150	1.00	23.98	.0300	.0219	-.0335	.0329	.0233	-.0328
.147	1.00	27.97	.0432	.0329	-.0502	.0391	.0315	-.0369
.148	1.00	31.96	.0550	.0461	-.0678	.0495	.0461	-.0471
.151	1.00	34.98	.0638	.0574	-.0829	.0487	.0512	-.0493
.149	2.59	15.97	.0198	.0143	-.0248	.0169	.0301	-.0427
.149	2.59	17.97	.0234	.0157	-.0286	.0190	.0317	-.0482
.148	2.59	19.97	.0295	.0191	-.0353	.0165	.0317	-.0439
.151	2.59	23.97	.0317	.0235	-.0358	.0231	.0335	-.0508
.151	2.59	27.98	.0462	.0356	-.0537	.0284	.0366	-.0522
.151	2.59	31.97	.0570	.0494	-.0707	.0350	.0450	-.0613
.150	2.59	34.96	.0667	.0623	-.0877	.0322	.0478	-.0638

Table 10. Longitudinal Aerodynamic Characteristics for A/B Nozzle With 100/25 A/B Sidewalls and $\delta_{v,p} = 0°$

(a) Total aft end

MACH	NPR	ALPHA	CLT	C(D-F)	CMT	CL	CD	CM
1.201	.95	-.01	-.0095	.0175	.0058	-.0095	.0175	.0058
1.198	3.01	.00	-.0086	-.0147	.0065	-.0086	.0165	.0035
1.198	5.00	.01	-.0106	-.0452	.0122	-.0106	.0159	.0062
1.200	6.98	.02	-.0110	-.0762	.0159	-.0110	.0144	.0069
1.200	9.01	.01	-.0111	-.1084	.0190	-.0112	.0128	.0069
1.203	.95	-2.02	-.0221	.0191	.0139	-.0221	.0191	.0139
1.199	.93	.00	-.0105	.0180	.0055	-.0105	.0180	.0055
1.200	.91	3.02	.0053	.0187	-.0062	.0054	.0187	-.0062
1.201	.89	6.00	.0216	.0222	-.0199	.0216	.0222	-.0199
1.201	.87	9.02	.0349	.0288	-.0310	.0350	.0288	-.0310
1.198	.81	12.01	.0468	.0378	-.0453	.0469	.0378	-.0453
1.200	.75	15.99	.0623	.0475	-.0618	.0624	.0475	-.0618
1.198	.70	18.01	.0723	.0543	-.0730	.0724	.0543	-.0730
1.201	7.00	-2.03	-.0262	-.0752	.0226	-.0230	.0155	.0136
1.201	7.00	-.01	-.0120	-.0763	.0161	-.0120	.0145	.0071
1.200	7.00	3.00	.0066	-.0759	.0091	.0019	.0149	.0000
1.200	7.00	6.03	.0271	-.0726	-.0020	.0175	.0178	-.0110
1.200	6.99	9.01	.0461	-.0663	-.0143	.0320	.0235	-.0233
1.201	7.01	12.00	.0637	-.0582	-.0286	.0449	.0308	-.0377
1.196	6.96	16.02	.0870	-.0469	-.0466	.0620	.0406	-.0557
1.199	6.99	18.00	.0995	-.0405	-.0571	.0715	.0460	-.0661
.903	1.09	.00	-.0075	.0035	.0050	-.0075	.0035	.0050
.902	2.00	-.02	-.0070	-.0258	.0075	-.0070	.0027	.0049
.901	3.03	-.01	-.0076	-.0518	.0111	-.0076	.0038	.0057
.898	5.03	.00	-.0075	-.1062	.0165	-.0075	.0033	.0057
.900	7.03	.02	-.0084	-.1605	.0224	-.0085	.0020	.0062
.899	1.11	-2.02	-.0070	.0034	.0034	-.0071	.0034	.0034
.902	1.09	-.02	-.0076	.0036	.0050	-.0076	.0036	.0050
.901	1.09	2.98	-.0043	.0031	.0057	-.0043	.0031	.0057
.900	1.10	6.00	-.0061	.0024	.0076	-.0061	.0025	.0076
.902	1.10	9.01	-.0034	.0027	.0074	-.0034	.0028	.0074
.900	1.10	11.99	.0136	.0076	-.0031	.0136	.0076	-.0031
.899	1.09	16.00	.0284	.0174	-.0146	.0285	.0174	-.0146
.898	1.08	18.00	.0364	.0249	-.0217	.0365	.0249	-.0217
.899	4.99	-2.04	-.0130	-.1051	.0156	-.0091	.0032	.0049
.902	5.01	-.03	-.0095	-.1051	.0169	-.0095	.0030	.0063
.901	5.00	2.98	-.0005	-.1056	.0171	-.0061	.0025	.0064
.896	4.98	6.02	.0034	-.1062	.0193	-.0079	.0021	.0085
.901	5.01	9.00	.0127	-.1045	.0185	-.0042	.0024	.0078
.899	4.99	12.01	.0352	-.0990	.0077	.0127	.0072	-.0030
.899	4.99	16.03	.0595	-.0867	-.0067	.0296	.0175	-.0174
.901	5.00	17.99	.0717	-.0781	-.0149	.0384	.0249	-.0256

Table 10. Continued

(a) Concluded

MACH	NPR	ALPHA	CLT	C(D-F)	CMT	CL	CD	CM
.600	1.03	.00	-.0076	.0049	.0040	-.0076	.0049	.0040
.603	2.01	.02	-.0058	-.0603	.0093	-.0058	.0040	.0034
.598	2.99	.02	-.0058	-.1193	.0159	-.0059	.0051	.0039
.597	3.50	.02	-.0055	-.1501	.0190	-.0055	.0051	.0038
.600	5.00	.02	-.0051	-.2399	.0275	-.0052	.0044	.0035
.599	1.03	-1.89	-.0069	.0043	.0037	-.0069	.0043	.0037
.601	1.03	-.02	-.0042	.0041	.0031	-.0042	.0041	.0031
.604	1.03	3.00	-.0015	.0042	.0029	-.0015	.0042	.0029
.601	1.03	6.01	.0017	.0049	.0015	.0018	.0049	.0015
.601	1.03	9.00	.0058	.0059	-.0013	.0059	.0059	-.0013
.599	1.03	12.00	.0106	.0076	-.0059	.0106	.0076	-.0059
.600	1.03	15.99	.0258	.0139	-.0181	.0259	.0140	-.0181
.598	1.02	18.00	.0342	.0191	-.0239	.0343	.0191	-.0239
.599	3.48	-1.83	-.0103	-.1486	.0191	-.0055	.0047	.0042
.602	3.54	-.02	-.0037	-.1502	.0184	-.0036	.0045	.0033
.600	3.50	2.98	.0071	-.1489	.0176	-.0008	.0045	.0026
.599	3.50	6.03	.0180	-.1479	.0165	.0019	.0051	.0015
.600	3.50	9.00	.0301	-.1455	.0130	.0062	.0059	-.0019
.603	3.51	12.01	.0428	-.1413	.0078	.0111	.0078	-.0070
.598	3.49	15.98	.0697	-.1339	-.0059	.0274	.0143	-.0209
.600	3.50	18.01	.0836	-.1267	-.0127	.0363	.0193	-.0277
.151	1.00	.00	-.0062	.0192	-.0015	-.0062	.0192	-.0015
.149	1.99	.01	.0045	-1.0258	.0894	.0044	.0018	-.0042
.150	2.61	.02	.0018	-1.5807	.1525	.0013	.0201	.0003
.150	3.00	.02	.0026	-1.9654	.1917	.0021	.0145	.0011
.152	3.79	.02	.0047	-2.6482	.2583	.0040	.0125	-.0019
.151	1.03	-1.53	-.0002	-.0019	-.0008	-.0002	-.0019	-.0008
.151	1.00	.03	.0271	.0085	-.0109	.0271	.0085	-.0109
.151	1.00	2.99	.0289	.0086	-.0102	.0289	.0086	-.0102
.150	1.00	5.99	.0326	.0103	-.0102	.0327	.0103	-.0102
.149	1.00	8.98	.0344	.0150	-.0128	.0344	.0150	-.0128
.149	1.00	11.99	.0404	.0217	-.0185	.0405	.0217	-.0185
.151	1.00	15.99	.0534	.0286	-.0297	.0535	.0286	-.0297
.151	1.00	18.00	.0585	.0366	-.0377	.0586	.0366	-.0377
.149	2.61	-1.55	-.0264	-1.6118	.1534	.0178	.0167	-.0014
.151	2.61	.02	.0181	-1.5804	.1493	.0176	.0164	-.0024
.151	2.61	2.98	.0986	-1.5734	.1501	.0155	.0207	-.0016
.151	2.61	5.99	.1803	-1.5564	.1495	.0151	.0190	-.0010
.151	2.61	9.01	.2752	-1.5474	.1448	.0261	.0237	-.0064
.150	2.61	11.99	.3625	-1.5447	.1431	.0289	.0267	-.0096
.150	2.61	15.99	.4893	-1.5211	.1312	.0432	.0356	-.0227
.151	2.61	17.99	.5489	-1.4790	.1178	.0547	.0437	-.0343

Table 10. Continued

(b) Afterbody and nozzle

MACH	NPR	ALPHA	CLAFT	CDAFT	CMAFT	CLN	CDN	CMN
1.201	.95	-.01	-.0086	.0084	.0083	-.0009	.0091	-.0024
1.198	3.01	.00	-.0084	.0086	.0080	-.0002	.0079	-.0045
1.198	5.00	.01	-.0084	.0086	.0080	-.0022	.0073	-.0018
1.200	6.98	.02	-.0084	.0086	.0080	-.0026	.0058	-.0011
1.200	9.01	.01	-.0085	.0086	.0080	-.0027	.0041	-.0011
1.203	.95	-2.02	-.0169	.0093	.0149	-.0052	.0098	-.0010
1.199	.93	.00	-.0083	.0087	.0079	-.0022	.0093	-.0024
1.200	.91	3.02	.0038	.0093	-.0023	.0016	.0094	-.0039
1.201	.89	6.00	.0180	.0116	-.0159	.0036	.0107	-.0040
1.201	.87	9.02	.0301	.0151	-.0287	.0049	.0137	-.0023
1.198	.81	12.01	.0403	.0198	-.0416	.0065	.0181	-.0038
1.200	.75	15.99	.0528	.0264	-.0553	.0096	.0211	-.0066
1.198	.70	18.01	.0603	.0308	-.0637	.0121	.0235	-.0092
1.201	7.00	-2.03	-.0169	.0094	.0150	-.0061	.0061	-.0013
1.201	7.00	-.01	-.0083	.0088	.0077	-.0037	.0057	-.0006
1.200	7.00	3.00	.0036	.0093	-.0023	-.0018	.0056	.0024
1.200	7.00	6.03	.0181	.0116	-.0161	-.0005	.0062	.0051
1.200	6.99	9.01	.0301	.0153	-.0288	.0018	.0083	.0055
1.201	7.01	12.00	.0406	.0198	-.0418	.0043	.0110	.0041
1.196	6.96	16.02	.0530	.0267	-.0556	.0090	.0139	-.0001
1.199	6.99	18.00	.0605	.0309	-.0642	.0109	.0152	-.0020
.903	1.09	.00	-.0033	.0058	.0028	-.0042	-.0023	.0021
.902	2.00	-.02	-.0034	.0053	.0030	-.0036	-.0026	.0019
.901	3.03	-.01	-.0034	.0054	.0030	-.0042	-.0016	.0027
.898	5.03	.00	-.0035	.0053	.0031	-.0040	-.0020	.0025
.900	7.03	.02	-.0035	.0051	.0032	-.0050	-.0031	.0031
.899	1.11	-2.02	-.0019	.0058	.0012	-.0052	-.0024	.0022
.902	1.09	-.02	-.0034	.0059	.0030	-.0042	-.0023	.0020
.901	1.09	2.98	-.0052	.0058	.0056	.0010	-.0026	.0001
.900	1.10	6.00	-.0060	.0055	.0067	.0000	-.0030	.0009
.902	1.10	9.01	-.0049	.0057	.0072	.0015	-.0029	.0002
.900	1.10	11.99	-.0005	.0071	.0053	.0141	.0005	-.0084
.899	1.09	16.00	.0140	.0140	-.0058	.0144	.0034	-.0088
.898	1.08	18.00	.0194	.0186	-.0100	.0171	.0063	-.0117
.899	4.99	-2.04	-.0021	.0053	.0014	-.0071	-.0021	.0035
.902	5.01	-.03	-.0034	.0054	.0030	-.0061	-.0023	.0033
.901	5.00	2.98	-.0052	.0052	.0056	-.0009	-.0027	.0008
.896	4.98	6.02	-.0053	.0050	.0062	-.0026	-.0029	.0023
.901	5.01	9.00	-.0045	.0051	.0069	.0003	-.0027	.0009
.899	4.99	12.01	-.0001	.0067	.0045	.0128	.0005	-.0075
.899	4.99	16.03	.0151	.0141	-.0072	.0145	.0034	-.0102
.901	5.00	17.99	.0205	.0187	-.0116	.0179	.0062	-.0139

Table 10. Concluded

(b) Concluded

MACH	NPR	ALPHA	CLAFT	CDAFT	CMAFT	CLN	CDN	CMN
.600	1.03	.00	-.0033	.0055	.0029	-.0042	-.0006	.0011
.603	2.01	.02	-.0033	.0051	.0030	-.0025	-.0011	.0005
.598	2.99	.02	-.0033	.0052	.0029	-.0026	-.0001	.0011
.597	3.50	.02	-.0033	.0052	.0029	-.0023	-.0001	.0009
.600	5.00	.02	-.0032	.0052	.0029	-.0020	-.0007	.0006
.599	1.03	-1.89	-.0037	.0055	.0028	-.0032	-.0012	.0009
.601	1.03	-.02	-.0031	.0054	.0028	-.0011	-.0012	.0003
.604	1.03	3.00	-.0019	.0054	.0024	.0005	-.0012	.0005
.601	1.03	6.01	-.0005	.0056	.0015	.0023	-.0007	.0000
.601	1.03	9.00	.0019	.0061	-.0008	.0039	-.0002	-.0006
.599	1.03	12.00	.0047	.0070	-.0038	.0059	.0006	-.0021
.600	1.03	15.99	.0147	.0106	-.0134	.0112	.0033	-.0047
.598	1.02	18.00	.0194	.0131	-.0172	.0149	.0059	-.0067
.599	3.48	-1.83	-.0037	.0051	.0029	-.0018	-.0004	.0013
.602	3.54	-.02	-.0031	.0050	.0030	-.0005	-.0006	.0004
.600	3.50	2.98	-.0018	.0051	.0024	.0010	-.0006	.0002
.599	3.50	6.03	-.0004	.0052	.0015	.0023	-.0001	.0000
.600	3.50	9.00	.0020	.0057	-.0007	.0042	.0003	-.0013
.603	3.51	12.01	.0053	.0067	-.0045	.0058	.0010	-.0026
.598	3.49	15.98	.0154	.0105	-.0143	.0119	.0038	-.0066
.600	3.50	18.01	.0206	.0132	-.0187	.0157	.0061	-.0090
.151	1.00	.00	-.0009	.0076	-.0019	-.0053	.0116	.0004
.149	1.99	.01	-.0014	.0078	-.0012	.0058	-.0059	-.0030
.150	2.61	.02	-.0024	.0076	.0002	.0037	.0125	.0001
.150	3.00	.02	-.0025	.0075	.0007	.0046	.0069	.0004
.152	3.79	.02	-.0018	.0079	.0003	.0059	.0046	-.0022
.151	1.03	-1.53	-.0022	.0055	.0015	.0020	-.0074	-.0023
.151	1.00	.03	-.0033	.0051	.0038	.0304	.0034	-.0147
.151	1.00	2.99	-.0017	.0050	.0025	.0306	.0036	-.0127
.150	1.00	5.99	-.0016	.0047	.0034	.0343	.0056	-.0136
.149	1.00	8.98	.0003	.0052	.0019	.0341	.0099	-.0147
.149	1.00	11.99	.0058	.0066	-.0044	.0347	.0151	-.0141
.151	1.00	15.99	.0143	.0098	-.0137	.0392	.0188	-.0160
.151	1.00	18.00	.0184	.0121	-.0179	.0402	.0246	-.0199
.149	2.61	-1.55	-.0022	.0065	.0023	.0200	.0102	-.0036
.151	2.61	.02	-.0019	.0061	.0022	.0195	.0103	-.0046
.151	2.61	2.98	-.0008	.0065	.0018	.0164	.0142	-.0034
.151	2.61	5.99	-.0024	.0060	.0045	.0175	.0129	-.0055
.151	2.61	9.01	.0007	.0068	.0011	.0254	.0169	-.0075
.150	2.61	11.99	.0046	.0076	-.0033	.0244	.0191	-.0062
.150	2.61	15.99	.0115	.0104	-.0104	.0317	.0252	-.0123
.151	2.61	17.99	.0157	.0126	-.0144	.0390	.0311	-.0199

Table 11. Lateral Aerodynamic Characteristics for A/B Nozzle With 100/25 A/B Sidewalls and $\delta_{v,p} = 0°$

MACH	NPR	ALPHA	CROLLT	CNT	CYT	CROLL	CN	CY
1.201	.95	-.01	.0000	.0009	-.0012	.0000	.0009	-.0012
1.198	3.01	.00	.0000	.0004	-.0009	.0000	.0007	-.0011
1.198	5.00	.01	.0001	.0021	-.0032	.0001	.0007	-.0009
1.200	6.98	.02	.0003	.0036	-.0054	.0003	.0006	-.0007
1.200	9.01	.01	.0004	.0052	-.0076	.0004	.0005	-.0004
1.203	.95	-2.02	.0000	.0009	-.0012	.0000	.0009	-.0012
1.199	.93	.00	.0001	.0010	-.0014	.0001	.0010	-.0014
1.200	.91	3.02	.0001	.0010	-.0020	.0001	.0010	-.0020
1.201	.89	6.00	.0002	.0009	-.0024	.0002	.0009	-.0024
1.201	.87	9.02	.0002	.0011	-.0024	.0002	.0011	-.0024
1.198	.81	12.01	.0001	.0001	-.0020	.0001	.0001	-.0020
1.200	.75	15.99	.0001	-.0004	-.0012	.0001	-.0004	-.0012
1.198	.70	18.01	.0001	-.0004	-.0011	.0001	-.0004	-.0011
1.201	7.00	-2.03	.0003	.0036	-.0054	.0003	.0005	-.0006
1.201	7.00	-.01	.0003	.0037	-.0056	.0003	.0007	-.0009
1.200	7.00	3.00	.0004	.0038	-.0060	.0004	.0008	-.0013
1.200	7.00	6.03	.0004	.0038	-.0063	.0004	.0007	-.0015
1.200	6.99	9.01	.0005	.0042	-.0068	.0005	.0011	-.0021
1.201	7.01	12.00	.0005	.0037	-.0075	.0005	.0007	-.0027
1.196	6.96	16.02	.0005	.0038	-.0076	.0005	.0008	-.0029
1.199	6.99	18.00	.0006	.0038	-.0076	.0006	.0007	-.0029
.903	1.09	.00	.0002	.0006	-.0024	.0002	.0006	-.0024
.902	2.00	-.02	.0001	-.0012	-.0002	.0001	.0000	-.0016
.901	3.03	-.01	.0001	-.0007	-.0010	.0001	-.0001	-.0013
.898	5.03	.00	.0004	.0024	-.0054	.0004	.0000	-.0013
.900	7.03	.02	.0006	.0054	-.0096	.0006	.0000	-.0012
.899	1.11	-2.02	.0002	.0006	-.0023	.0002	.0006	-.0023
.902	1.09	-.02	.0002	.0006	-.0023	.0002	.0006	-.0023
.901	1.09	2.98	.0002	.0006	-.0025	.0002	.0006	-.0025
.900	1.10	6.00	.0001	.0003	-.0019	.0001	.0003	-.0019
.902	1.10	9.01	.0001	.0002	-.0016	.0001	.0002	-.0016
.900	1.10	11.99	.0001	.0002	-.0017	.0001	.0002	-.0017
.899	1.09	16.00	.0001	.0000	-.0013	.0001	.0000	-.0013
.898	1.08	18.00	.0002	.0001	-.0020	.0002	.0001	-.0020
.899	4.99	-2.04	.0003	.0023	-.0050	.0003	-.0001	-.0010
.902	5.01	-.03	.0003	.0023	-.0050	.0003	-.0001	-.0010
.901	5.00	2.98	.0003	.0023	-.0050	.0003	-.0001	-.0010
.896	4.98	6.02	.0003	.0023	-.0052	.0003	-.0001	-.0012
.901	5.01	9.00	.0003	.0021	-.0046	.0003	-.0003	-.0006
.899	4.99	12.01	.0003	.0020	-.0044	.0003	-.0004	-.0004
.899	4.99	16.03	.0003	.0021	-.0047	.0003	-.0003	-.0007
.901	5.00	17.99	.0004	.0023	-.0055	.0004	-.0001	-.0015

Table 11. Concluded

MACH	NPR	ALPHA	CROLLT	CNT	CYT	CROLL	CN	CY
.600	1.03	.00	.0003	.0003	-.0020	.0003	.0003	-.0020
.603	2.01	.02	-.0001	-.0028	.0019	-.0001	-.0001	-.0012
.598	2.99	.02	.0000	-.0013	-.0006	.0000	-.0001	-.0014
.597	3.50	.02	.0002	.0005	-.0032	.0002	.0000	-.0016
.600	5.00	.02	.0007	.0056	-.0107	.0007	.0001	-.0017
.599	1.03	-1.89	.0003	.0003	-.0020	.0003	.0003	-.0020
.601	1.03	-.02	.0003	.0003	-.0022	.0003	.0003	-.0022
.604	1.03	3.00	.0003	.0004	-.0023	.0003	.0004	-.0023
.601	1.03	6.01	.0003	.0003	-.0022	.0003	.0003	-.0022
.601	1.03	9.00	.0003	.0001	-.0018	.0003	.0001	-.0018
.599	1.03	12.00	.0003	.0001	-.0021	.0003	.0001	-.0021
.600	1.03	15.99	.0002	.0003	-.0026	.0002	.0003	-.0026
.598	1.02	18.00	.0002	.0002	-.0027	.0002	.0002	-.0027
.599	3.48	-1.83	.0001	.0004	-.0033	.0001	.0001	-.0018
.602	3.54	-.02	.0002	.0006	-.0036	.0002	.0001	-.0018
.600	3.50	2.98	.0002	.0005	-.0036	.0002	.0001	-.0020
.599	3.50	6.03	.0002	.0005	-.0036	.0002	.0001	-.0020
.600	3.50	9.00	.0002	.0004	-.0033	.0002	.0000	-.0017
.603	3.51	12.01	.0002	.0005	-.0036	.0002	.0001	-.0020
.598	3.49	15.98	.0003	.0006	-.0041	.0003	.0002	-.0025
.600	3.50	18.01	.0003	.0008	-.0050	.0003	.0004	-.0034
.151	1.00	.00	.0026	.0042	-.0225	.0026	.0042	-.0225
.149	1.99	.01	-.0015	-.0420	.0294	-.0015	.0028	-.0217
.150	2.61	.02	-.0012	-.0333	.0142	-.0012	.0001	-.0177
.150	3.00	.02	-.0001	-.0162	-.0105	-.0001	.0041	-.0245
.152	3.79	.02	.0025	.0233	-.0649	.0025	.0018	-.0177
.151	1.03	-1.53	.0022	.0039	-.0192	.0022	.0039	-.0192
.151	1.00	.03	.0021	.0043	-.0211	.0021	.0043	-.0211
.151	1.00	2.99	.0020	.0038	-.0192	.0020	.0038	-.0192
.150	1.00	5.99	.0016	.0034	-.0161	.0016	.0034	-.0161
.149	1.00	8.98	.0016	.0033	-.0161	.0016	.0033	-.0161
.149	1.00	11.99	.0015	.0030	-.0143	.0015	.0030	-.0143
.151	1.00	15.99	.0014	.0027	-.0137	.0014	.0027	-.0137
.151	1.00	18.00	.0013	.0026	-.0121	.0013	.0026	-.0121
.149	2.61	-1.55	-.0018	-.0353	.0214	-.0018	-.0012	-.0112
.151	2.61	.02	-.0017	-.0345	.0210	-.0017	-.0012	-.0108
.151	2.61	2.98	-.0017	-.0344	.0209	-.0017	-.0012	-.0107
.151	2.61	5.99	-.0020	-.0345	.0226	-.0020	-.0016	-.0089
.151	2.61	9.01	-.0020	-.0352	.0244	-.0020	-.0021	-.0072
.150	2.61	11.99	-.0023	-.0355	.0263	-.0023	-.0021	-.0056
.150	2.61	15.99	-.0022	-.0357	.0250	-.0022	-.0019	-.0072
.151	2.61	17.99	-.0022	-.0350	.0246	-.0022	-.0017	-.0072

Table 12. Longitudinal Aerodynamic Characteristics for Dry Nozzle With 100/25 A/B Sidewalls and $\delta_{v,p} = 0°$

(a) Total aft end

MACH	NPR	ALPHA	CLT	C(D-F)	CMT	CL	CD	CM
1.200	.93	.01	-.0075	.0167	.0050	-.0075	.0167	.0050
1.200	2.96	.01	-.0077	-.0042	.0064	-.0077	.0166	.0044
1.200	5.01	.02	-.0087	-.0246	.0095	-.0088	.0171	.0056
1.202	7.06	.01	-.0103	-.0463	.0137	-.0104	.0163	.0080
1.200	8.96	.02	-.0102	-.0672	.0154	-.0102	.0150	.0078
1.201	.94	-2.01	-.0230	.0184	.0185	-.0230	.0184	.0185
1.202	.92	.01	-.0078	.0171	.0033	-.0078	.0171	.0033
1.202	.88	3.01	.0115	.0195	-.0142	.0115	.0195	-.0142
1.201	.84	6.00	.0311	.0250	-.0329	.0311	.0250	-.0329
1.200	.80	9.01	.0424	.0317	-.0408	.0424	.0317	-.0408
1.200	.77	11.99	.0570	.0401	-.0559	.0571	.0401	-.0559
1.202	.76	16.02	.0725	.0506	-.0704	.0726	.0506	-.0704
1.197	.76	18.00	.0810	.0571	-.0798	.0811	.0571	-.0798
1.202	7.03	-2.01	-.0213	-.0446	.0197	-.0191	.0177	.0140
1.202	7.06	.01	-.0088	-.0457	.0129	-.0088	.0169	.0071
1.201	7.00	3.03	.0094	-.0441	.0027	.0061	.0179	-.0030
1.200	6.99	5.99	.0292	-.0408	-.0095	.0228	.0209	-.0153
1.200	6.98	9.01	.0463	-.0333	-.0221	.0366	.0279	-.0278
1.201	6.99	12.00	.0649	-.0255	-.0378	.0521	.0352	-.0435
1.203	7.01	15.99	.0859	-.0146	-.0551	.0689	.0450	-.0608
1.199	6.98	17.98	.0981	-.0073	-.0662	.0791	.0517	-.0720
.899	1.10	-.03	-.0085	.0039	.0045	-.0085	.0039	.0045
.900	2.01	-.01	-.0090	-.0164	.0082	-.0090	.0031	.0062
.897	2.99	-.01	-.0081	-.0338	.0091	-.0081	.0038	.0055
.896	4.97	.00	-.0077	-.0701	.0123	-.0077	.0040	.0054
.902	7.01	.00	-.0076	-.1071	.0158	-.0076	.0033	.0056
.899	1.11	-2.03	-.0069	.0040	.0033	-.0069	.0040	.0033
.900	1.10	.03	-.0067	.0040	.0038	-.0067	.0040	.0038
.903	1.10	3.03	-.0016	.0038	.0036	-.0015	.0038	.0036
.901	1.10	6.00	-.0023	.0036	.0035	-.0022	.0036	.0035
.902	1.10	9.01	.0045	.0047	-.0023	.0046	.0047	-.0023
.901	1.10	11.99	.0200	.0099	-.0119	.0201	.0100	-.0119
.901	1.09	16.03	.0375	.0215	-.0254	.0376	.0215	-.0254
.900	1.06	18.00	.0423	.0277	-.0257	.0424	.0278	-.0257
.901	4.99	-2.02	-.0093	-.0695	.0102	-.0067	.0041	.0034
.900	4.99	.00	-.0072	-.0699	.0120	-.0072	.0038	.0051
.900	5.00	3.03	.0013	-.0702	.0120	-.0026	.0038	.0051
.903	5.01	6.01	.0033	-.0701	.0143	-.0044	.0032	.0074
.899	4.99	8.99	.0107	-.0694	.0123	-.0008	.0037	.0054
.900	4.99	12.01	.0322	-.0634	.0010	.0169	.0088	-.0059
.902	5.00	16.03	.0553	-.0507	-.0134	.0350	.0202	-.0203
.898	4.99	17.99	.0659	-.0432	-.0206	.0432	.0273	-.0275

Table 12. Continued

(a) Continued

MACH	NPR	ALPHA	CLT	C(D-F)	CMT	CL	CD	CM
.600	1.04	.00	-.0081	.0037	.0043	-.0081	.0037	.0043
.601	1.98	.02	-.0085	-.0410	.0109	-.0085	.0015	.0067
.601	2.99	.01	-.0070	-.0813	.0125	-.0070	.0027	.0045
.599	3.50	.01	-.0069	-.1019	.0145	-.0069	.0035	.0046
.597	4.98	.00	-.0056	-.1639	.0197	-.0056	.0035	.0041
.603	1.04	-1.90	-.0016	.0049	.0010	-.0016	.0049	.0010
.599	1.04	.00	.0000	.0048	.0016	.0000	.0048	.0016
.600	1.04	2.99	.0017	.0047	.0028	.0017	.0047	.0028
.599	1.04	6.00	.0064	.0056	-.0008	.0064	.0056	-.0008
.600	1.05	8.99	.0092	.0065	-.0026	.0093	.0065	-.0026
.599	1.05	12.00	.0145	.0085	-.0067	.0146	.0085	-.0067
.600	1.05	15.99	.0297	.0148	-.0185	.0298	.0148	-.0185
.599	1.05	18.02	.0371	.0195	-.0234	.0372	.0196	-.0234
.599	3.53	-1.88	-.0060	-.1021	.0127	-.0025	.0044	.0027
.601	3.51	.03	-.0004	-.1003	.0119	-.0005	.0046	.0020
.600	3.50	3.00	.0072	-.1000	.0117	.0017	.0046	.0018
.599	3.49	6.00	.0157	-.0994	.0105	.0048	.0049	.0006
.601	3.49	9.00	.0252	-.0969	.0073	.0089	.0061	-.0025
.601	3.49	12.00	.0356	-.0943	.0026	.0140	.0078	-.0072
.603	3.50	16.00	.0584	-.0856	-.0109	.0299	.0142	-.0207
.596	3.48	18.01	.0716	-.0810	-.0175	.0391	.0195	-.0274
.600	1.05	20.02	.0395	.0221	-.0251	.0396	.0221	-.0251
.600	2.00	20.01	.0537	-.0212	-.0200	.0389	.0197	-.0243
.600	3.00	20.00	.0703	-.0581	-.0223	.0415	.0214	-.0304
.599	3.51	20.02	.0782	-.0777	-.0213	.0423	.0214	-.0312
.599	5.03	20.00	.1005	-.1365	-.0174	.0431	.0215	-.0331
.600	1.05	16.66	.0262	.0138	-.0181	.0263	.0138	-.0181
.599	1.05	18.00	.0311	.0166	-.0210	.0313	.0166	-.0210
.599	1.05	19.99	.0373	.0212	-.0247	.0374	.0212	-.0247
.601	1.03	23.98	.0540	.0360	-.0404	.0542	.0360	-.0404
.599	1.01	27.98	.0722	.0566	-.0633	.0724	.0566	-.0633
.599	.98	31.99	.0863	.0803	-.0903	.0865	.0803	-.0903
.602	3.48	16.82	.0569	-.0862	-.0117	.0271	.0128	-.0214
.599	3.49	17.98	.0650	-.0841	-.0153	.0327	.0158	-.0252
.599	3.49	19.99	.0769	-.0778	-.0211	.0411	.0209	-.0310
.598	3.49	23.98	.1016	-.0605	-.0392	.0589	.0360	-.0492
.598	3.50	27.97	.1307	-.0350	-.0689	.0814	.0582	-.0788
.599	3.50	31.99	.1547	-.0055	-.1017	.0991	.0838	-.1116

Table 12. Continued

(a) Concluded

MACH	NPR	ALPHA	CLT	C(D-F)	CMT	CL	CD	CM
.152	1.00	.02	.0205	.0253	-.0121	.0205	.0253	-.0121
.150	2.02	.02	.0184	-.7185	.0717	.0181	-.0065	.0015
.150	2.61	.01	.0310	-1.0952	.0915	.0307	.0002	-.0137
.151	2.98	.01	.0324	-1.3186	.1125	.0322	.0056	-.0134
.151	3.86	.00	.0334	-1.8846	.1652	.0332	.0098	-.0128
.149	1.00	-1.32	.0382	.0233	-.0154	.0382	.0233	-.0154
.151	1.00	.03	.0401	.0173	-.0144	.0401	.0173	-.0144
.151	1.00	3.03	.0375	.0197	-.0107	.0375	.0197	-.0107
.149	1.00	6.03	.0416	.0187	-.0127	.0416	.0187	-.0127
.150	1.00	8.99	.0485	.0253	-.0162	.0485	.0253	-.0162
.151	1.00	11.99	.0507	.0274	-.0191	.0508	.0274	-.0191
.150	1.00	16.02	.0571	.0378	-.0281	.0572	.0378	-.0281
.150	1.00	18.00	.0691	.0448	-.0392	.0692	.0448	-.0392
.151	2.60	-1.36	-.0003	-1.0686	.0967	.0250	-.0012	-.0058
.151	2.60	.03	.0257	-1.0706	.0980	.0251	-.0028	-.0045
.153	2.60	3.02	.0827	-1.0521	.0959	.0274	-.0019	-.0051
.152	2.60	6.04	.1356	-1.0494	.0977	.0245	.0014	-.0038
.152	2.60	9.00	.1988	-1.0405	.0929	.0334	.0034	-.0086
.152	2.60	11.99	.2540	-1.0321	.0916	.0339	.0042	-.0102
.151	2.60	15.99	.3450	-1.0177	.0774	.0501	.0118	-.0254
.151	2.60	18.02	.3886	-1.0041	.0693	.0561	.0181	-.0339
.153	1.00	20.00	.0483	.0210	-.0273	.0484	.0210	-.0273
.150	1.98	20.00	.2804	-.6343	.0596	.0486	.0029	-.0074
.149	2.59	19.98	.4387	-1.0083	.0614	.0651	.0192	-.0436
.150	3.03	19.98	.5402	-1.2708	.0849	.0698	.0234	-.0459
.150	3.81	19.99	.7148	-1.7498	.1327	.0704	.0227	-.0446
.150	2.79	15.99	.3534	-1.1673	.0964	.0199	-.0029	-.0193
.150	1.01	15.99	.0098	.0106	-.0092	.0099	.0106	-.0092
.150	1.00	17.98	.0199	.0121	-.0172	.0200	.0122	-.0172
.151	1.00	19.98	.0368	.0200	-.0261	.0369	.0200	-.0261
.151	1.00	23.98	.0539	.0339	-.0371	.0540	.0339	-.0371
.151	1.00	27.99	.0754	.0563	-.0583	.0756	.0564	-.0583
.153	1.00	31.99	.0924	.0793	-.0798	.0926	.0794	-.0798
.152	1.00	35.10	.0998	.0980	-.0943	.1000	.0981	-.0943
.149	2.63	15.98	.3603	-1.0684	.0755	.0508	.0122	-.0324
.149	2.60	17.98	.4079	-1.0316	.0619	.0675	.0175	-.0440
.149	2.60	19.98	.4470	-1.0189	.0600	.0684	.0225	-.0464
.152	2.60	23.99	.5147	-.9411	.0474	.0804	.0352	-.0552
.150	2.60	27.98	.6086	-.9178	.0329	.0940	.0511	-.0724
.153	2.61	31.98	.6688	-.8252	.0055	.1102	.0698	-.0958
.152	2.61	34.97	.7293	-.7816	-.0144	.1203	.0895	-.1165

Table 12. Continued

(b) Afterbody and nozzle

MACH	NPR	ALPHA	CLAFT	CDAFT	CMAFT	CLN	CDN	CMN
1.200	.93	.01	-.0083	.0084	.0080	.0008	.0083	-.0030
1.200	2.96	.01	-.0081	.0084	.0078	.0004	.0082	-.0035
1.200	5.01	.02	-.0081	.0085	.0078	-.0006	.0086	-.0022
1.202	7.06	.01	-.0082	.0085	.0078	-.0021	.0078	.0001
1.200	8.96	.02	-.0082	.0086	.0078	-.0020	.0064	.0000
1.201	.94	-2.01	-.0166	.0091	.0149	-.0064	.0093	.0036
1.202	.92	.01	-.0077	.0086	.0074	.0000	.0086	-.0041
1.202	.88	3.01	.0052	.0092	-.0037	.0063	.0103	-.0105
1.201	.84	6.00	.0197	.0116	-.0174	.0114	.0134	-.0155
1.200	.80	9.01	.0304	.0154	-.0299	.0120	.0163	-.0109
1.200	.77	11.99	.0421	.0201	-.0436	.0150	.0200	-.0124
1.202	.76	16.02	.0547	.0268	-.0574	.0179	.0238	-.0129
1.197	.76	18.00	.0618	.0313	-.0660	.0193	.0258	-.0138
1.202	7.03	-2.01	-.0166	.0092	.0148	-.0026	.0085	-.0008
1.202	7.06	.01	-.0078	.0086	.0074	-.0010	.0083	-.0003
1.201	7.00	3.03	.0045	.0092	-.0032	.0017	.0086	.0002
1.200	6.99	5.99	.0192	.0116	-.0171	.0036	.0093	.0018
1.200	6.98	9.01	.0303	.0154	-.0299	.0063	.0125	.0021
1.201	6.99	12.00	.0421	.0201	-.0436	.0100	.0150	.0001
1.203	7.01	15.99	.0545	.0267	-.0574	.0145	.0183	-.0034
1.199	6.98	17.98	.0620	.0313	-.0664	.0171	.0204	-.0056
.899	1.10	-.03	-.0031	.0060	.0024	-.0054	-.0021	.0021
.900	2.01	-.01	-.0035	.0057	.0029	-.0055	-.0026	.0033
.897	2.99	-.01	-.0035	.0057	.0030	-.0046	-.0019	.0025
.896	4.97	.00	-.0034	.0057	.0029	-.0043	-.0018	.0025
.902	7.01	.00	-.0033	.0056	.0028	-.0043	-.0023	.0028
.899	1.11	-2.03	-.0017	.0058	.0011	-.0052	-.0019	.0023
.900	1.10	.03	-.0031	.0059	.0024	-.0036	-.0019	.0014
.903	1.10	3.03	-.0050	.0059	.0052	.0034	-.0020	-.0015
.901	1.10	6.00	-.0052	.0056	.0053	.0029	-.0020	-.0018
.902	1.10	9.01	-.0030	.0059	.0047	.0076	-.0012	-.0070
.901	1.10	11.99	.0010	.0075	.0033	.0191	.0024	-.0151
.901	1.09	16.03	.0159	.0150	-.0076	.0217	.0065	-.0179
.900	1.06	18.00	.0199	.0191	-.0102	.0225	.0087	-.0155
.901	4.99	-2.02	-.0017	.0056	.0010	-.0050	-.0015	.0024
.900	4.99	.00	-.0033	.0057	.0028	-.0038	-.0018	.0023
.900	5.00	3.03	-.0048	.0056	.0052	.0022	-.0018	-.0001
.903	5.01	6.01	-.0061	.0052	.0067	.0017	-.0020	.0007
.899	4.99	8.99	-.0036	.0055	.0059	.0029	-.0019	-.0005
.900	4.99	12.01	.0006	.0072	.0038	.0163	.0017	-.0097
.902	5.00	16.03	.0158	.0149	-.0072	.0192	.0054	-.0131
.898	4.99	17.99	.0211	.0190	-.0122	.0221	.0083	-.0153

Table 12. Continued

(b) Continued

MACH	NPR	ALPHA	CLAFT	CDAFT	CMAFT	CLN	CDN	CMN
.600	1.04	.00	-.0028	.0055	.0024	-.0053	-.0019	.0019
.601	1.98	.02	-.0031	.0053	.0030	-.0054	-.0038	.0037
.601	2.99	.01	-.0032	.0054	.0031	-.0038	-.0026	.0014
.599	3.50	.01	-.0031	.0054	.0029	-.0038	-.0019	.0017
.597	4.98	.00	-.0032	.0053	.0030	-.0024	-.0018	.0011
.603	1.04	-1.90	-.0033	.0054	.0023	.0016	-.0005	-.0014
.599	1.04	.00	-.0026	.0054	.0024	.0027	-.0006	-.0008
.600	1.04	2.99	-.0019	.0053	.0027	.0037	-.0007	.0001
.599	1.04	6.00	.0002	.0056	.0008	.0062	.0000	-.0015
.600	1.05	8.99	.0023	.0061	-.0011	.0070	.0004	-.0016
.599	1.05	12.00	.0049	.0070	-.0038	.0097	.0016	-.0029
.600	1.05	15.99	.0148	.0108	-.0134	.0149	.0041	-.0051
.599	1.05	18.02	.0197	.0134	-.0175	.0175	.0062	-.0060
.599	3.53	-1.88	-.0036	.0053	.0027	.0011	-.0009	.0000
.601	3.51	.03	-.0027	.0052	.0023	.0022	-.0006	-.0003
.600	3.50	3.00	-.0016	.0053	.0022	.0034	-.0007	-.0003
.599	3.49	6.00	.0000	.0055	.0010	.0047	-.0005	-.0004
.601	3.49	9.00	.0022	.0059	-.0010	.0067	.0001	-.0015
.601	3.49	12.00	.0052	.0069	-.0043	.0087	.0009	-.0030
.603	3.50	16.00	.0154	.0108	-.0141	.0145	.0034	-.0066
.596	3.48	18.01	.0204	.0135	-.0185	.0187	.0060	-.0090
.600	1.05	20.02	.0213	.0163	-.0204	.0184	.0058	-.0048
.600	2.00	20.01	.0216	.0162	-.0207	.0174	.0035	-.0036
.600	3.00	20.00	.0220	.0164	-.0216	.0194	.0050	-.0088
.599	3.51	20.02	.0224	.0166	-.0220	.0199	.0048	-.0092
.599	5.03	20.00	.0229	.0168	-.0228	.0202	.0047	-.0102
.600	1.05	16.66	.0144	.0119	-.0146	.0120	.0019	-.0035
.599	1.05	18.00	.0169	.0134	-.0166	.0143	.0032	-.0044
.599	1.05	19.99	.0213	.0163	-.0206	.0161	.0049	-.0041
.601	1.03	23.98	.0345	.0259	-.0351	.0196	.0102	-.0052
.599	1.01	27.98	.0495	.0393	-.0556	.0229	.0173	-.0077
.599	.98	31.99	.0642	.0563	-.0805	.0223	.0240	-.0099
.602	3.48	16.82	.0154	.0121	-.0159	.0118	.0007	-.0056
.599	3.49	17.98	.0177	.0135	-.0177	.0151	.0023	-.0075
.599	3.49	19.99	.0224	.0166	-.0221	.0187	.0043	-.0090
.598	3.49	23.98	.0363	.0265	-.0377	.0226	.0094	-.0115
.598	3.50	27.97	.0520	.0406	-.0595	.0294	.0176	-.0194
.599	3.50	31.99	.0677	.0586	-.0861	.0314	.0252	-.0254

Table 12. Concluded

(b) Concluded

MACH	NPR	ALPHA	CLAFT	CDAFT	CMAFT	CLN	CDN	CMN
.152	1.00	.02	.0012	.0068	-.0043	.0193	.0185	-.0078
.150	2.02	.02	.0022	.0073	-.0056	.0159	-.0139	.0071
.150	2.61	.01	.0044	.0075	-.0082	.0263	-.0073	-.0054
.151	2.98	.01	.0033	.0076	-.0066	.0288	-.0020	-.0069
.151	3.86	.00	.0039	.0079	-.0063	.0294	.0019	-.0064
.149	1.00	-1.32	-.0031	.0058	.0030	.0413	.0175	-.0185
.151	1.00	.03	-.0010	.0053	.0011	.0410	.0120	-.0155
.151	1.00	3.03	-.0011	.0052	.0026	.0386	.0145	-.0133
.149	1.00	6.03	.0004	.0054	.0023	.0412	.0133	-.0150
.150	1.00	8.99	.0029	.0059	.0002	.0457	.0194	-.0164
.151	1.00	11.99	.0079	.0070	-.0060	.0429	.0204	-.0132
.150	1.00	16.02	.0161	.0106	-.0148	.0411	.0272	-.0133
.150	1.00	18.00	.0224	.0136	-.0218	.0468	.0312	-.0174
.151	2.60	-1.36	.0036	.0056	-.0052	.0214	-.0068	-.0006
.151	2.60	.03	.0036	.0058	-.0049	.0215	-.0085	.0004
.153	2.60	3.02	.0059	.0062	-.0068	.0214	-.0081	.0017
.152	2.60	6.04	.0086	.0068	-.0091	.0159	-.0054	.0053
.152	2.60	9.00	.0124	.0083	-.0133	.0210	-.0049	.0047
.152	2.60	11.99	.0128	.0091	-.0138	.0210	-.0049	.0037
.151	2.60	15.99	.0200	.0122	-.0219	.0300	-.0004	-.0036
.151	2.60	18.02	.0281	.0163	-.0318	.0280	.0018	-.0021
.153	1.00	20.00	.0198	.0149	-.0203	.0286	.0061	-.0070
.150	1.98	20.00	.0175	.0150	-.0176	.0311	-.0121	.0101
.149	2.59	19.98	.0201	.0163	-.0214	.0450	.0029	-.0222
.150	3.03	19.98	.0198	.0162	-.0219	.0500	.0072	-.0240
.150	3.81	19.99	.0200	.0166	-.0234	.0504	.0060	-.0211
.150	2.79	15.99	.0085	.0113	-.0111	.0114	-.0142	-.0083
.150	1.01	15.99	.0082	.0095	-.0097	.0017	.0012	.0005
.150	1.00	17.98	.0172	.0124	-.0199	.0028	-.0003	.0028
.151	1.00	19.98	.0189	.0140	-.0204	.0180	.0060	-.0057
.151	1.00	23.98	.0267	.0199	-.0278	.0273	.0141	-.0092
.151	1.00	27.99	.0383	.0304	-.0424	.0373	.0260	-.0158
.153	1.00	31.99	.0512	.0439	-.0608	.0414	.0355	-.0190
.152	1.00	35.10	.0560	.0527	-.0703	.0440	.0454	-.0241
.149	2.63	15.98	.0097	.0104	-.0107	.0411	.0018	-.0217
.149	2.60	17.98	.0165	.0129	-.0187	.0510	.0046	-.0253
.149	2.60	19.98	.0191	.0147	-.0214	.0494	.0078	-.0250
.152	2.60	23.99	.0266	.0209	-.0266	.0539	.0143	-.0286
.150	2.60	27.98	.0378	.0311	-.0408	.0562	.0200	-.0317
.153	2.61	31.98	.0500	.0448	-.0595	.0602	.0250	-.0363
.152	2.61	34.97	.0606	.0577	-.0770	.0597	.0318	-.0395

Table 13. Lateral Aerodynamic Characteristics for Dry Nozzle With 100/25 A/B Sidewalls and $\delta_{v,p} = 0°$

MACH	NPR	ALPHA	CROLLT	CNT	CYT	CROLL	CN	CY
1.200	.93	.01	.0000	.0006	-.0007	.0000	.0006	-.0007
1.200	2.96	.01	.0000	.0005	-.0009	.0000	.0005	-.0008
1.200	5.01	.02	.0002	.0019	-.0031	.0002	.0007	-.0012
1.202	7.06	.01	.0003	.0030	-.0047	.0003	.0006	-.0012
1.200	8.96	.02	.0004	.0041	-.0061	.0004	.0006	-.0009
1.201	.94	-2.01	.0000	.0005	-.0009	.0000	.0005	-.0009
1.202	.92	.01	.0001	.0006	-.0011	.0001	.0006	-.0011
1.202	.88	3.01	.0002	.0006	-.0013	.0002	.0006	-.0013
1.201	.84	6.00	.0001	.0003	-.0007	.0001	.0003	-.0007
1.200	.80	9.01	.0002	.0001	-.0007	.0002	.0001	-.0007
1.200	.77	11.99	.0001	-.0002	-.0006	.0001	-.0002	-.0006
1.202	.76	16.02	.0001	-.0001	-.0004	.0001	-.0001	-.0004
1.197	.76	18.00	.0001	-.0004	.0004	.0001	-.0004	.0004
1.202	7.03	-2.01	.0003	.0030	-.0047	.0003	.0006	-.0011
1.202	7.06	.01	.0004	.0032	-.0051	.0004	.0008	-.0015
1.201	7.00	3.03	.0004	.0032	-.0052	.0004	.0009	-.0017
1.200	6.99	5.99	.0004	.0033	-.0053	.0004	.0009	-.0018
1.200	6.98	9.01	.0005	.0033	-.0056	.0005	.0009	-.0021
1.201	6.99	12.00	.0004	.0030	-.0055	.0004	.0006	-.0020
1.203	7.01	15.99	.0005	.0029	-.0050	.0005	.0006	-.0015
1.199	6.98	17.98	.0005	.0027	-.0046	.0005	.0003	-.0011
.899	1.10	-.03	.0002	.0008	-.0021	.0002	.0008	-.0021
.900	2.01	-.01	.0001	-.0003	-.0008	.0001	.0005	-.0018
.897	2.99	-.01	.0002	.0000	-.0014	.0002	.0000	-.0012
.896	4.97	.00	.0004	.0023	-.0048	.0004	.0003	-.0016
.902	7.01	.00	.0006	.0045	-.0078	.0006	.0003	-.0015
.899	1.11	-2.03	.0002	.0007	-.0021	.0002	.0007	-.0021
.900	1.10	.03	.0002	.0008	-.0023	.0002	.0008	-.0023
.903	1.10	3.03	.0002	.0008	-.0023	.0002	.0008	-.0023
.901	1.10	6.00	.0002	.0005	-.0020	.0002	.0005	-.0020
.902	1.10	9.01	.0002	.0005	-.0017	.0002	.0005	-.0017
.901	1.10	11.99	.0002	.0006	-.0019	.0002	.0006	-.0019
.901	1.09	16.03	.0002	.0003	-.0015	.0002	.0003	-.0015
.900	1.06	18.00	.0002	.0001	-.0014	.0002	.0001	-.0014
.901	4.99	-2.02	.0004	.0023	-.0048	.0004	.0002	-.0016
.900	4.99	.00	.0004	.0024	-.0050	.0004	.0003	-.0018
.900	5.00	3.03	.0004	.0024	-.0049	.0004	.0002	-.0017
.903	5.01	6.01	.0004	.0024	-.0052	.0004	.0003	-.0020
.899	4.99	8.99	.0004	.0021	-.0045	.0004	.0000	-.0012
.900	4.99	12.01	.0004	.0021	-.0045	.0004	.0000	-.0012
.902	5.00	16.03	.0004	.0022	-.0047	.0004	.0001	-.0015
.898	4.99	17.99	.0004	.0023	-.0048	.0004	.0002	-.0016

Table 13. Continued

MACH	NPR	ALPHA	CROLLT	CNT	CYT	CROLL	CN	CY
.600	1.04	.00	.0001	.0004	-.0008	.0001	.0004	-.0008
.601	1.98	.02	-.0001	-.0019	.0024	-.0001	.0001	.0000
.601	2.99	.01	.0001	-.0002	-.0005	.0001	-.0002	.0000
.599	3.50	.01	.0002	.0011	-.0024	.0002	-.0001	-.0003
.597	4.98	.00	.0005	.0048	-.0076	.0005	.0000	-.0003
.603	1.04	-1.90	.0003	.0009	-.0028	.0003	.0009	-.0028
.599	1.04	.00	.0003	.0009	-.0026	.0003	.0009	-.0026
.600	1.04	2.99	.0003	.0009	-.0027	.0003	.0009	-.0027
.599	1.04	6.00	.0003	.0008	-.0026	.0003	.0008	-.0026
.600	1.05	8.99	.0003	.0008	-.0026	.0003	.0008	-.0026
.599	1.05	12.00	.0003	.0010	-.0031	.0003	.0010	-.0031
.600	1.05	15.99	.0003	.0006	-.0022	.0003	.0006	-.0022
.599	1.05	18.02	.0003	.0007	-.0025	.0003	.0007	-.0025
.599	3.53	-1.88	.0003	.0015	-.0044	.0003	.0003	-.0021
.601	3.51	.03	.0004	.0015	-.0042	.0004	.0003	-.0020
.600	3.50	3.00	.0003	.0014	-.0041	.0003	.0003	-.0019
.599	3.49	6.00	.0003	.0014	-.0039	.0003	.0002	-.0018
.601	3.49	9.00	.0003	.0013	-.0036	.0003	.0001	-.0015
.601	3.49	12.00	.0003	.0014	-.0042	.0003	.0003	-.0020
.603	3.50	16.00	.0004	.0015	-.0043	.0004	.0003	-.0021
.596	3.48	18.01	.0004	.0016	-.0046	.0004	.0004	-.0025
.600	1.05	20.02	.0000	.0008	-.0022	.0000	.0008	-.0022
.600	2.00	20.01	-.0002	-.0012	-.0002	-.0002	.0007	-.0025
.600	3.00	20.00	.0000	.0004	-.0025	.0000	.0004	-.0020
.599	3.51	20.02	.0002	.0016	-.0043	.0002	.0004	-.0021
.599	5.03	20.00	.0005	.0052	-.0093	.0005	.0004	-.0019
.600	1.05	16.66	.0000	.0003	-.0010	.0000	.0003	-.0010
.599	1.05	18.00	.0000	.0004	-.0013	.0000	.0004	-.0013
.599	1.05	19.99	.0001	.0009	-.0026	.0001	.0009	-.0026
.601	1.03	23.98	.0010	.0073	-.0174	.0010	.0073	-.0174
.599	1.01	27.98	.0016	.0126	-.0272	.0016	.0126	-.0272
.599	.98	31.99	.0014	.0124	-.0258	.0014	.0124	-.0258
.602	3.48	16.82	.0001	.0010	-.0024	.0001	-.0002	-.0004
.599	3.49	17.98	.0001	.0012	-.0032	.0001	.0000	-.0010
.599	3.49	19.99	.0002	.0017	-.0044	.0002	.0005	-.0023
.598	3.49	23.98	.0012	.0087	-.0205	.0012	.0075	-.0184
.598	3.50	27.97	.0019	.0141	-.0303	.0019	.0129	-.0281
.599	3.50	31.99	.0017	.0144	-.0299	.0017	.0132	-.0278

Table 13. Concluded

MACH	NPR	ALPHA	CROLLT	CNT	CYT	CROLL	CN	CY
.152	1.00	.02	.0045	.0073	-.0305	.0045	.0073	-.0305
.150	2.02	.02	.0009	-.0266	.0105	.0009	.0043	-.0265
.150	2.61	.01	.0023	-.0096	-.0157	.0023	.0051	-.0301
.151	2.98	.01	.0030	.0031	-.0301	.0030	.0037	-.0241
.151	3.86	.00	.0056	.0371	-.0793	.0056	.0047	-.0257
.149	1.00	-1.32	.0028	.0045	-.0188	.0028	.0045	-.0188
.151	1.00	.03	.0026	.0047	-.0200	.0026	.0047	-.0200
.151	1.00	3.03	.0026	.0042	-.0167	.0026	.0042	-.0167
.149	1.00	6.03	.0024	.0043	-.0170	.0024	.0043	-.0170
.150	1.00	8.99	.0024	.0042	-.0168	.0024	.0042	-.0168
.151	1.00	11.99	.0020	.0036	-.0132	.0020	.0036	-.0132
.150	1.00	16.02	.0023	.0034	-.0147	.0023	.0034	-.0147
.150	1.00	18.00	.0018	.0030	-.0113	.0018	.0030	-.0113
.151	2.60	-1.36	.0002	-.0143	.0012	.0002	.0006	-.0135
.151	2.60	.03	.0000	-.0144	.0013	.0000	.0005	-.0134
.153	2.60	3.02	-.0003	-.0144	.0030	-.0003	.0002	-.0114
.152	2.60	6.04	-.0004	-.0146	.0046	-.0004	.0000	-.0099
.152	2.60	9.00	-.0006	-.0150	.0063	-.0006	-.0004	-.0081
.152	2.60	11.99	-.0004	-.0152	.0064	-.0004	-.0006	-.0081
.151	2.60	15.99	-.0003	-.0149	.0048	-.0003	-.0002	-.0097
.151	2.60	18.02	-.0008	-.0150	.0051	-.0008	-.0001	-.0095
.153	1.00	20.00	-.0008	.0001	.0002	-.0008	.0001	.0002
.150	1.98	20.00	-.0036	-.0331	.0349	-.0036	-.0011	-.0036
.149	2.59	19.98	-.0020	-.0169	.0110	-.0020	-.0014	-.0045
.150	3.03	19.98	-.0006	-.0013	-.0100	-.0006	-.0025	-.0014
.150	3.81	19.99	.0009	.0273	-.0486	.0009	-.0035	.0028
.150	2.79	15.99	.0009	-.0107	.0035	.0009	-.0028	-.0011
.150	1.01	15.99	.0017	.0007	-.0026	.0017	.0007	-.0026
.150	1.00	17.98	.0018	.0012	-.0043	.0018	.0012	-.0043
.151	1.00	19.98	.0017	.0007	-.0025	.0017	.0007	-.0025
.151	1.00	23.98	.0015	.0006	-.0023	.0015	.0006	-.0023
.151	1.00	27.99	.0022	.0019	-.0046	.0022	.0019	-.0046
.153	1.00	31.99	.0010	-.0029	.0073	.0010	-.0029	.0073
.152	1.00	35.10	.0014	-.0029	.0059	.0014	-.0029	.0059
.149	2.63	15.98	.0008	-.0152	.0059	.0008	-.0009	-.0078
.149	2.60	17.98	.0005	-.0163	.0082	.0005	-.0011	-.0069
.149	2.60	19.98	.0005	-.0161	.0081	.0005	-.0008	-.0070
.152	2.60	23.99	.0007	-.0154	.0048	.0007	-.0007	-.0097
.150	2.60	27.98	.0007	-.0145	.0044	.0007	.0006	-.0105
.153	2.61	31.98	.0000	-.0186	.0159	.0000	-.0043	.0019
.152	2.61	34.97	-.0003	-.0208	.0217	-.0003	-.0064	.0075

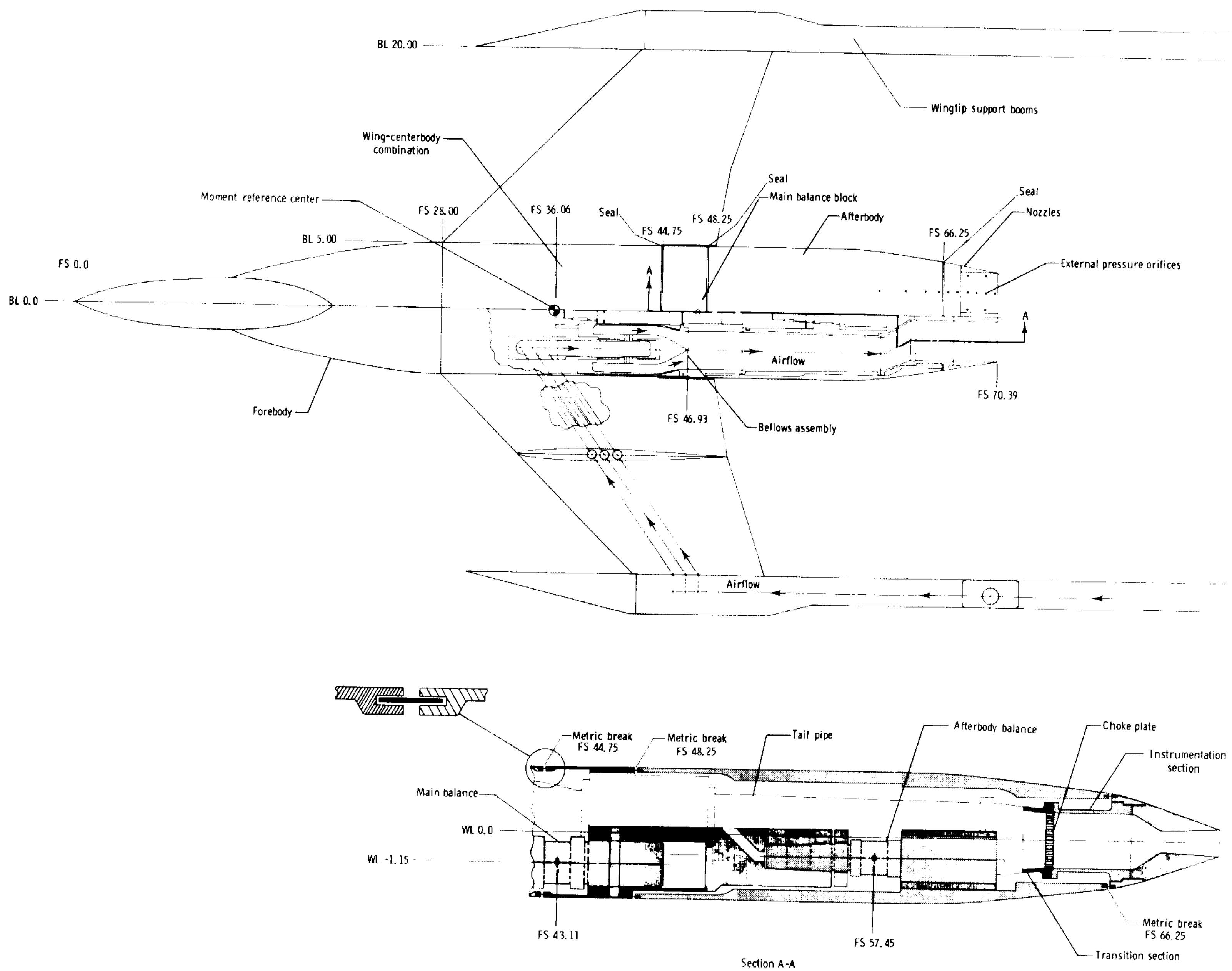
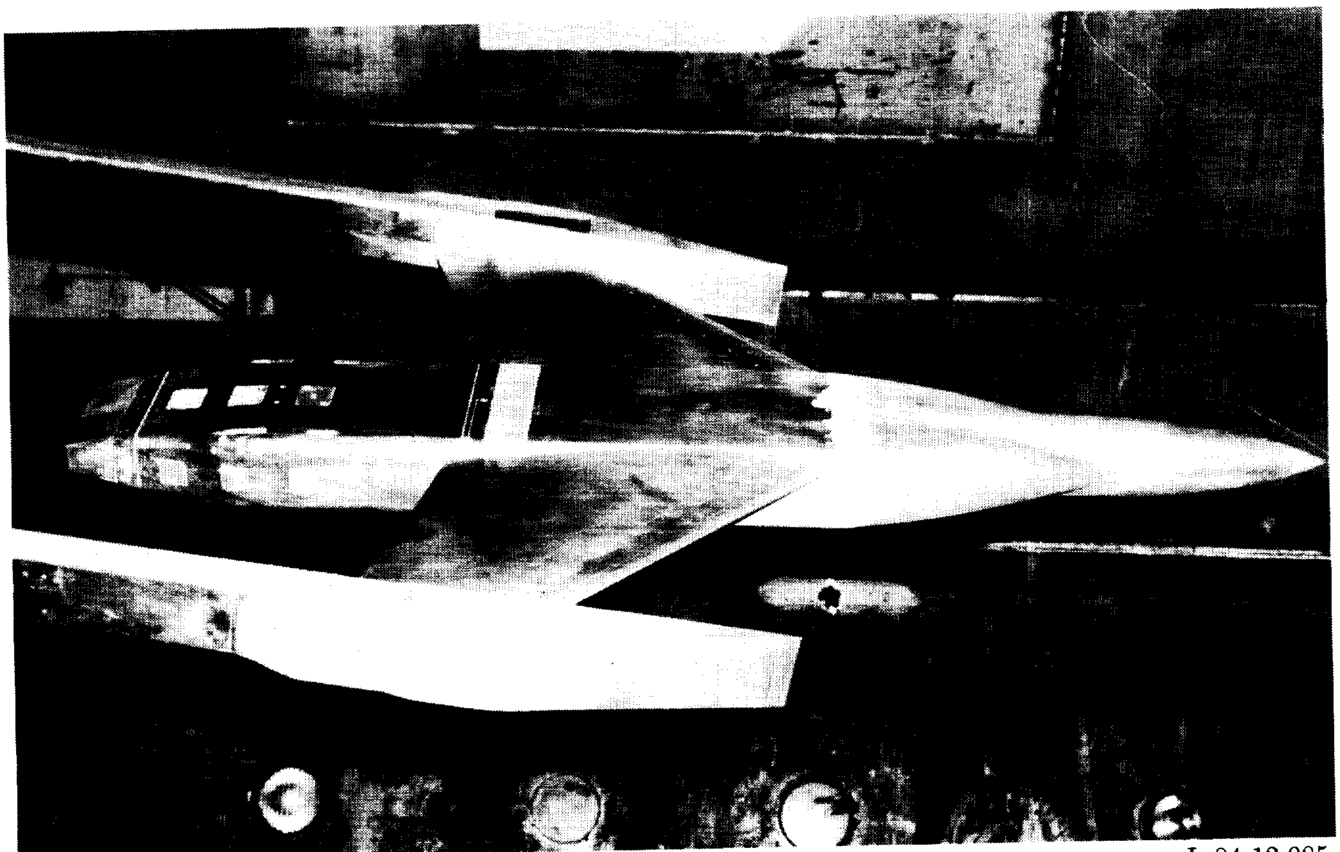


Figure 1. Air-powered, twin-engine, wingtip-supported model with dry power nozzle showing jet simulation system and balance arrangement. All linear dimensions are in inches.

ORIGINAL PAGE
COLOR PHOTOGRAPH



L-84-12,085

Figure 2. Model with afterburner power nozzles installed in the Langley 16-Foot Transonic Tunnel.

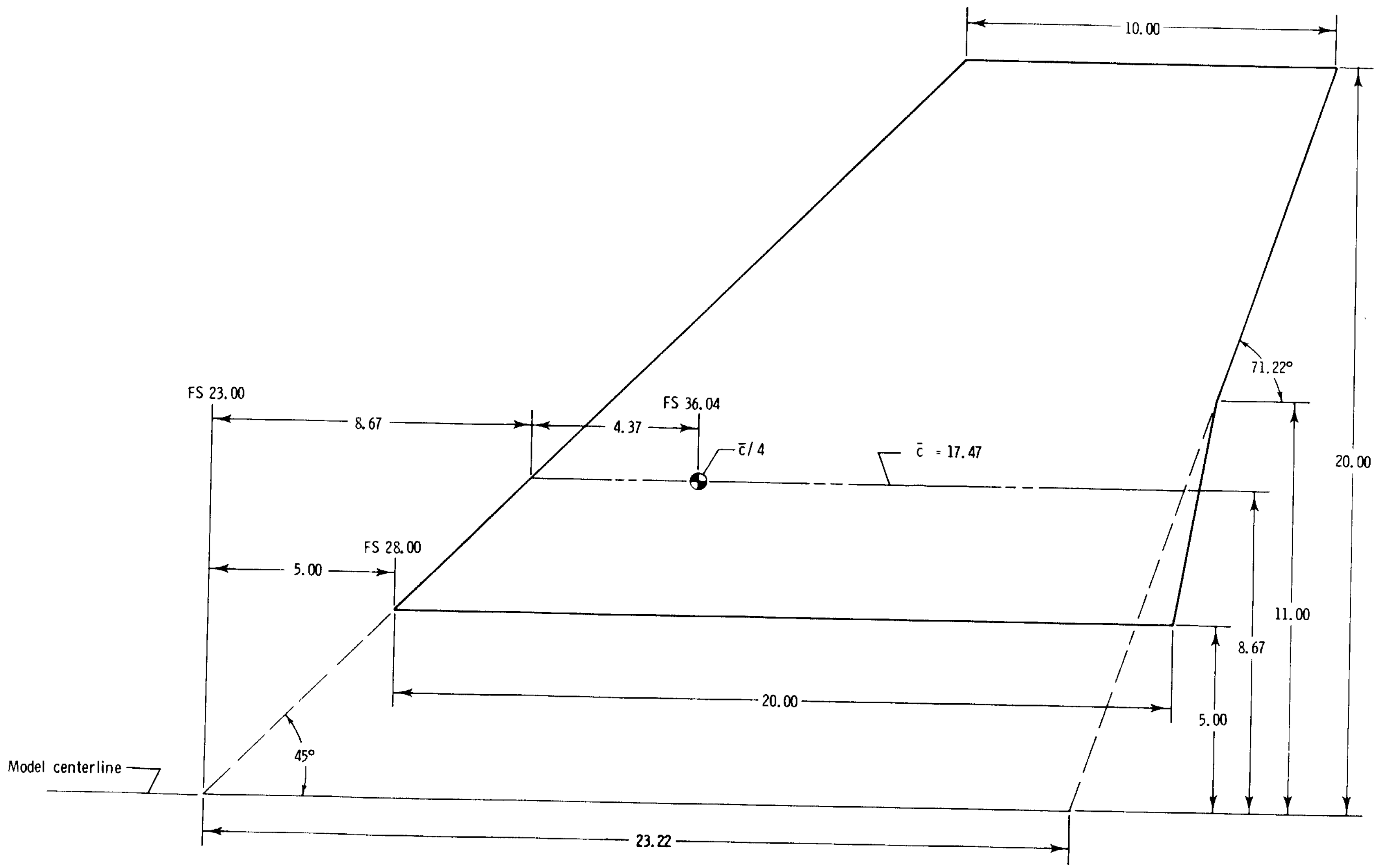


Figure 3. Wing planform geometry. All linear dimensions are in inches.

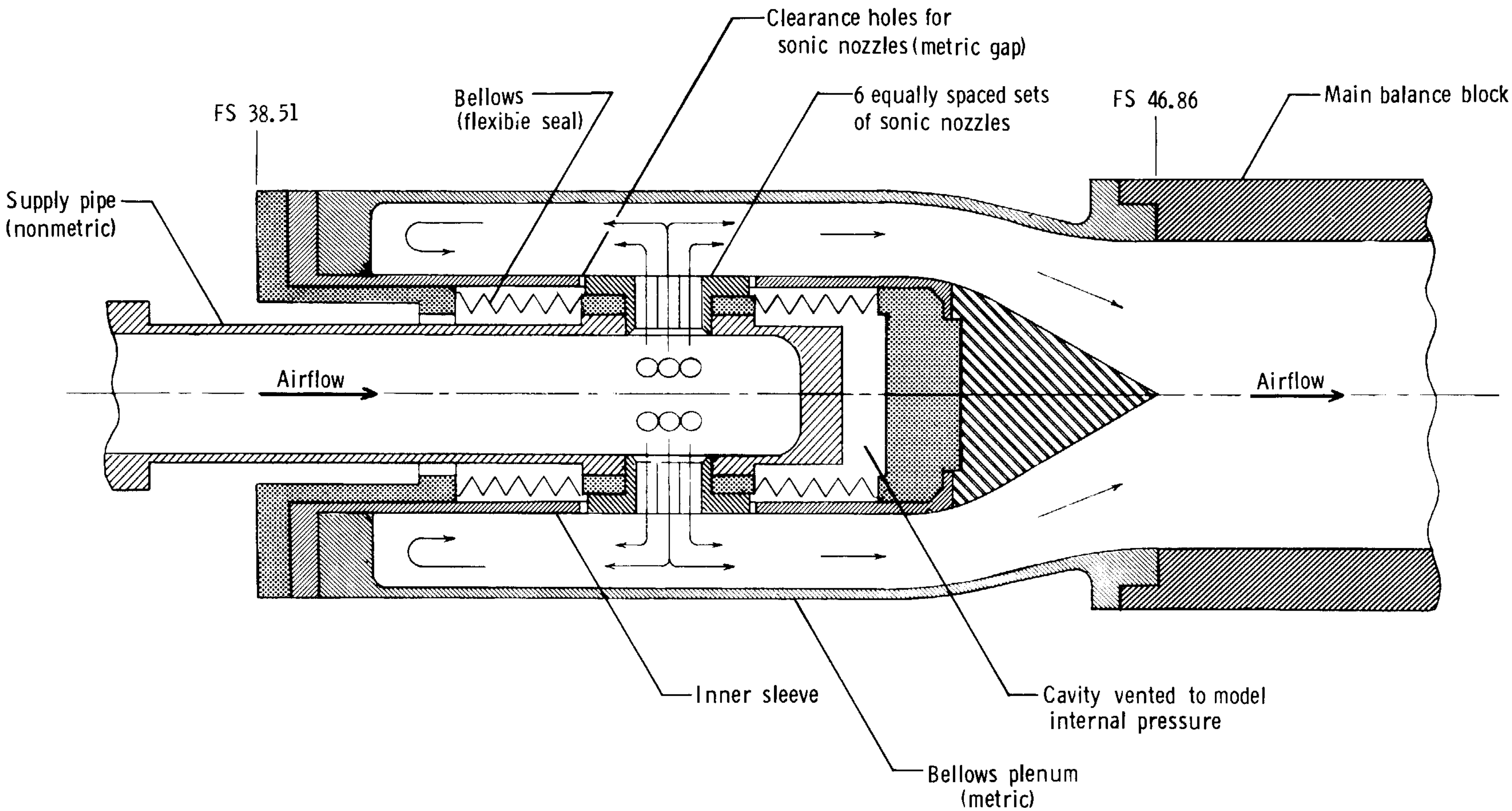
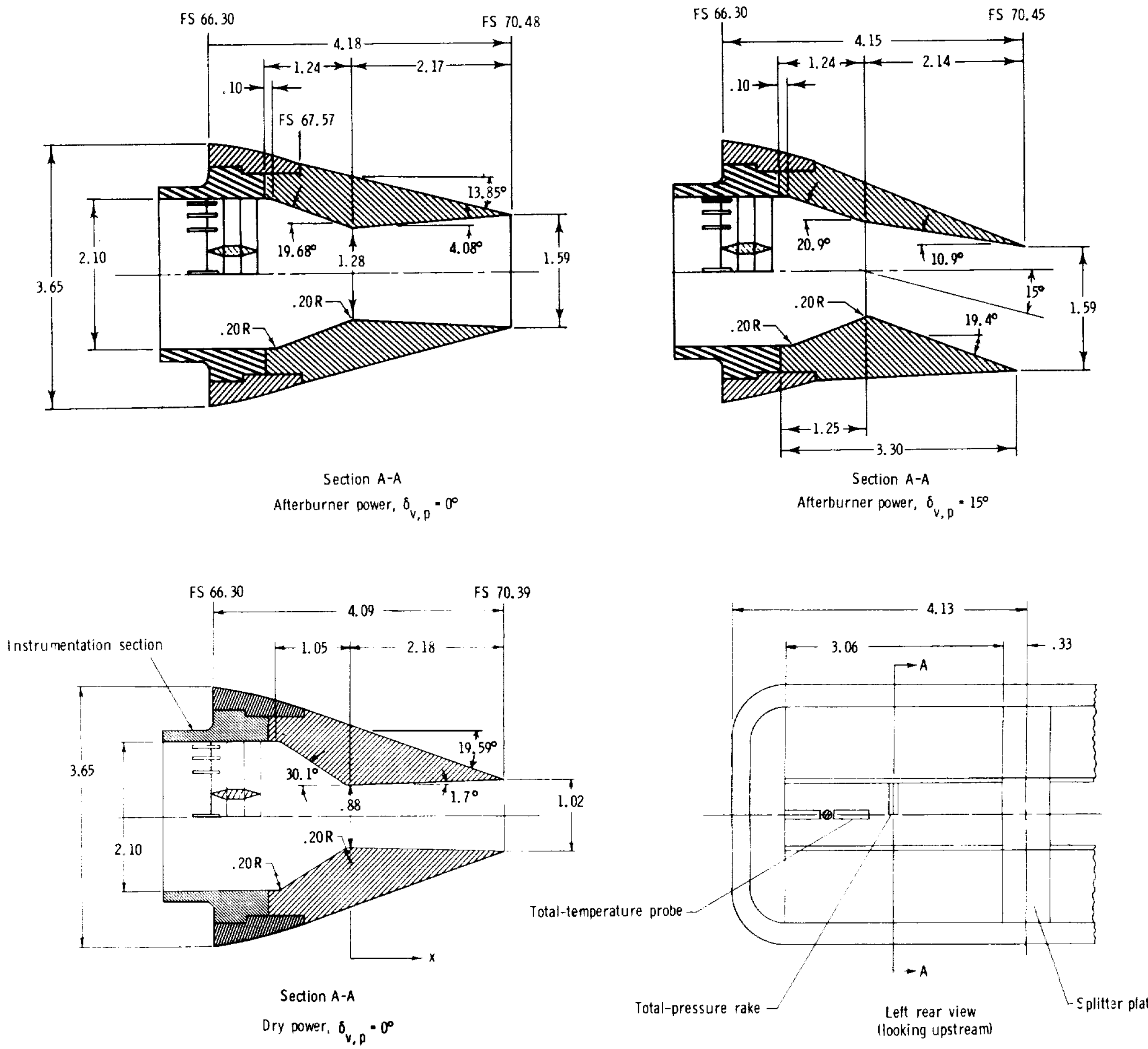
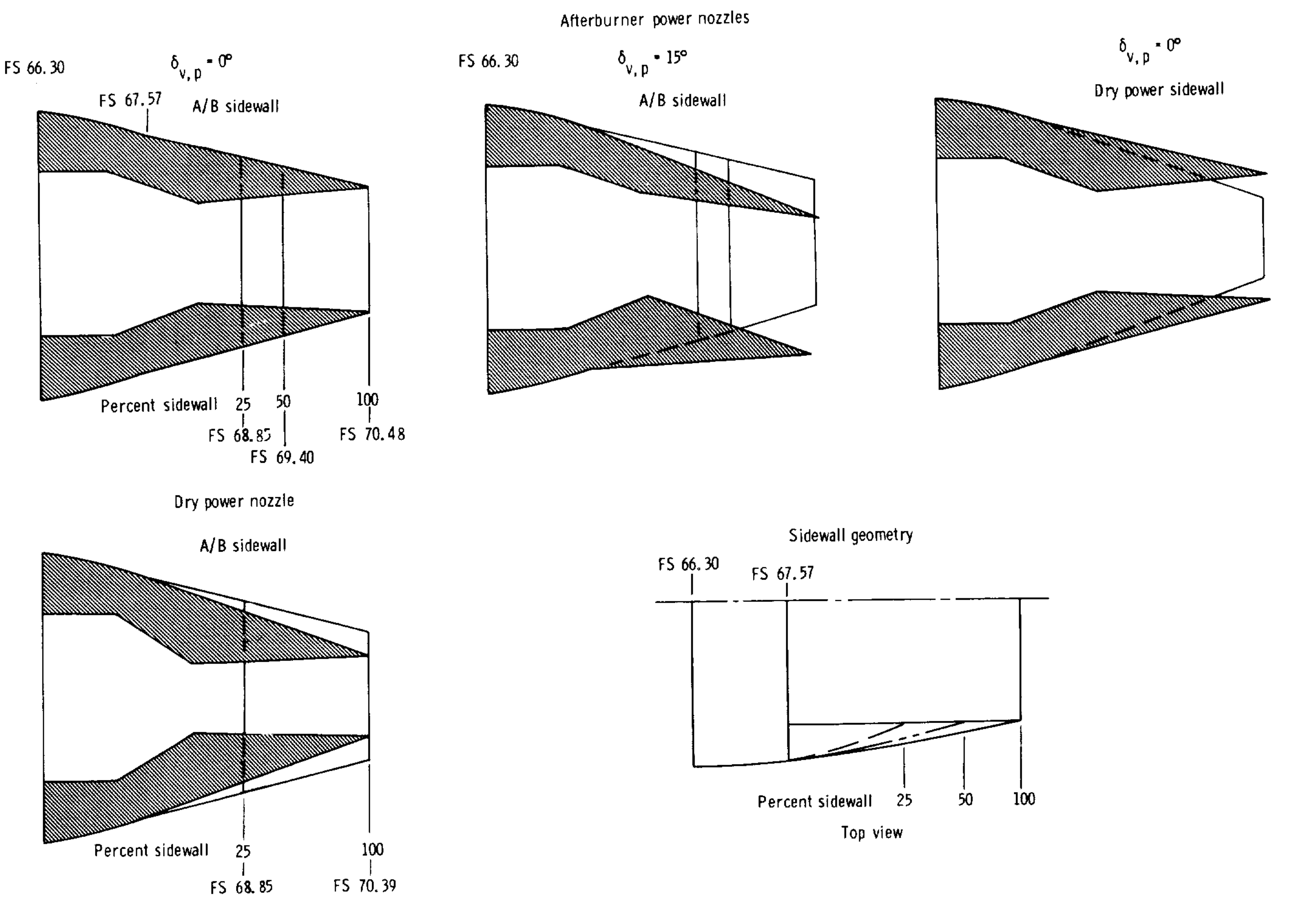


Figure 4. Schematic of bellows used to transfer air from nonmetric to metric portion of the model.



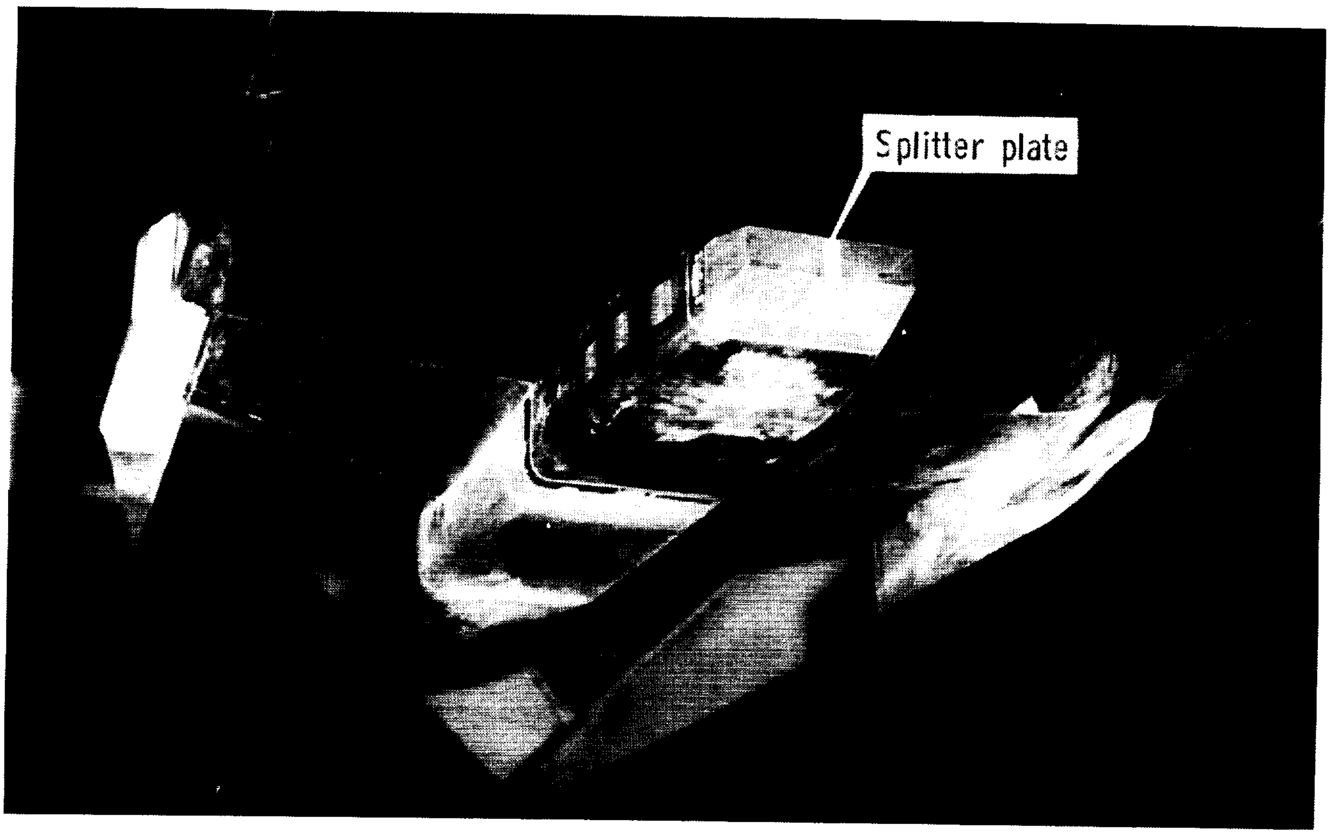
(a) Nozzles.

Figure 5. Nozzle geometric characteristics. All linear dimensions in inches.



(b) Sidewall configurations.

Figure 5. Continued.



L-84-12,084

(c) Afterburner power nozzle with 100-percent sidewalls and $\delta_{v,p} = 0°$.

Figure 5. Concluded.

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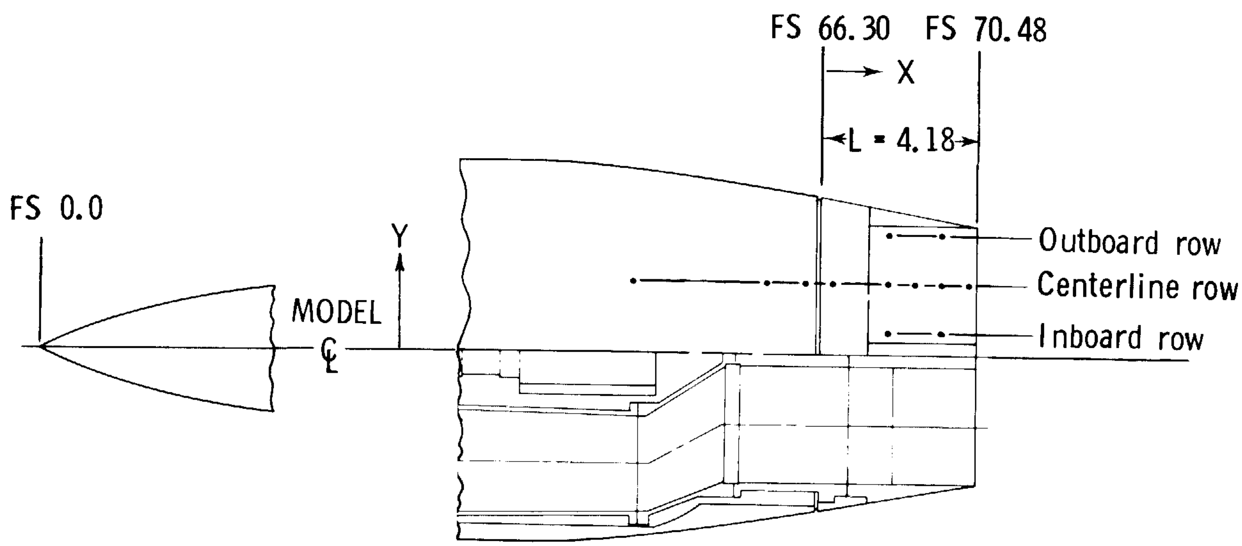
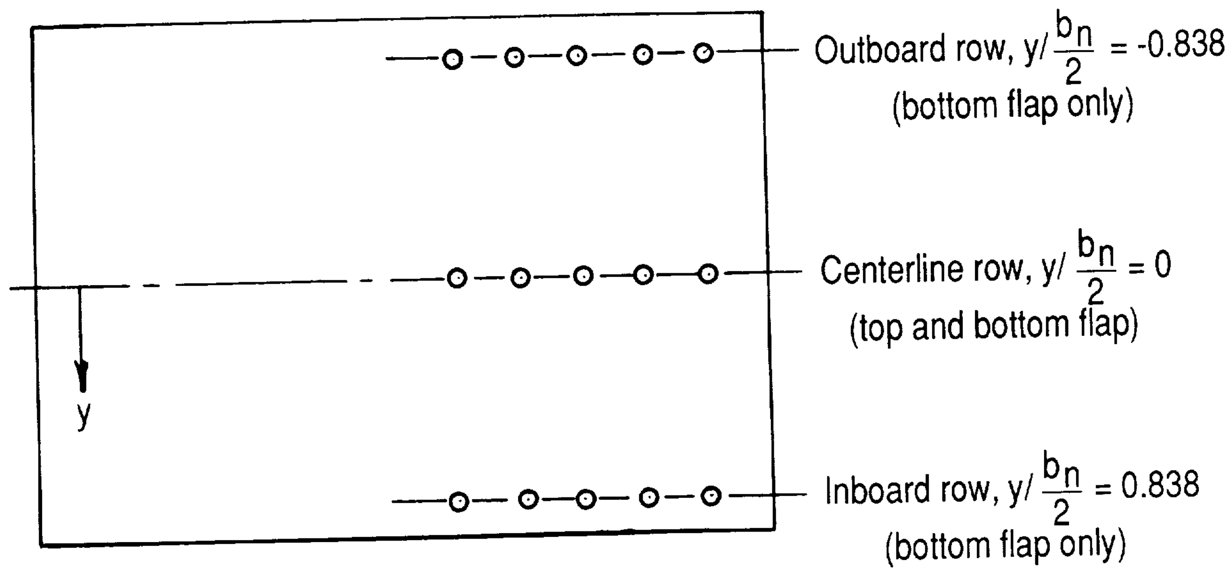
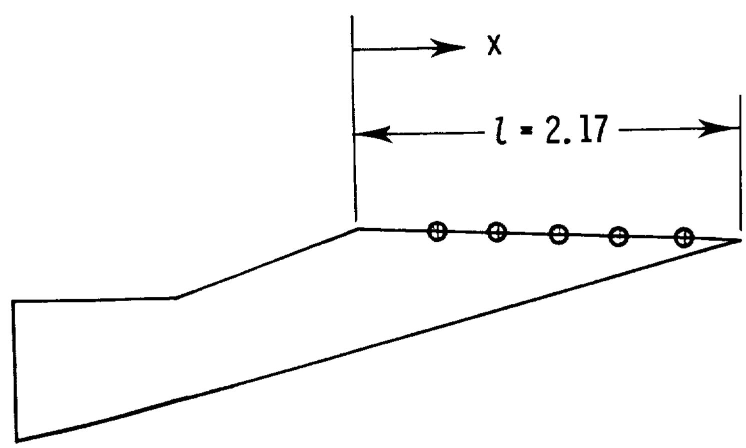


X/L	$Y/\frac{b_n}{2}$
-1.165	0.00
-.323	
-.087	
.081	
.435	
.603	
.772	
.940	
.435	.838
.772	
.435	-.838
.772	

(a) External afterbody nozzle.

Figure 6. Static pressure orifice locations for A/B nozzle.





x	x/l
0.36	0.167
.72	.334
1.09	.501
1.45	.667
1.81	.835

(b) Internal nozzle.

Figure 6. Concluded.

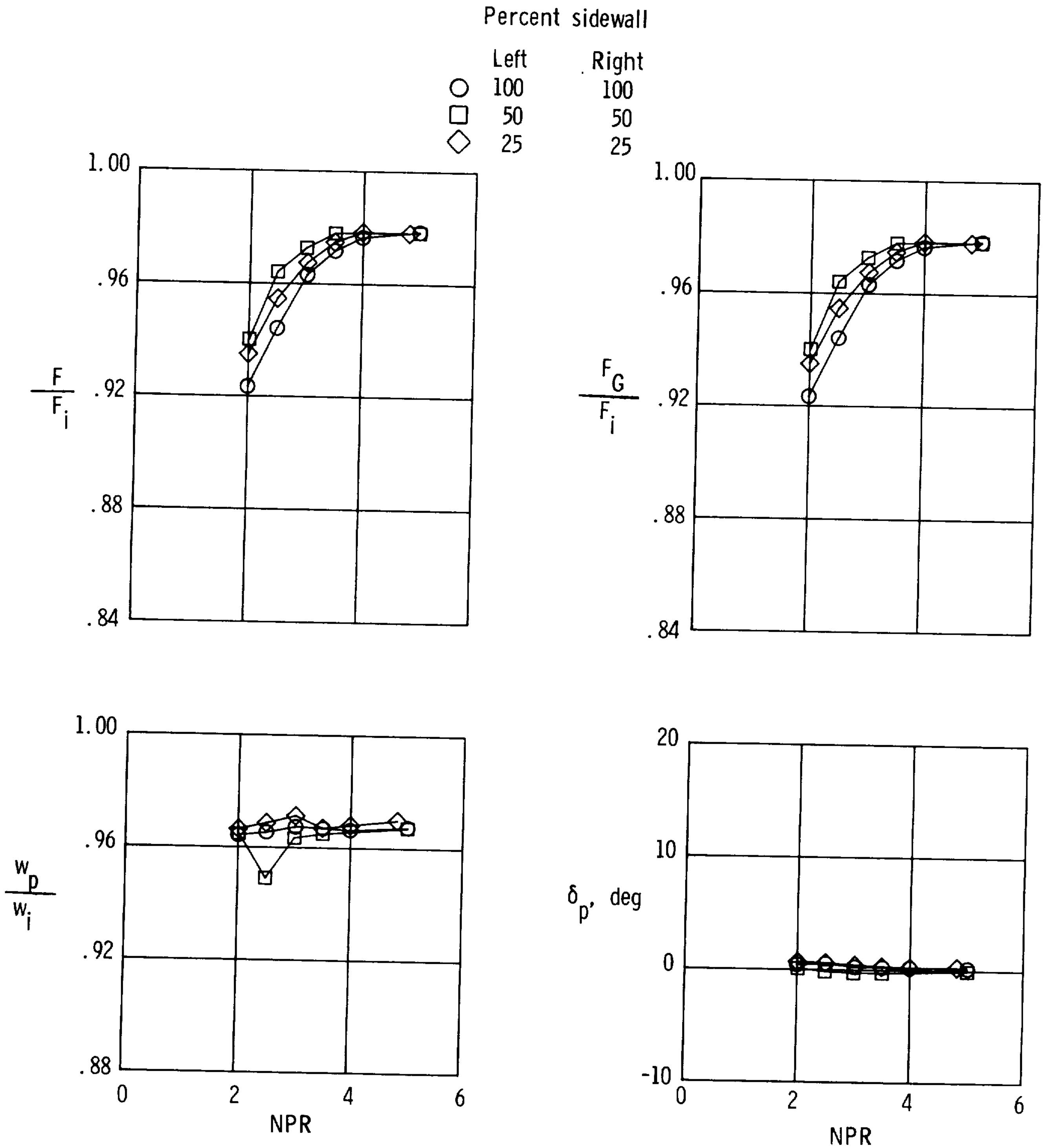


Figure 7. Effect of cutback sidewalls on A/B nozzle static performance with $\alpha = 0°$ and $\delta_{v,p} = 0°$.

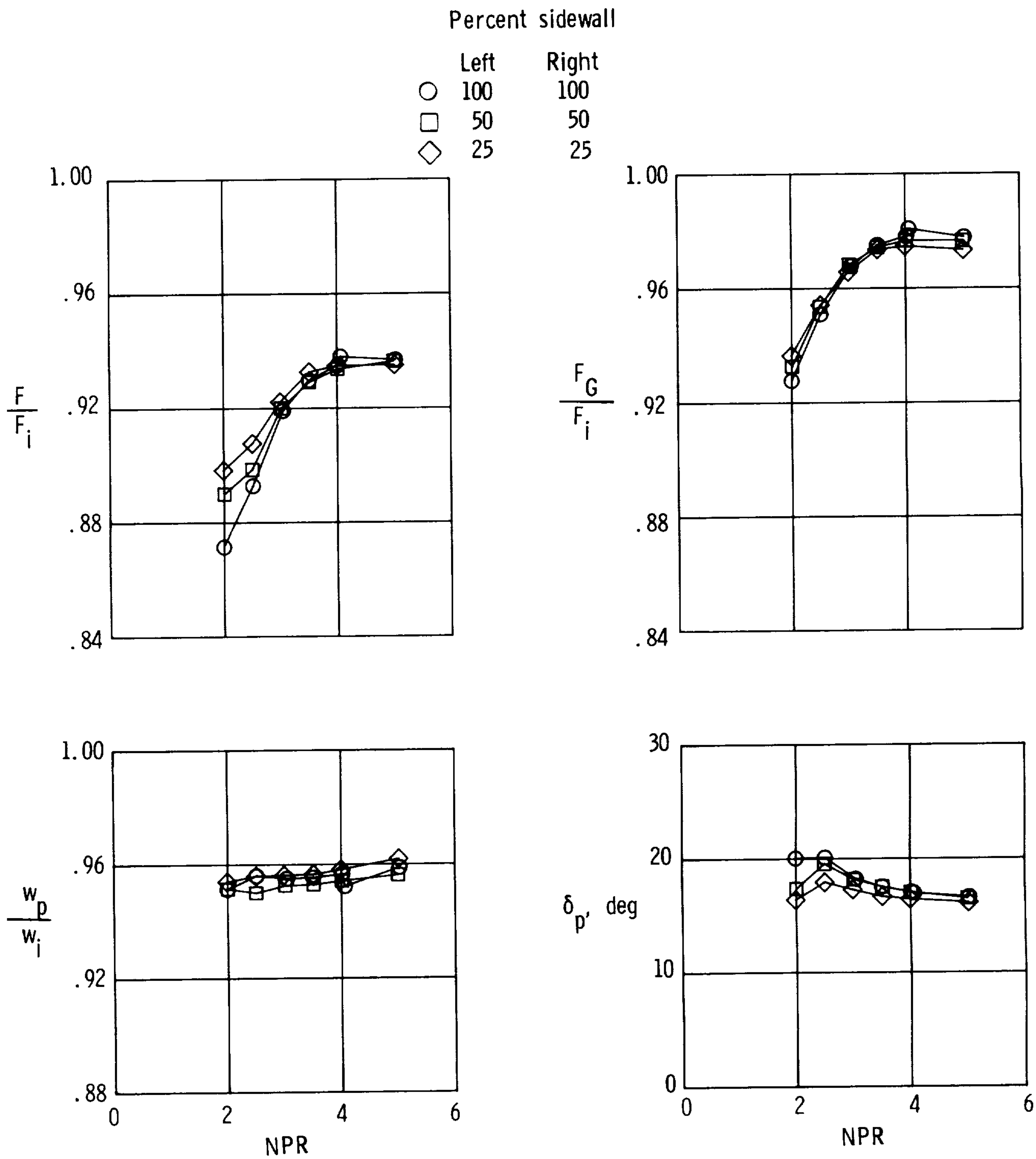
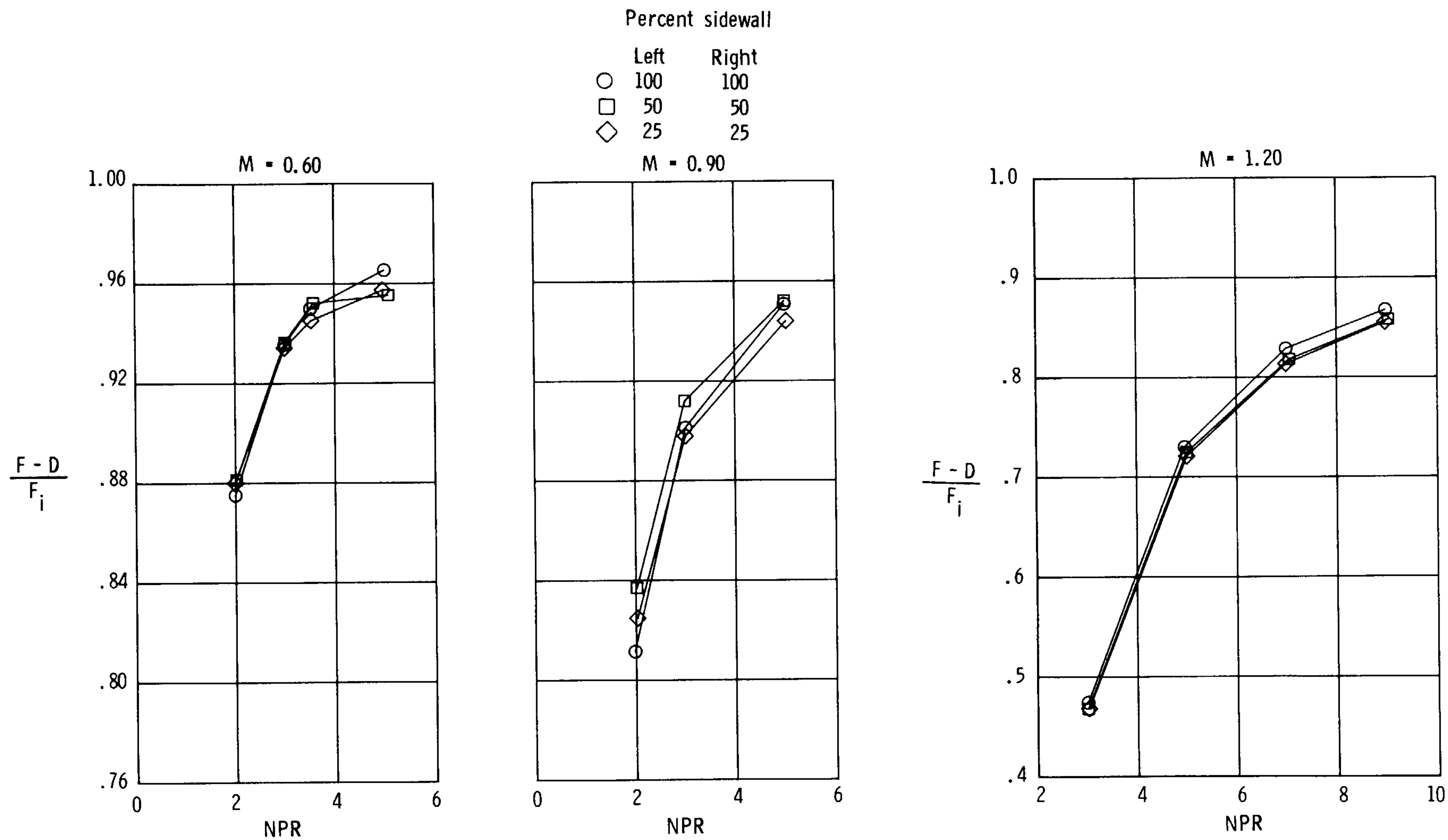
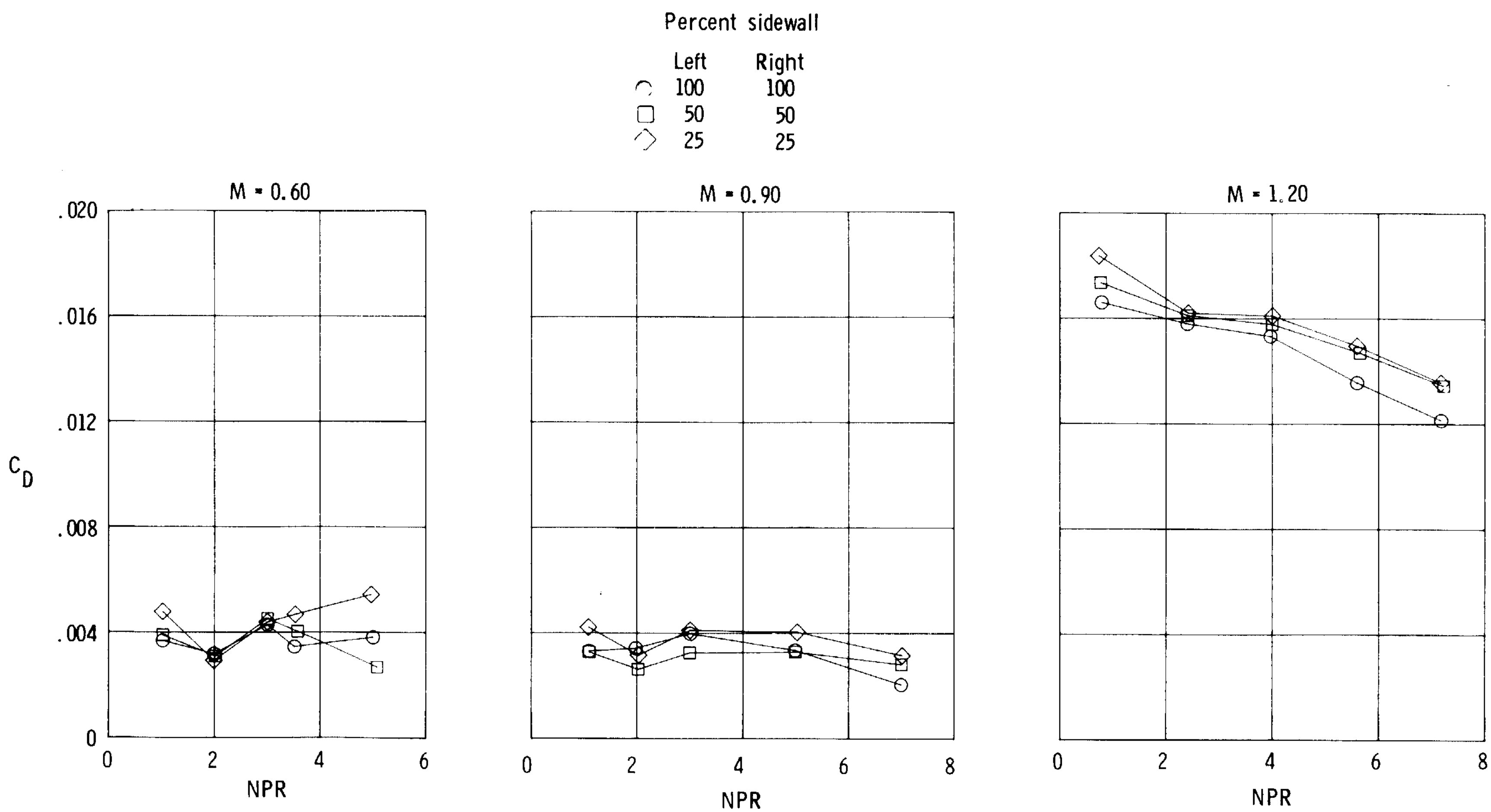


Figure 8. Effect of cutback sidewalls on A/B nozzle static performance with $\alpha = 0^{\circ}$ and $\delta_{v,p} = 15^{\circ}$.



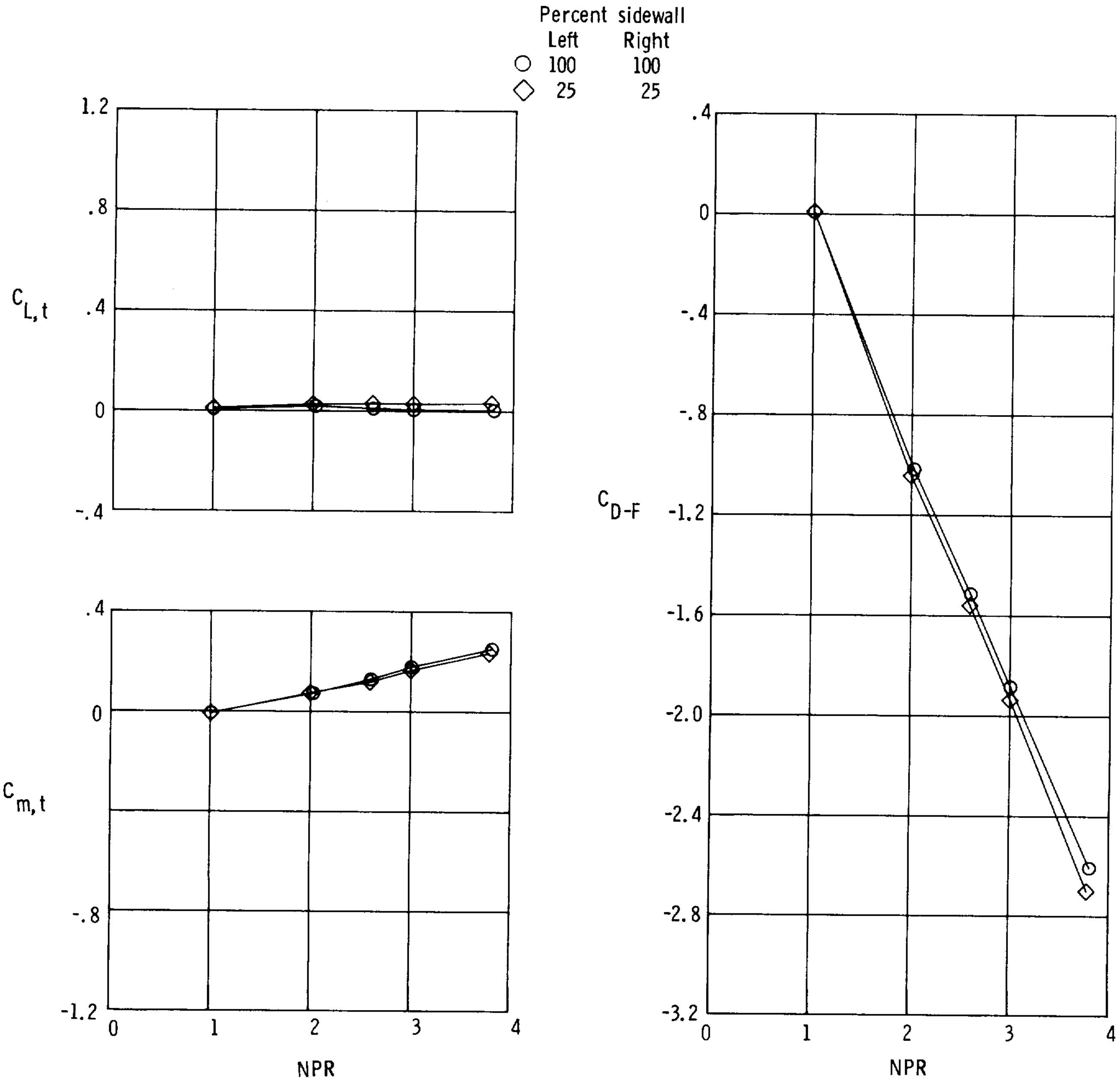
(a) Thrust-minus-drag performance.

Figure 9. Effect of cutback sidewalls on afterbody aeropropulsive performance with $\delta_{v,p} = 0°$ and $\alpha = 0°$.



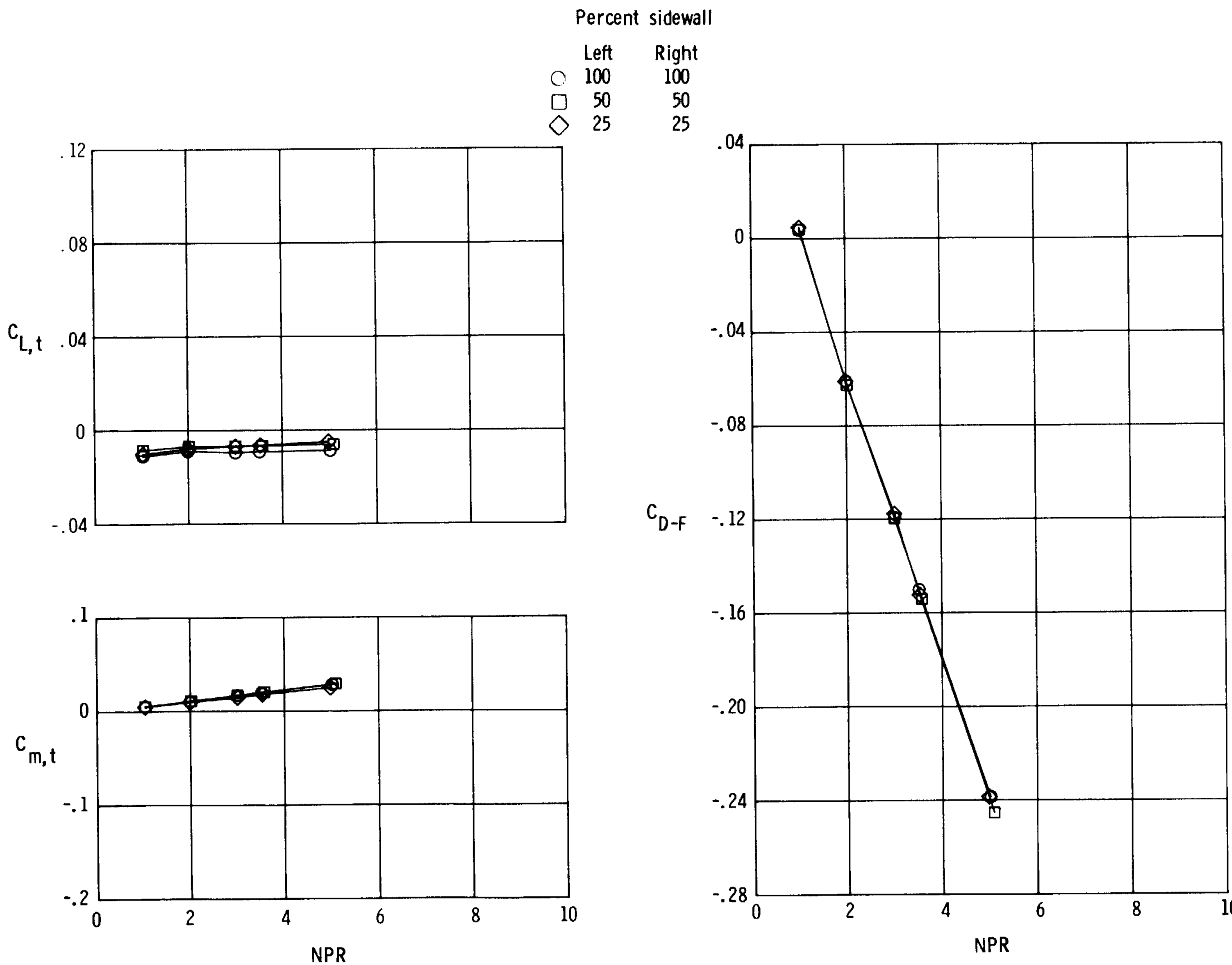
(b) Afterbody drag.

Figure 9. Concluded.



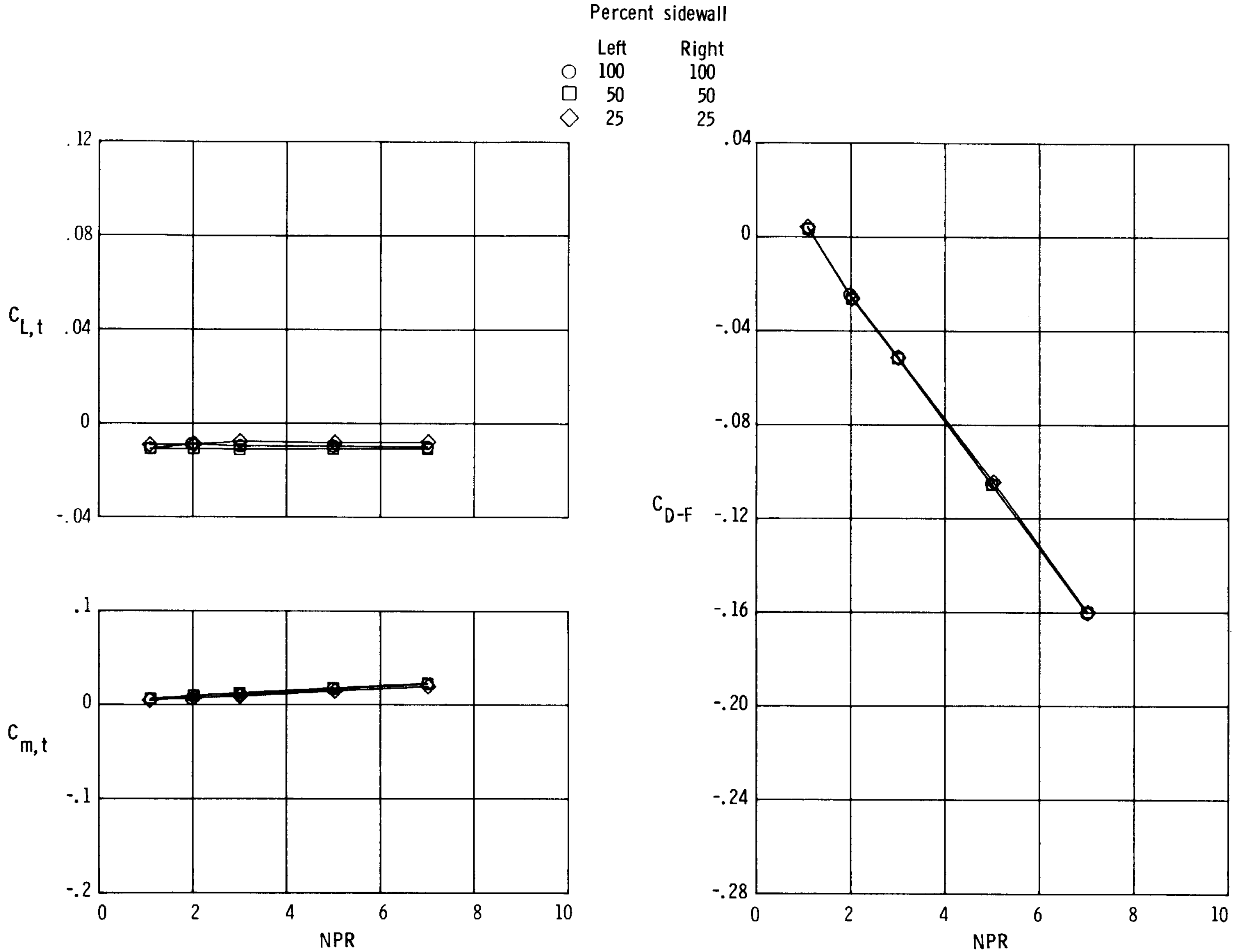
(a) $M = 0.15$.

Figure 10. Effect of cutback sidewalls on total lift coefficient, drag coefficient, and pitching-moment coefficient (including thrust) with $\alpha = 0°$ and $\delta_{v,p} = 0°$.



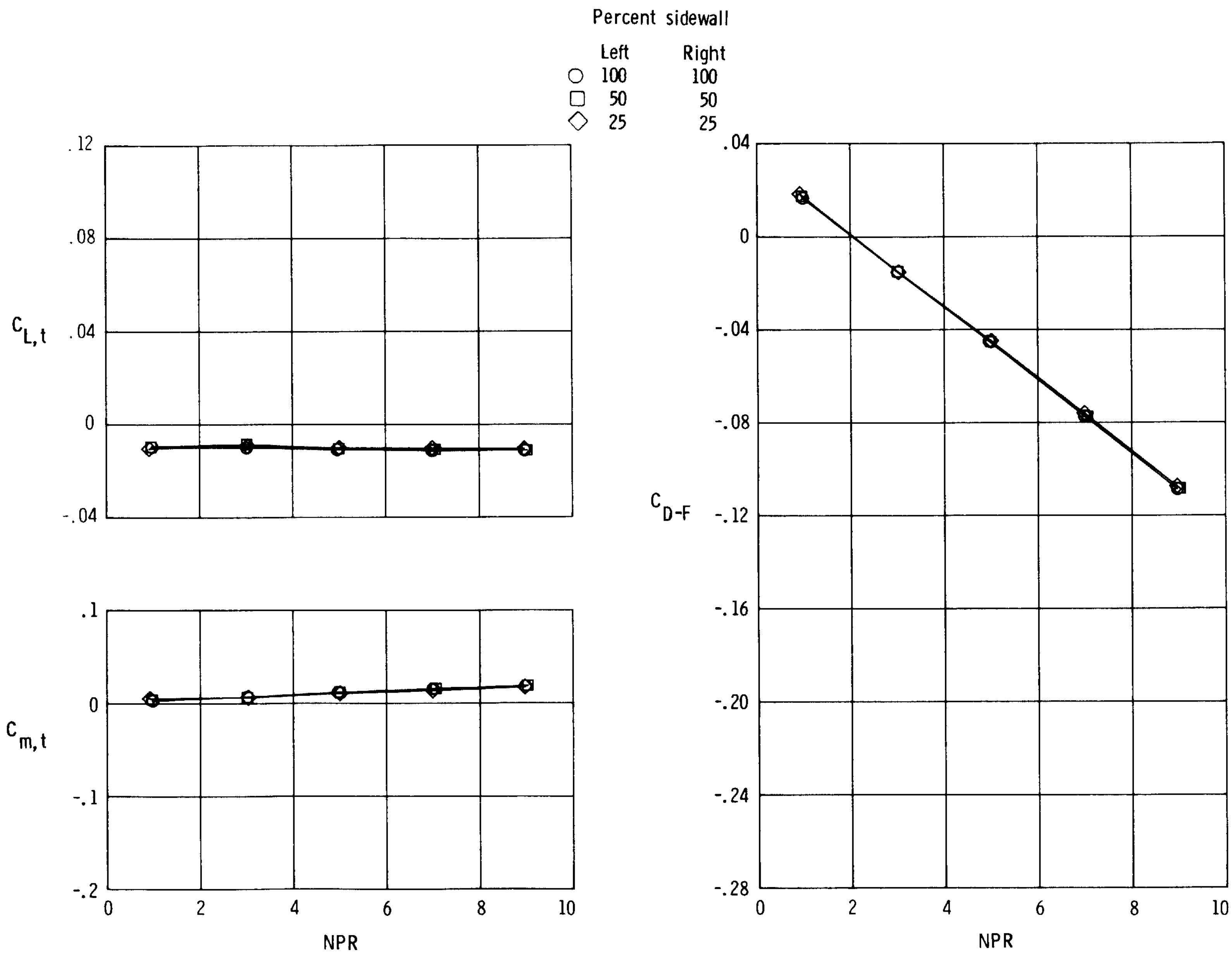
(b) $M = 0.60$.

Figure 10. Continued.



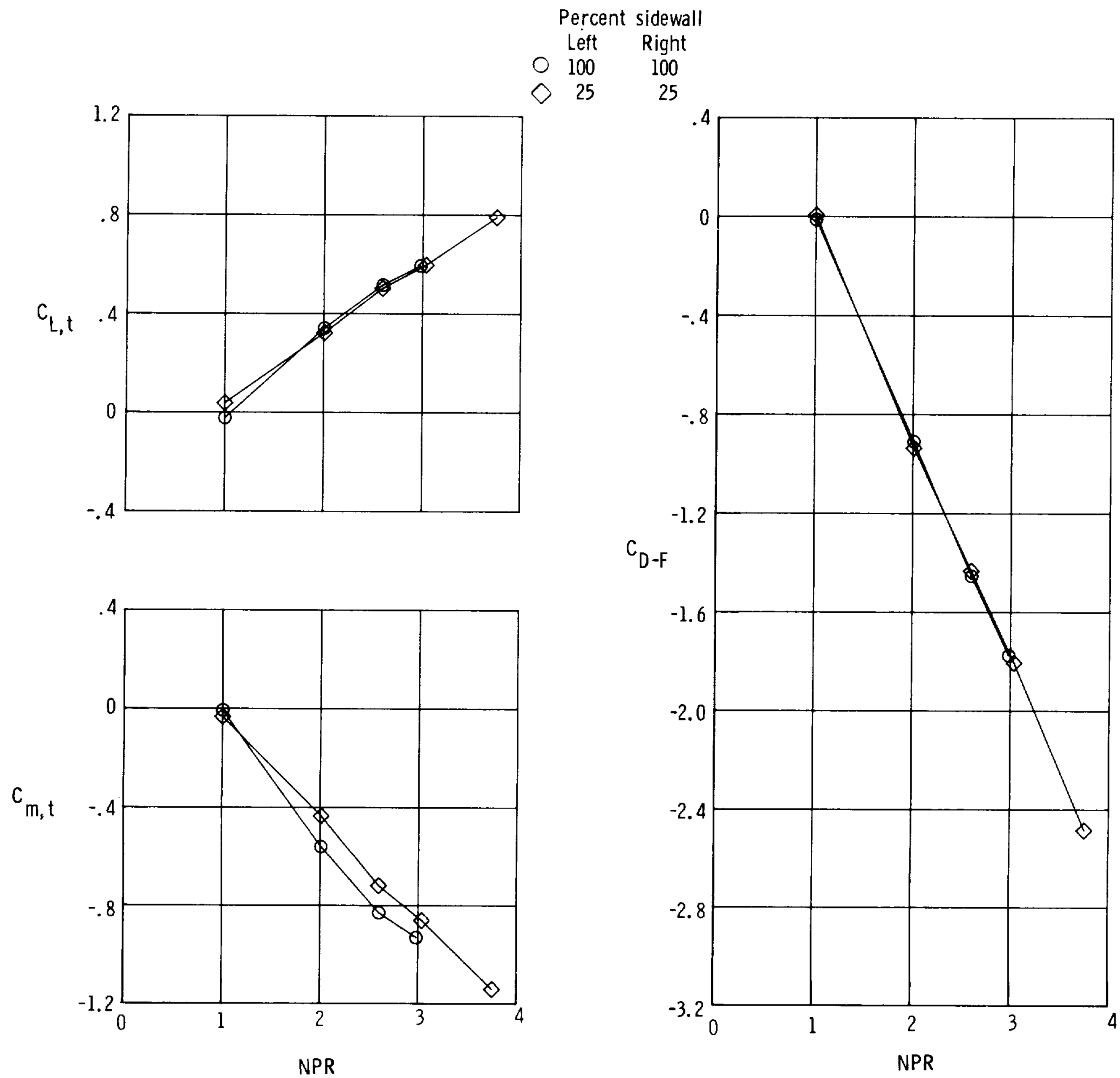
(c) $M = 0.90$.

Figure 10. Continued.



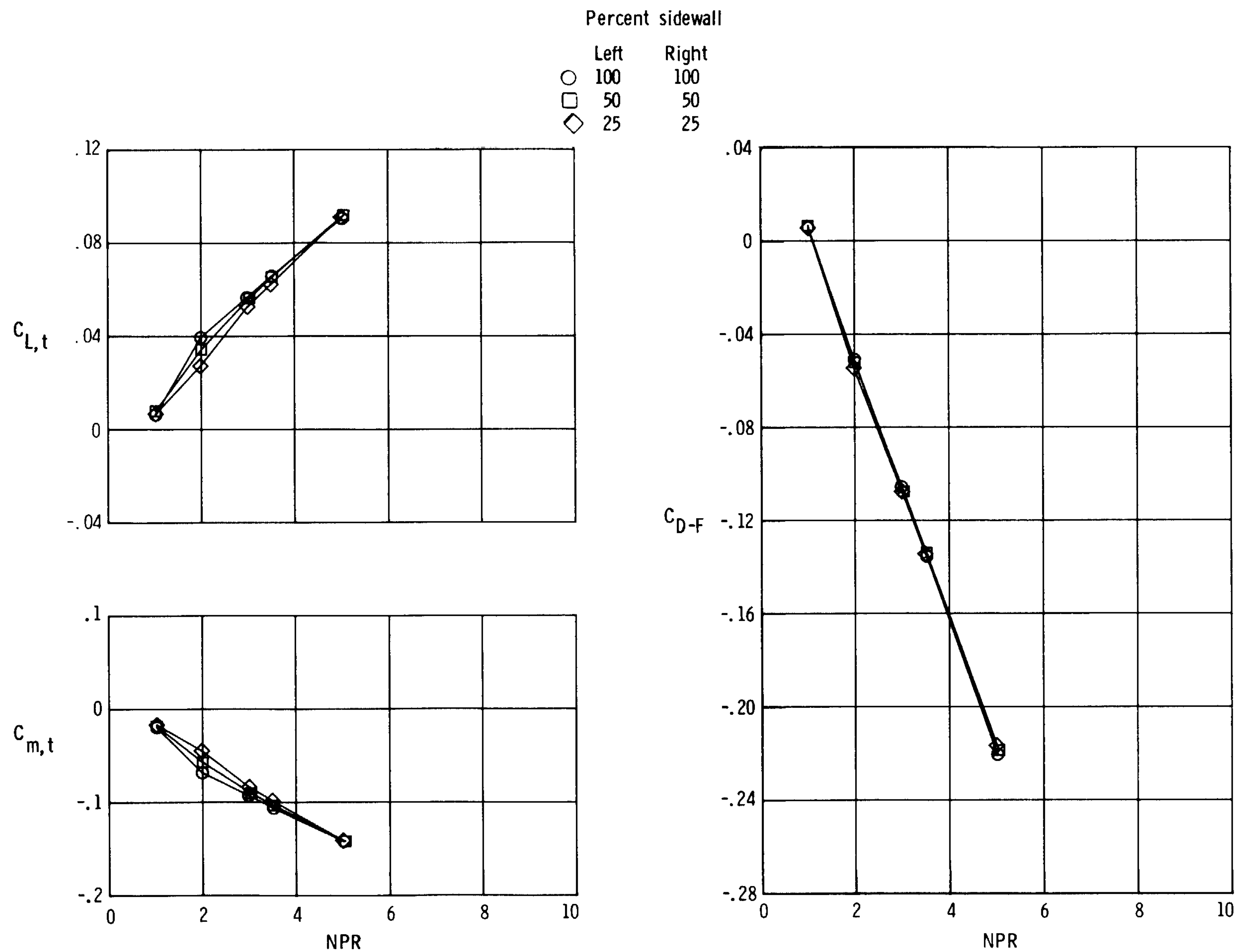
(d) $M = 1.20$.

Figure 10. Concluded.



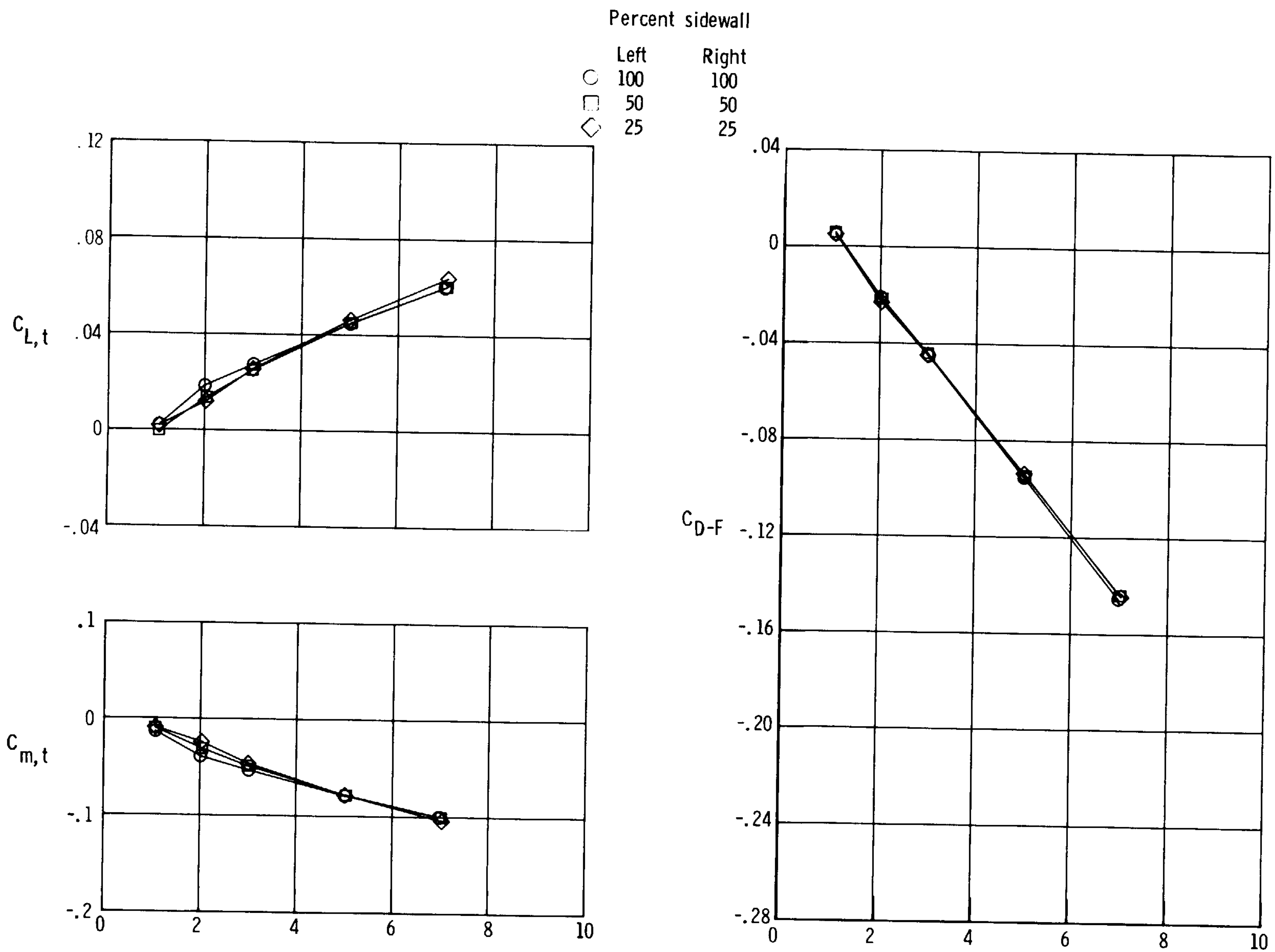
(a) $M = 0.15$.

Figure 11. Effect of cutback sidewalls on total lift coefficient, drag coefficient, and pitching-moment coefficient (including thrust) with $\alpha = 0°$ and $\delta_{v,p} = 15°$.



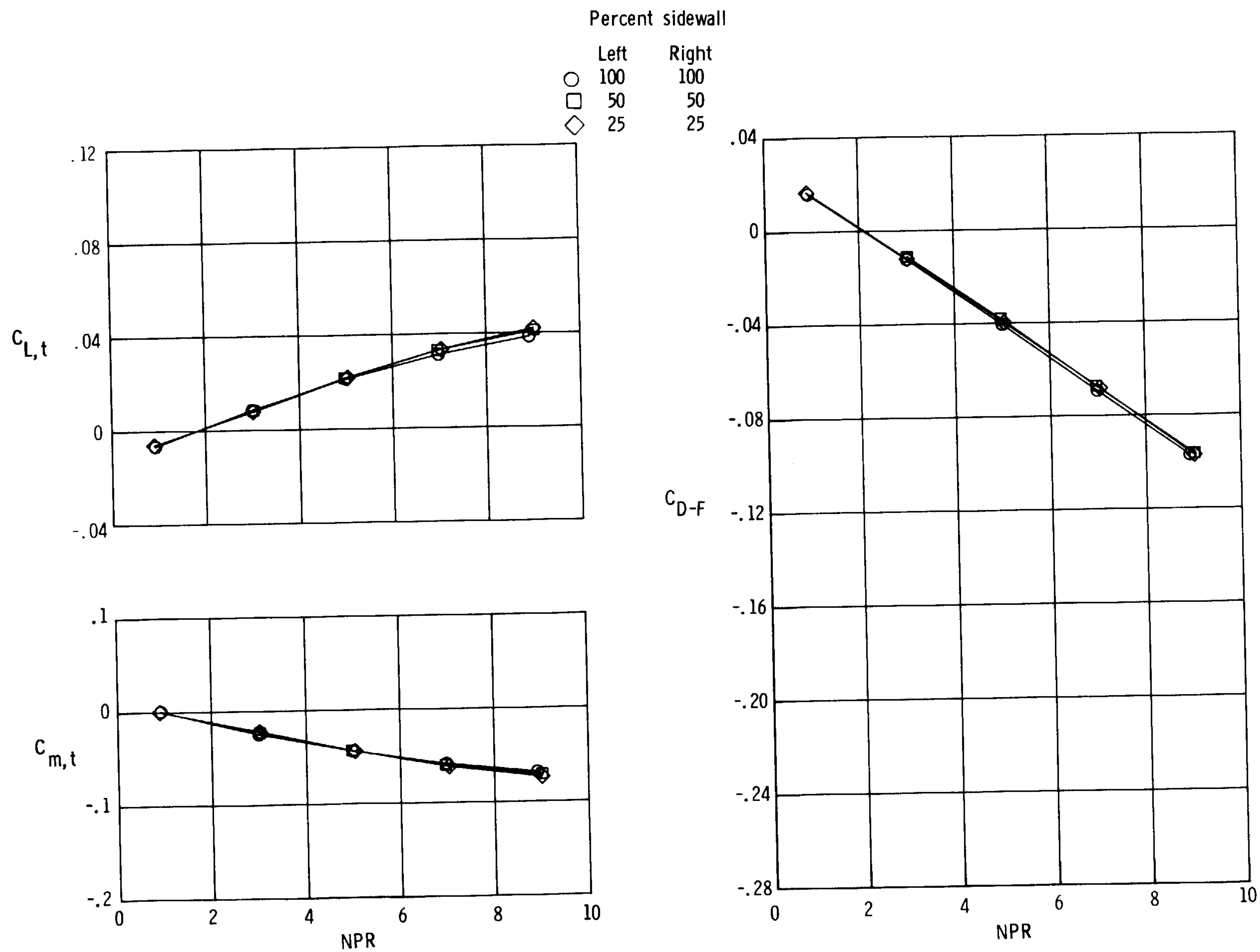
(b) $M = 0.60$.

Figure 11. Continued.



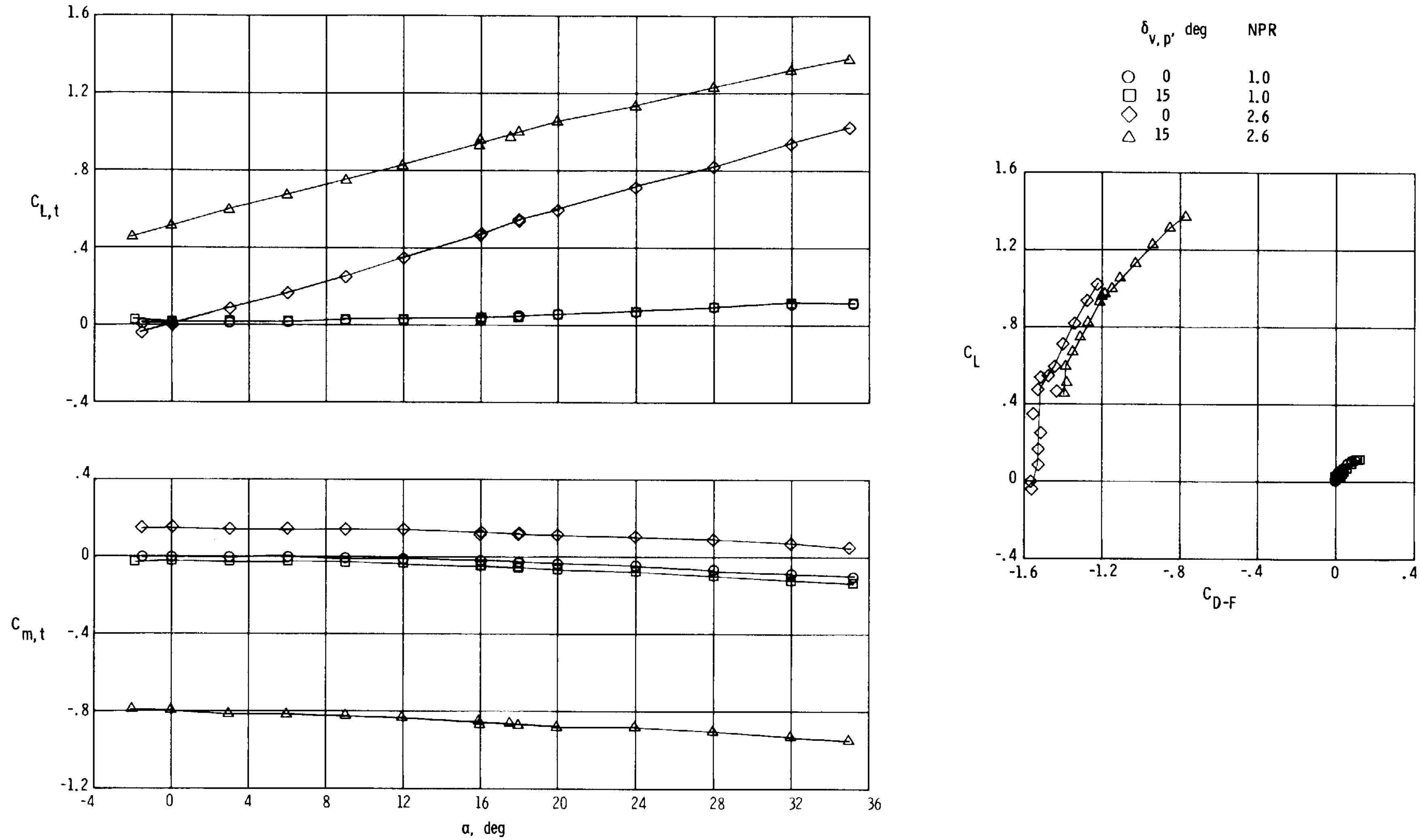
(c) $M = 0.90$.

Figure 11. Continued.



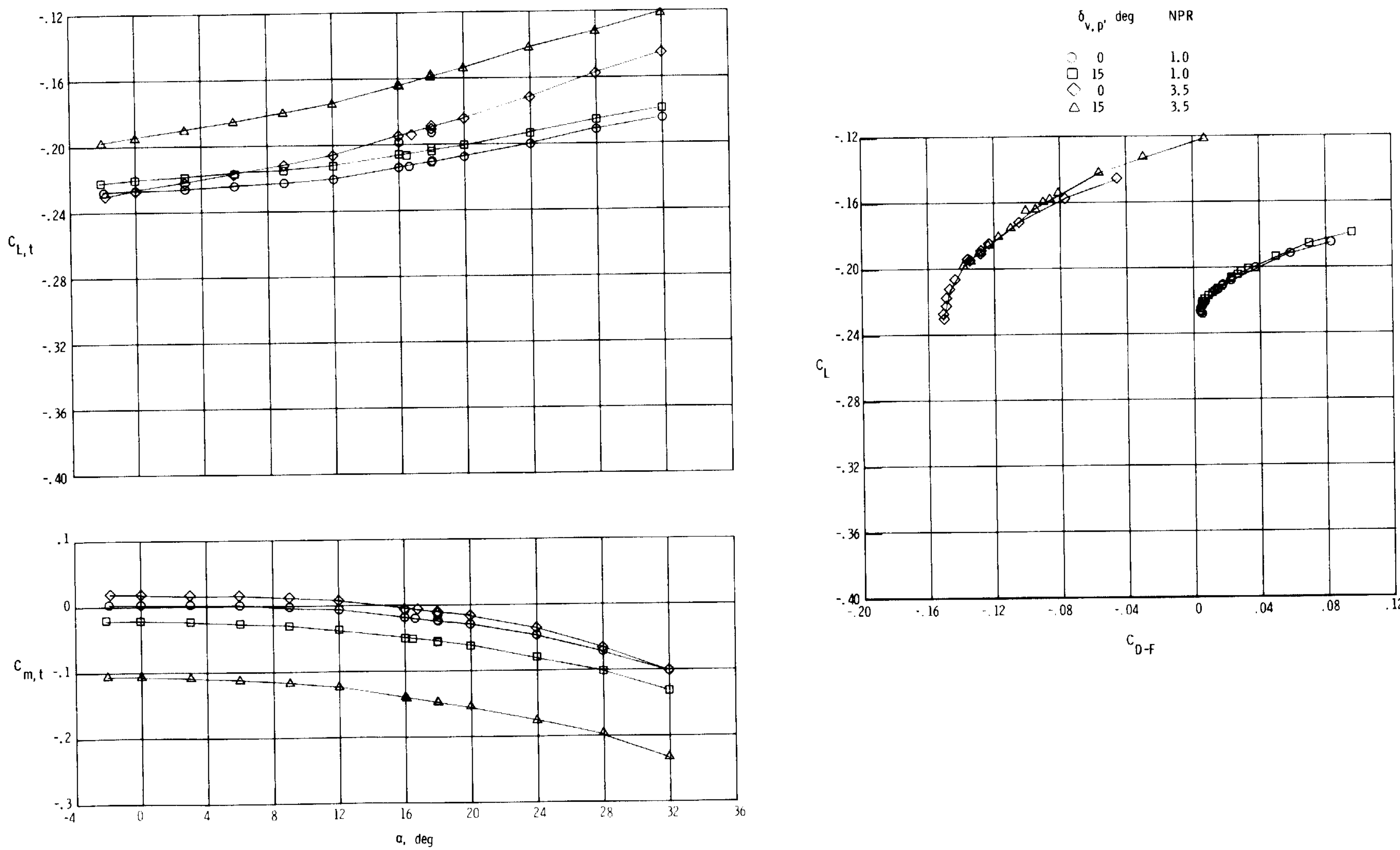
(d) $M = 1.20$.

Figure 11. Concluded.



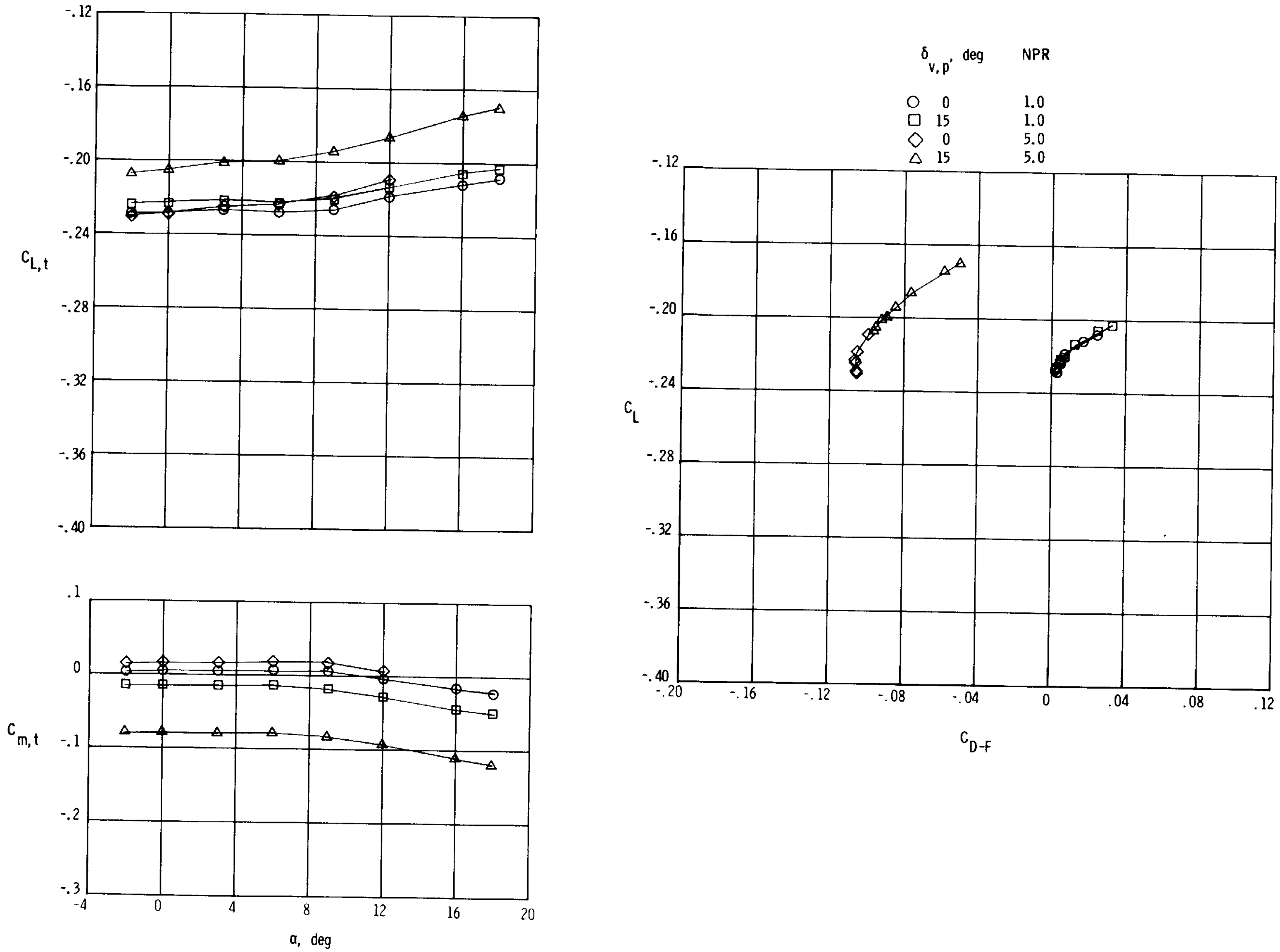
(a) $M = 0.15$.

Figure 12. Effect of pitch vectoring on total aerodynamic coefficients (including thrust) at constant NPR settings with 100-percent sidewalls.



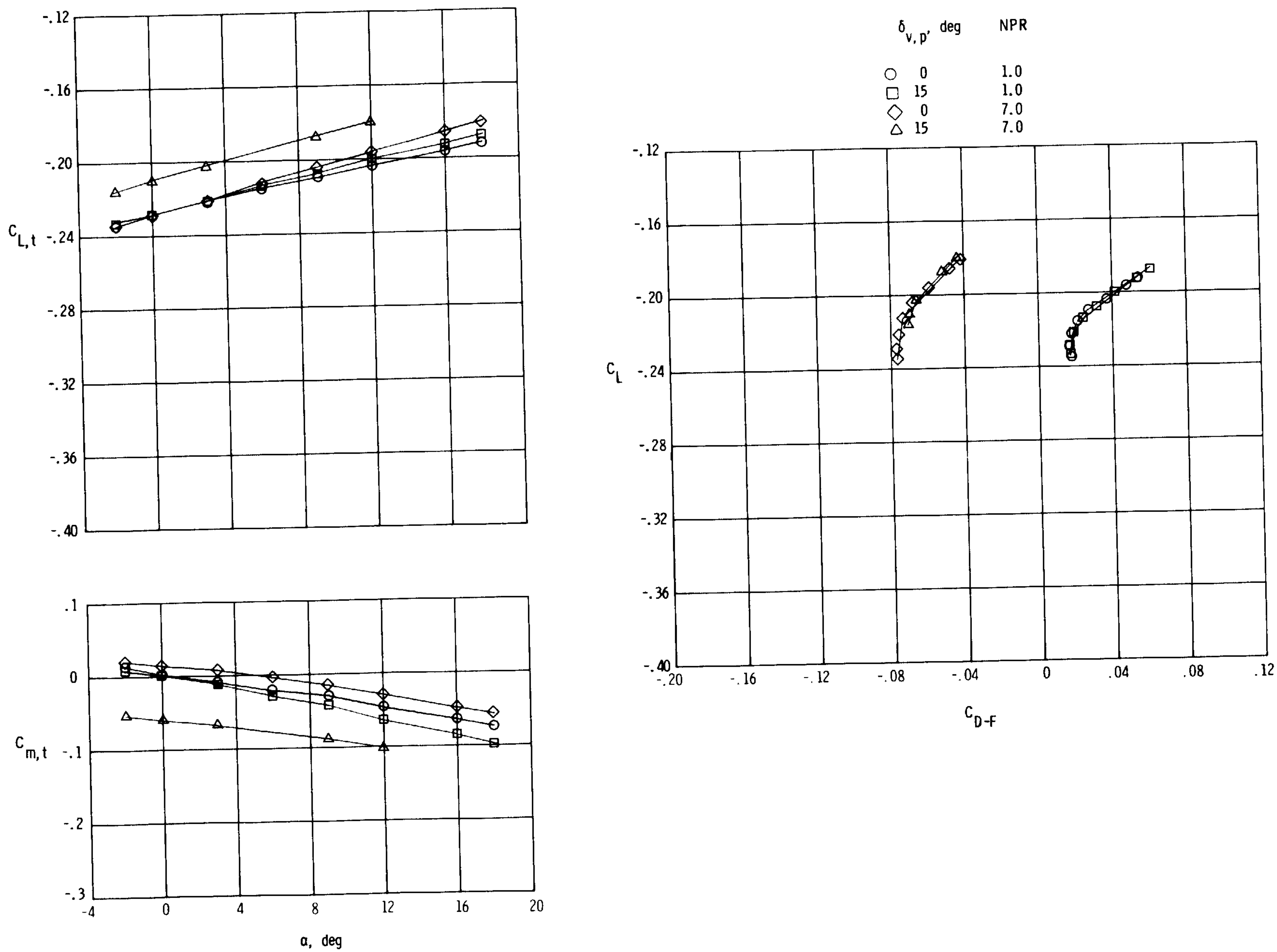
(b) $M = 0.60$.

Figure 12. Continued.



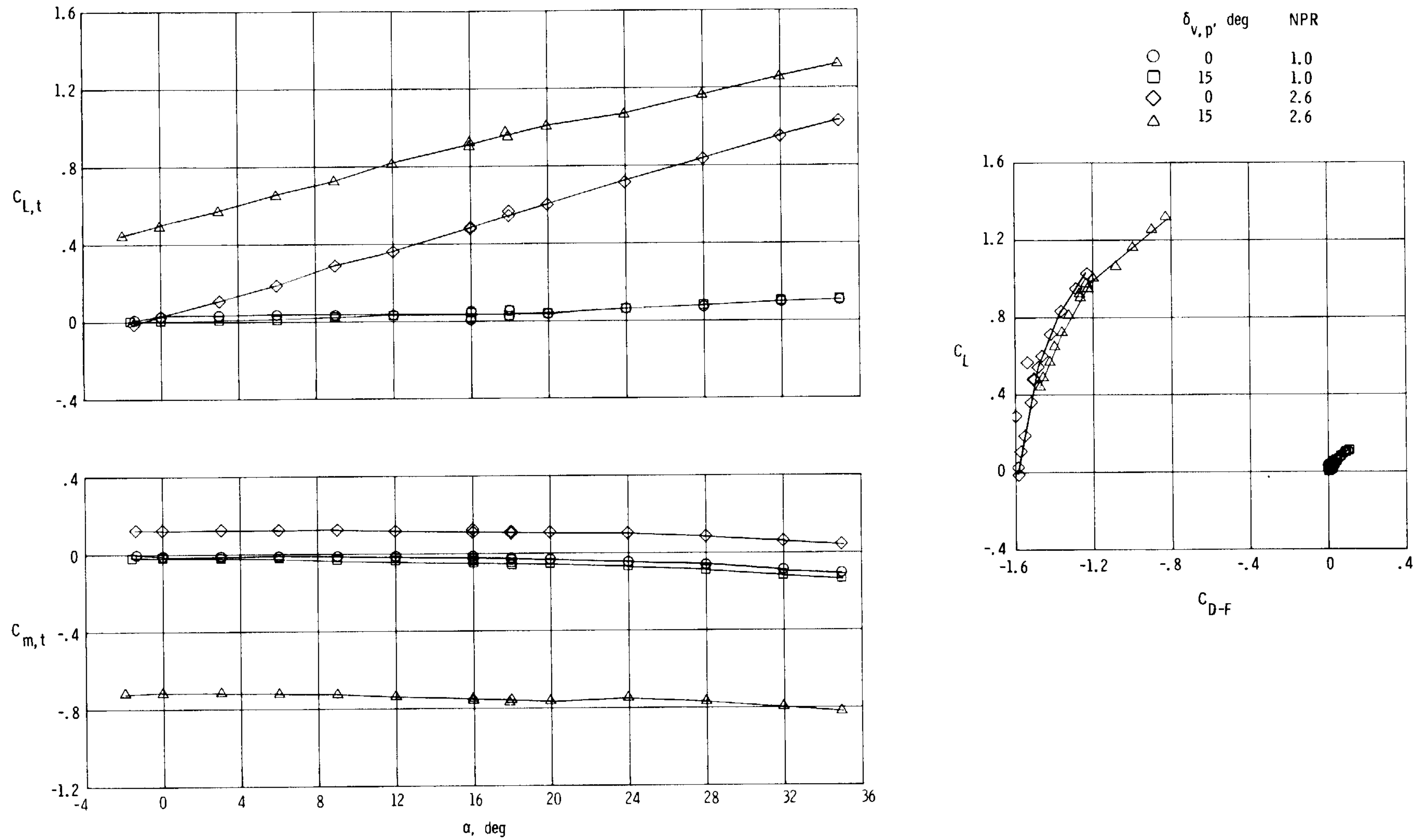
(c) $M = 0.90$.

Figure 12. Continued.



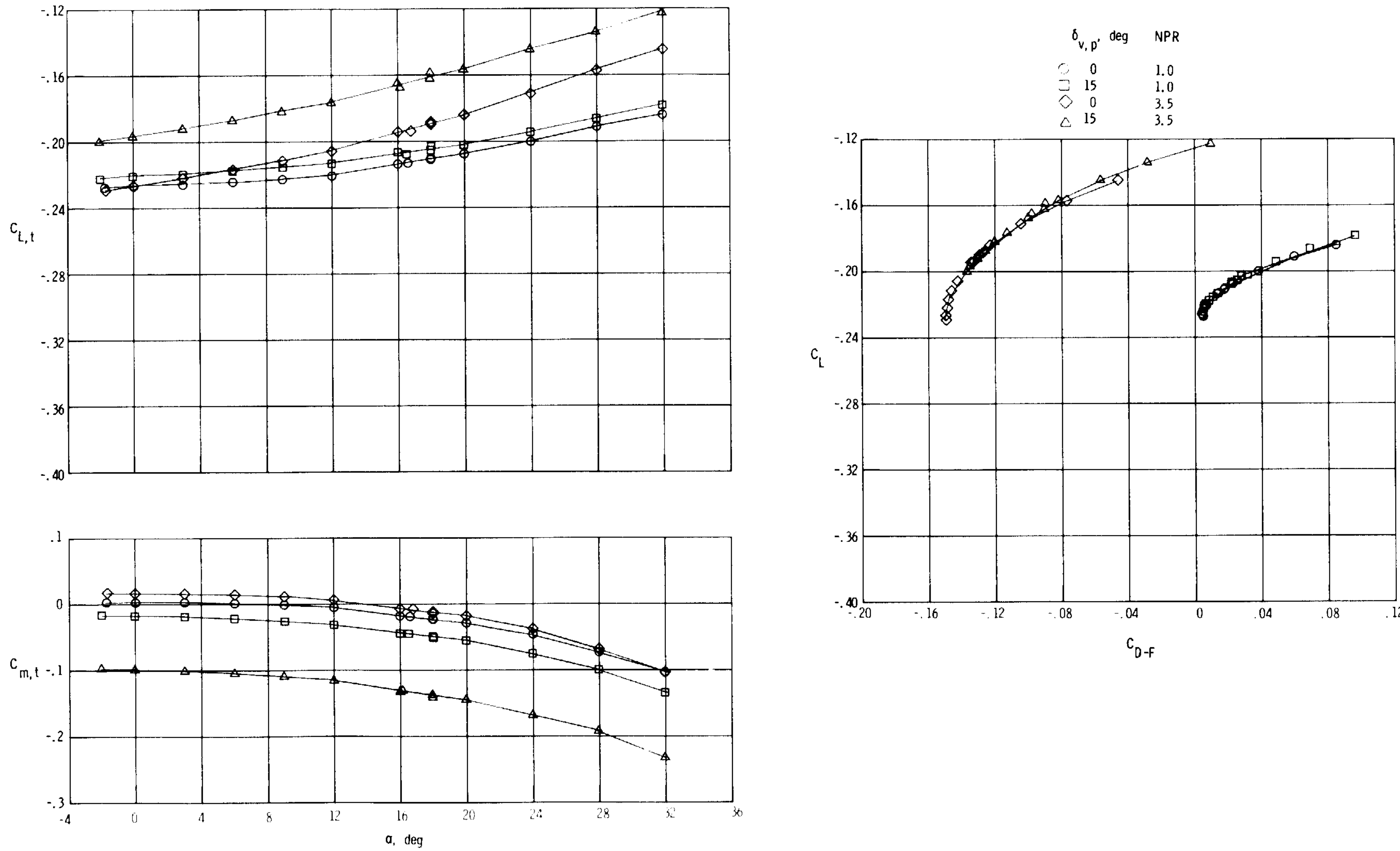
(d) $M = 1.20$.

Figure 12. Concluded.



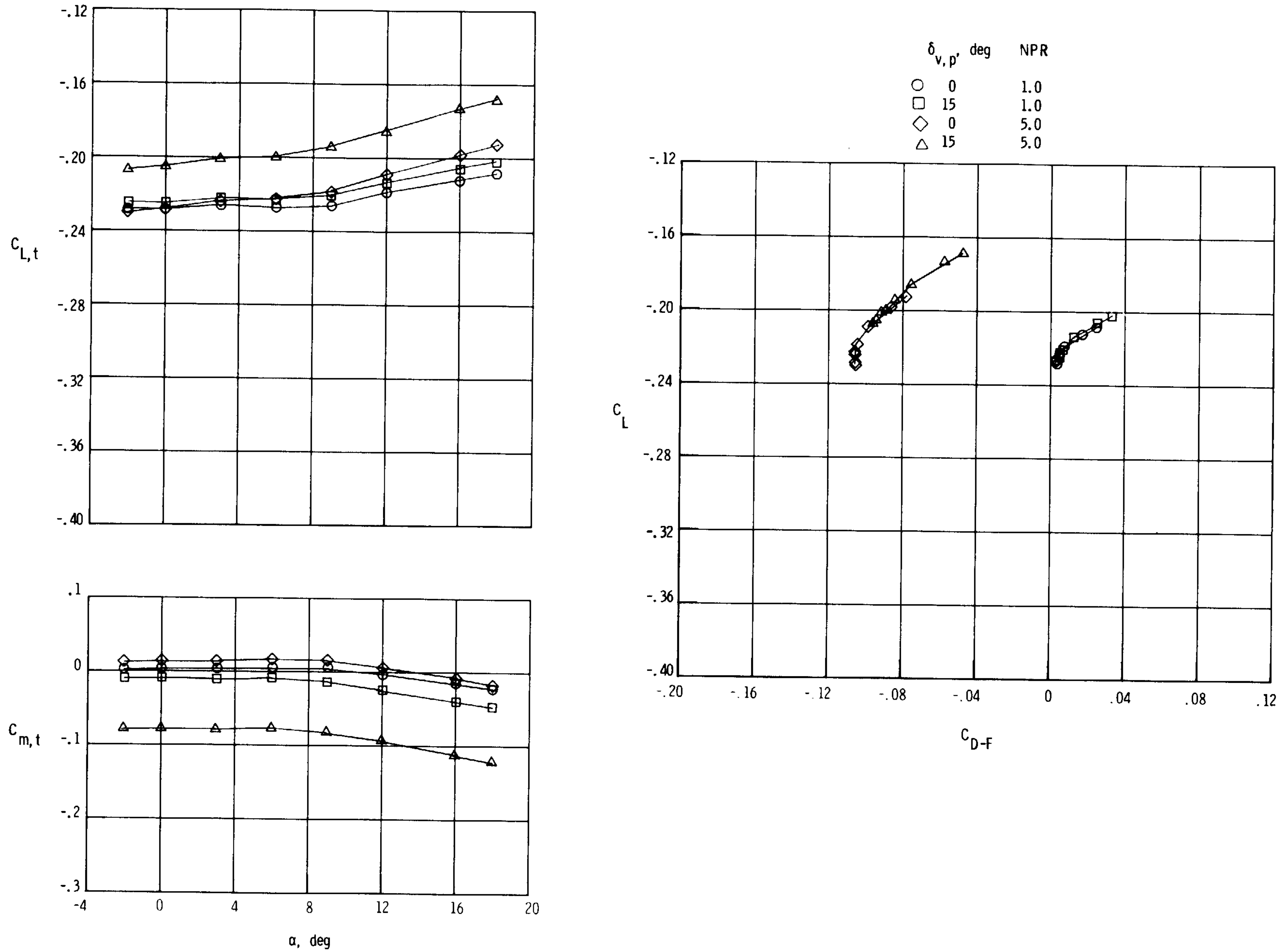
(a) $M = 0.15$.

Figure 13. Effect of pitch vectoring on total aerodynamic coefficients (including thrust) at constant NPR settings with 25-percent sidewalls.



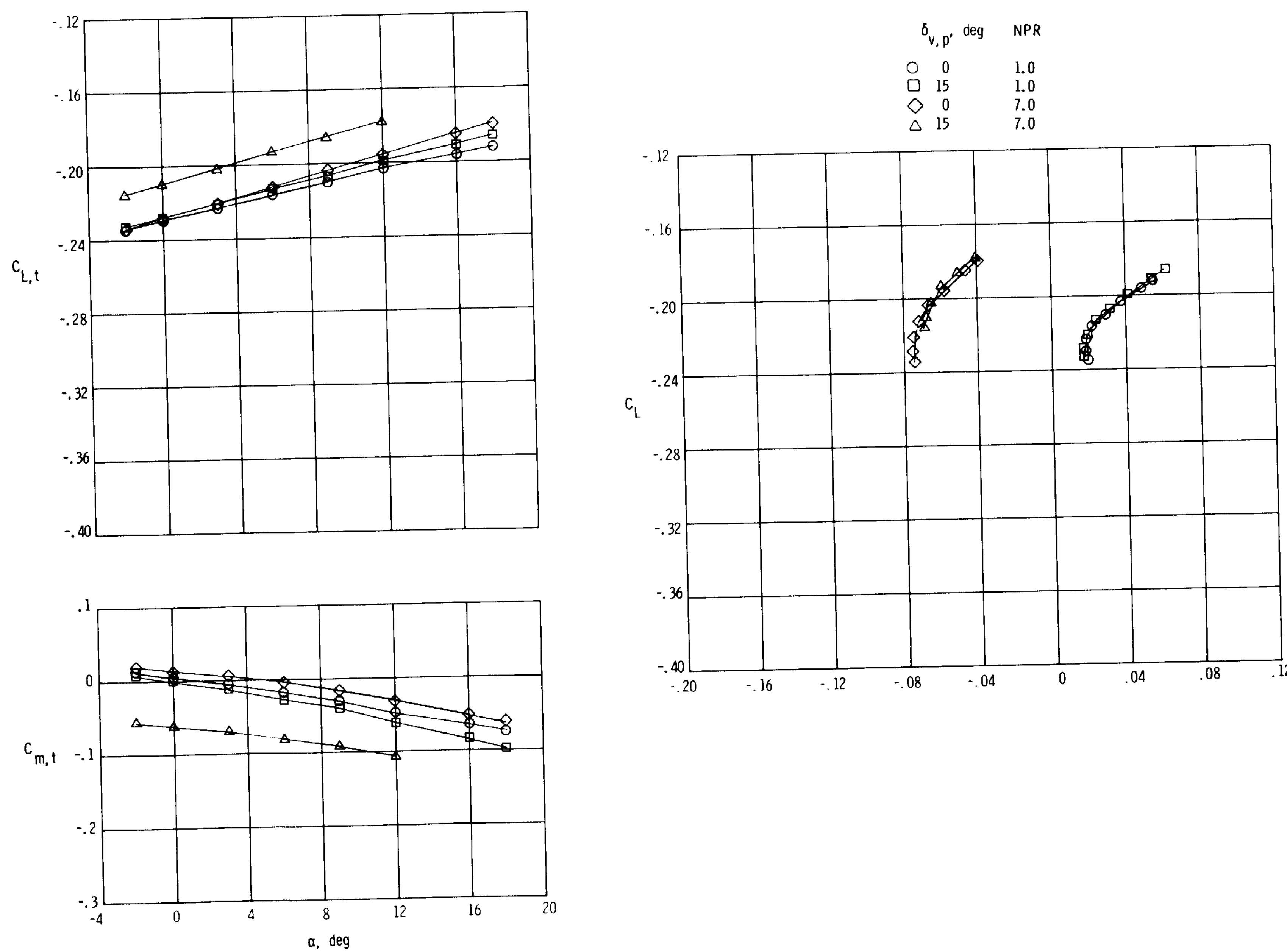
(b) $M = 0.60$.

Figure 13. Continued.



(c) $M = 0.90$.

Figure 13. Continued.



(d) $M = 1.20$.

Figure 13. Concluded.

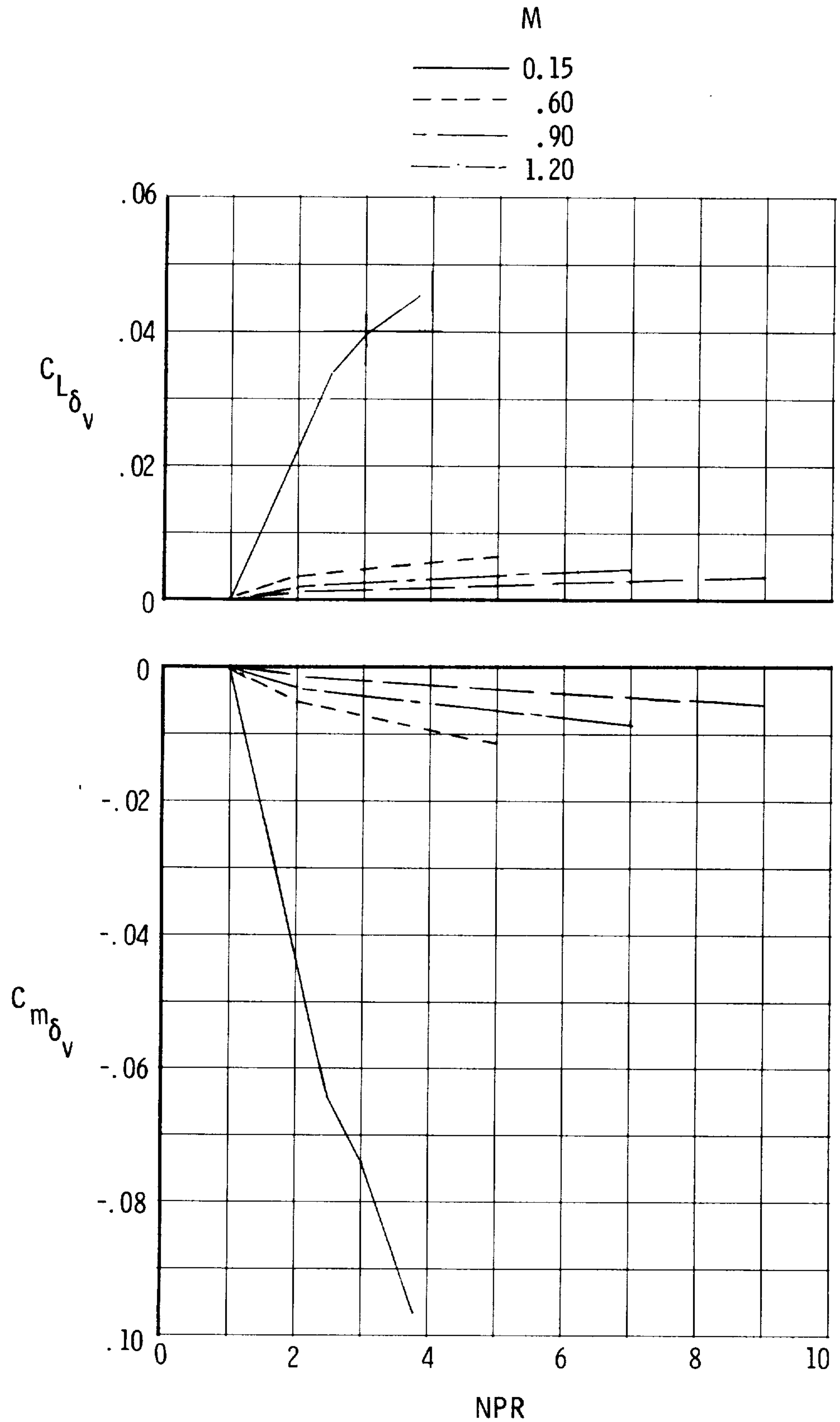


Figure 14. Effect of nozzle pressure ratio on longitudinal control power and lift effectiveness due to pitch vectoring with $\alpha = 0°$.

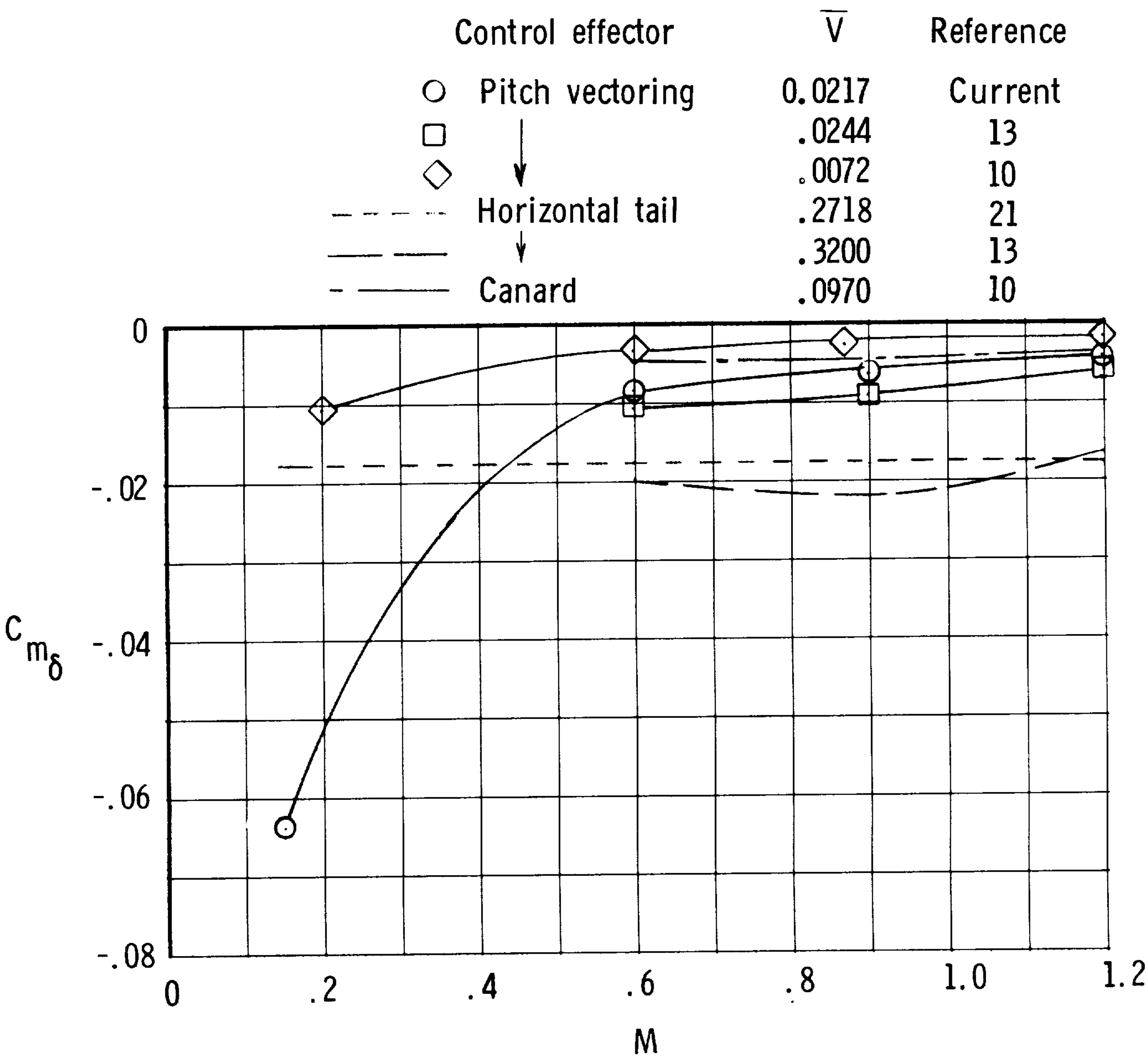


Figure 15. Comparison of longitudinal control power from powered and aerodynamic control effectors with $\alpha = 0°$.

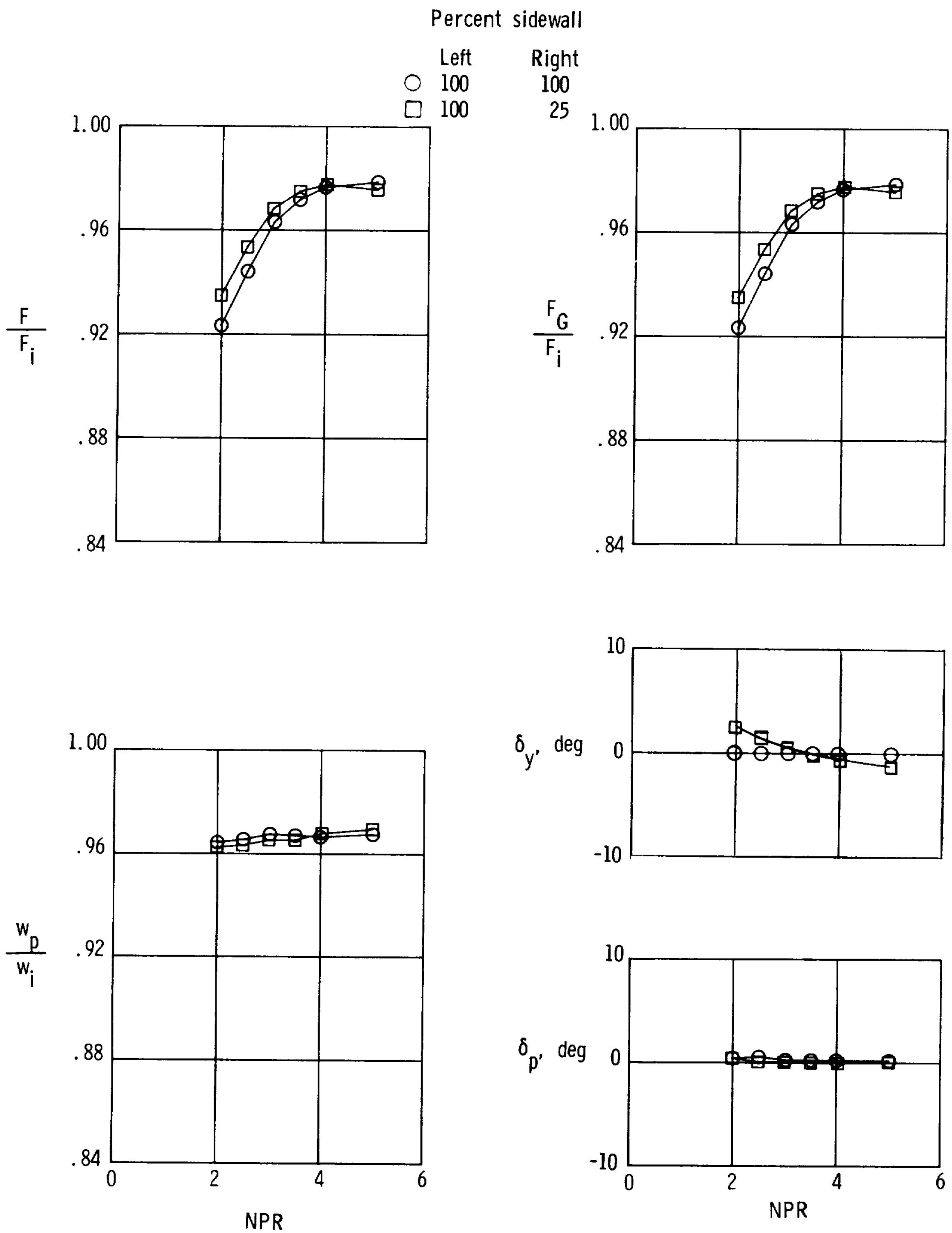
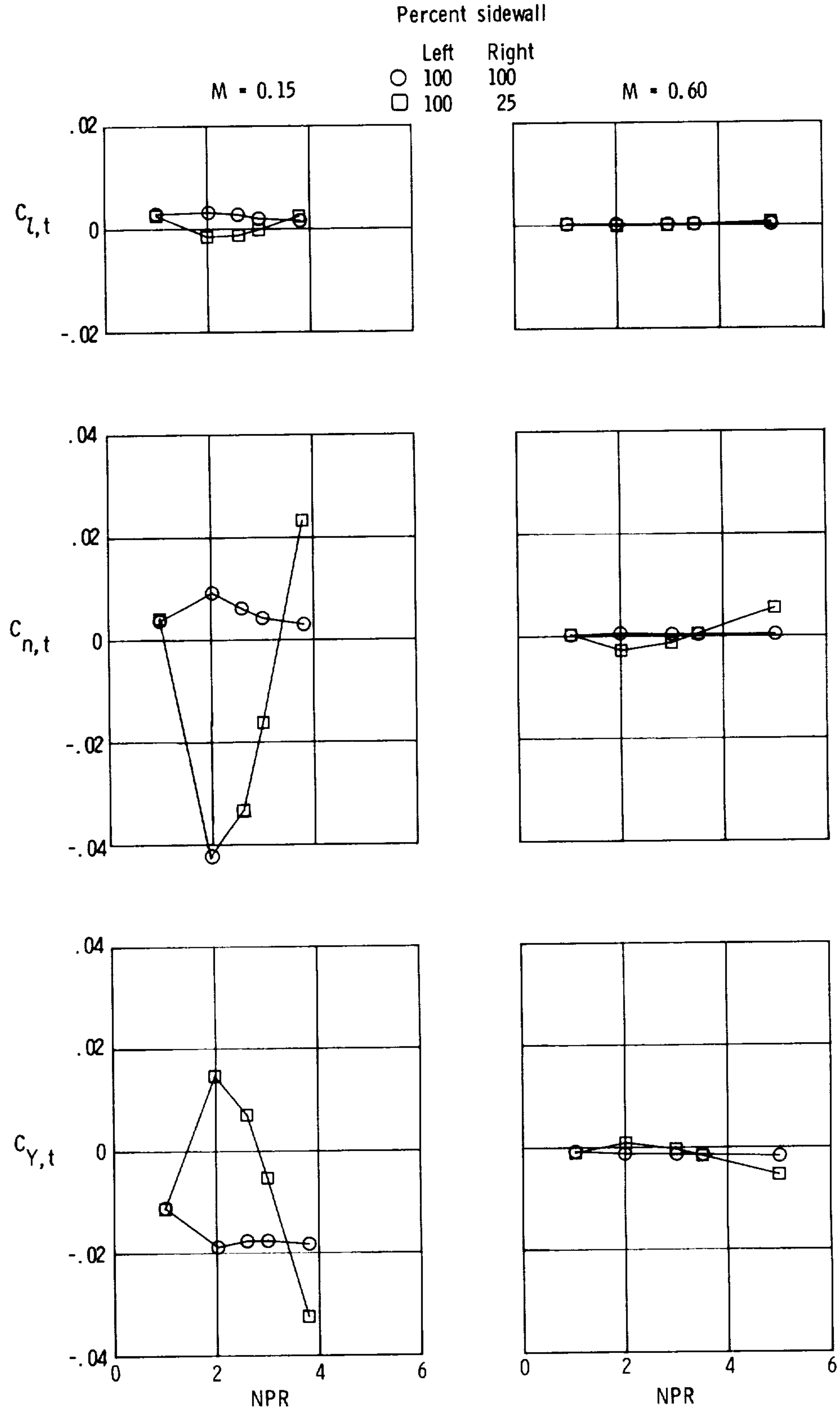
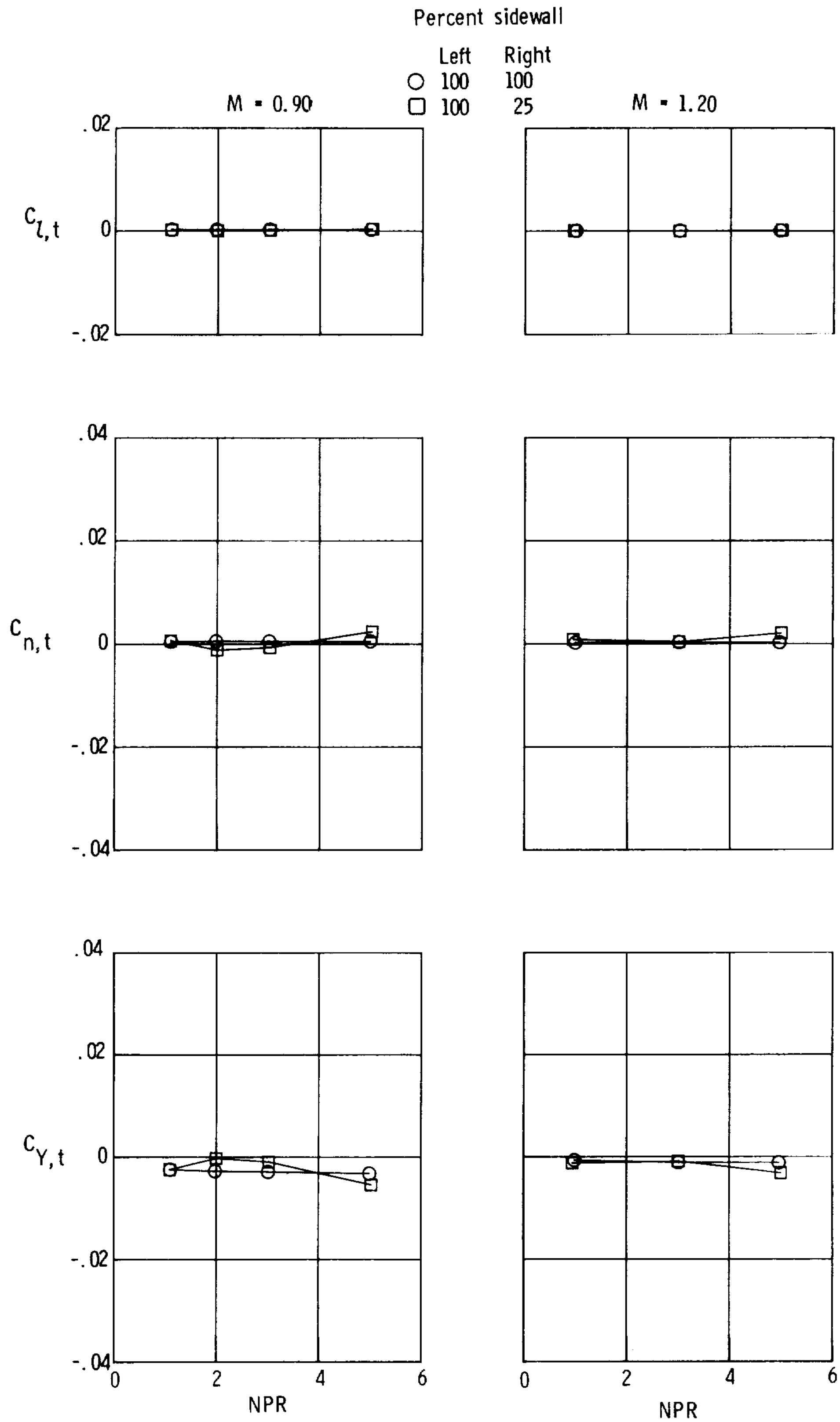


Figure 16. Effect of yaw vectoring by cutback sidewalls on nozzle static performance with $\alpha = 0°$ and $\delta_{v,p} = 0°$.



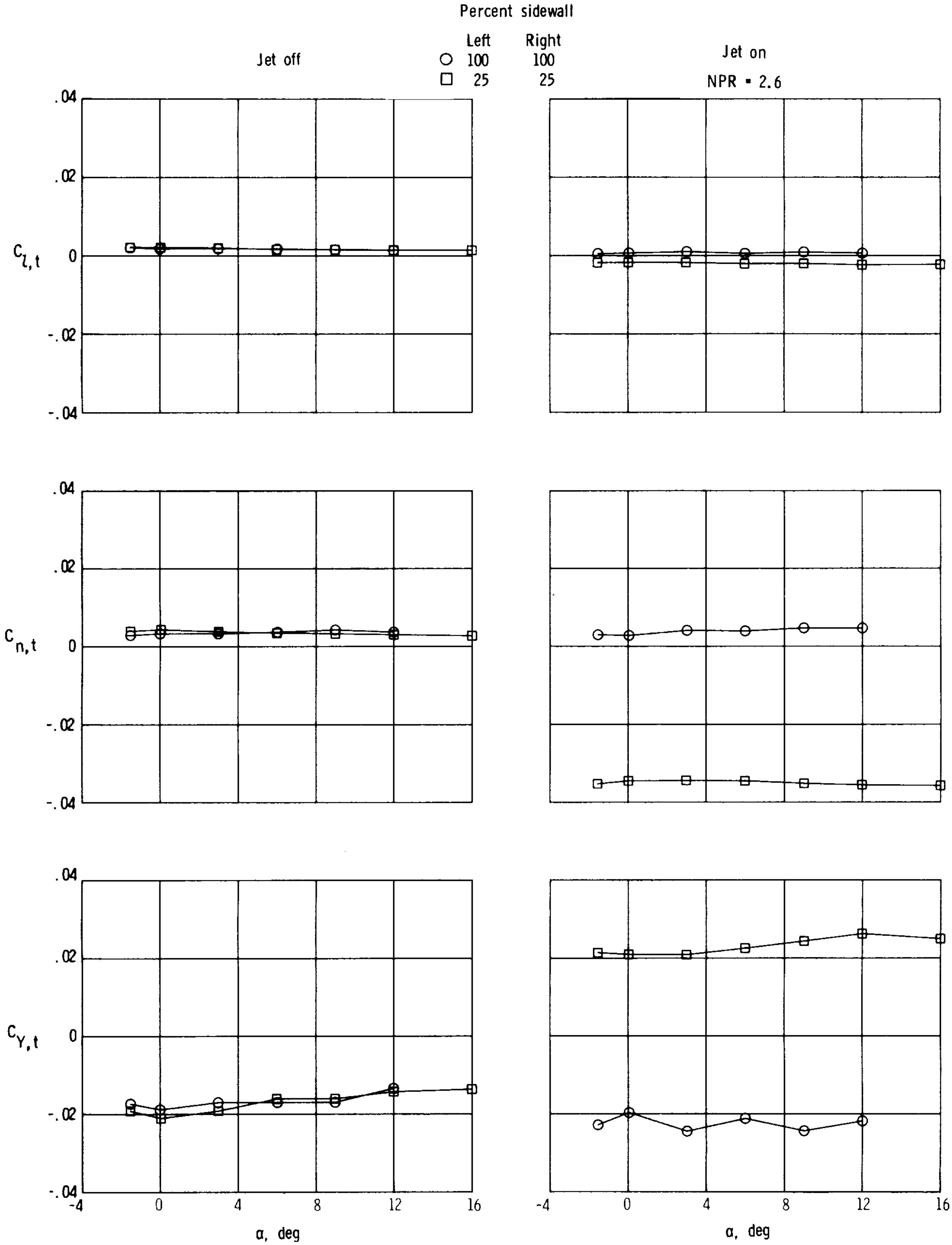
(a) $M = 0.15$ and 0.60.

Figure 17. Effect of yaw vectoring by cutback sidewalls on total afterbody lateral coefficients (including thrust) for A/B power nozzle with $\alpha = 0°$ and $\delta_{v,p} = 0°$.



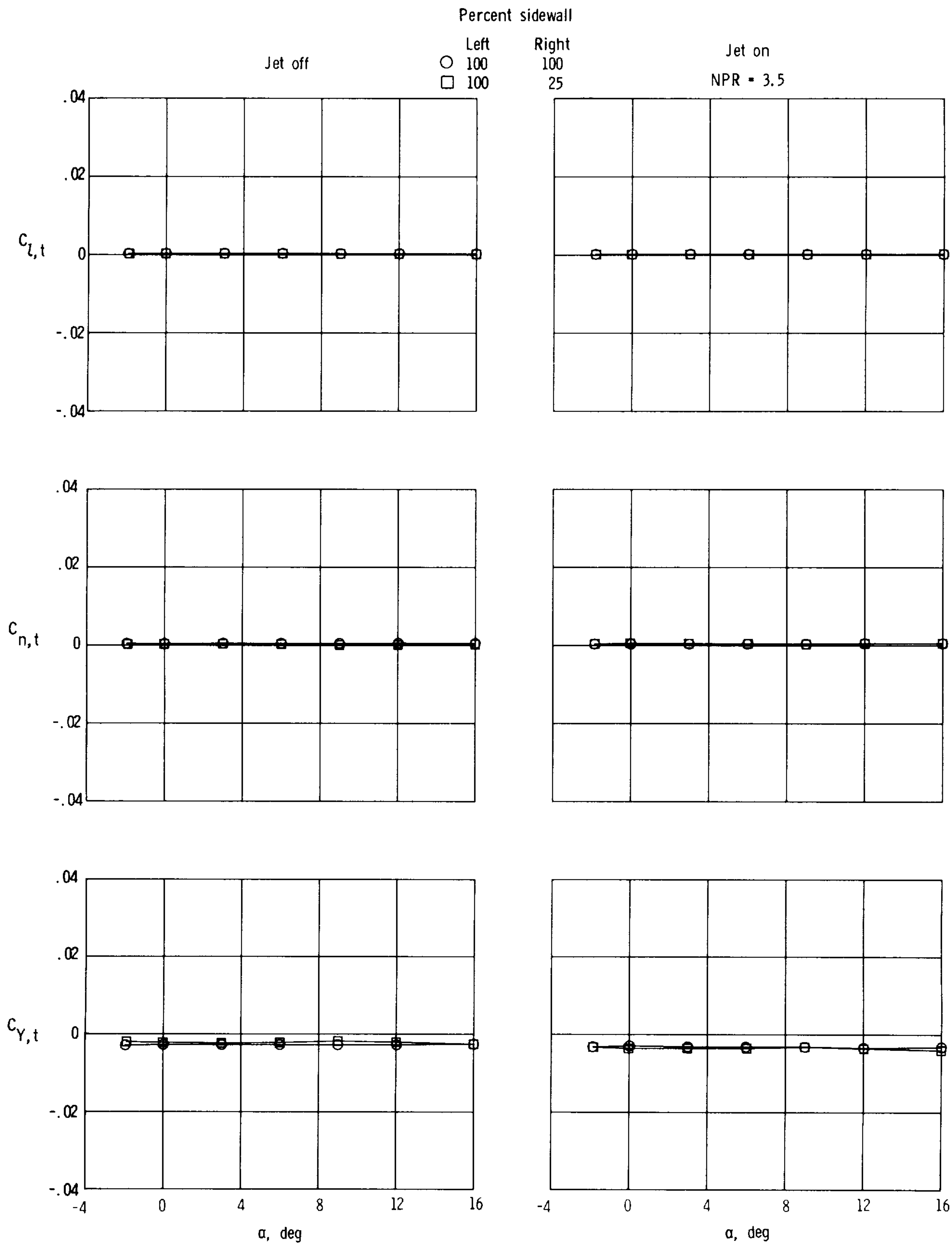
(b) $M = 0.90$ and 1.20.

Figure 17. Concluded.



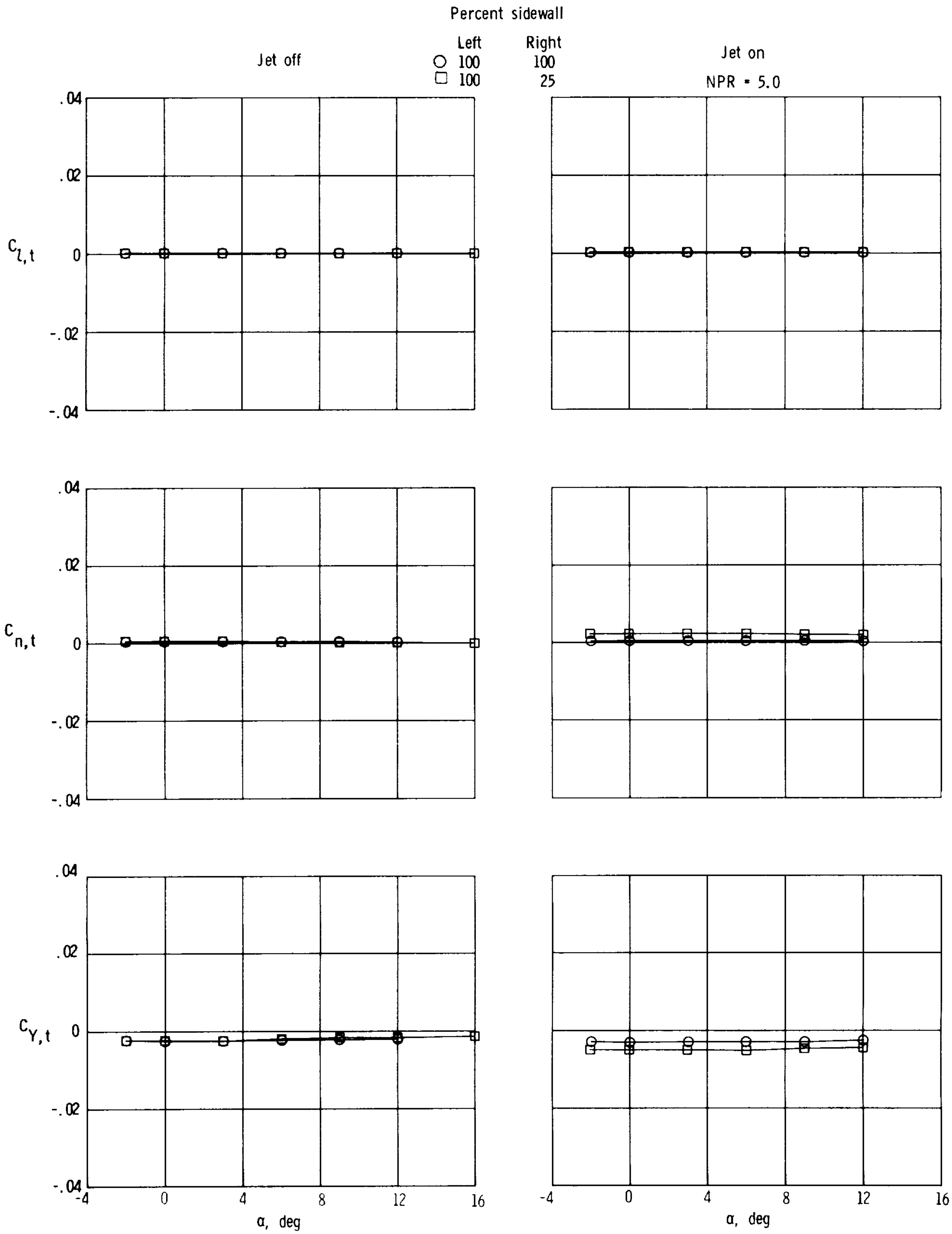
(a) $M = 0.15$.

Figure 18. Effect of yaw vectoring by cutback sidewalls on total lateral aerodynamic coefficients (including thrust) at constant NPR settings with $\delta_{v,p} = 0°$.



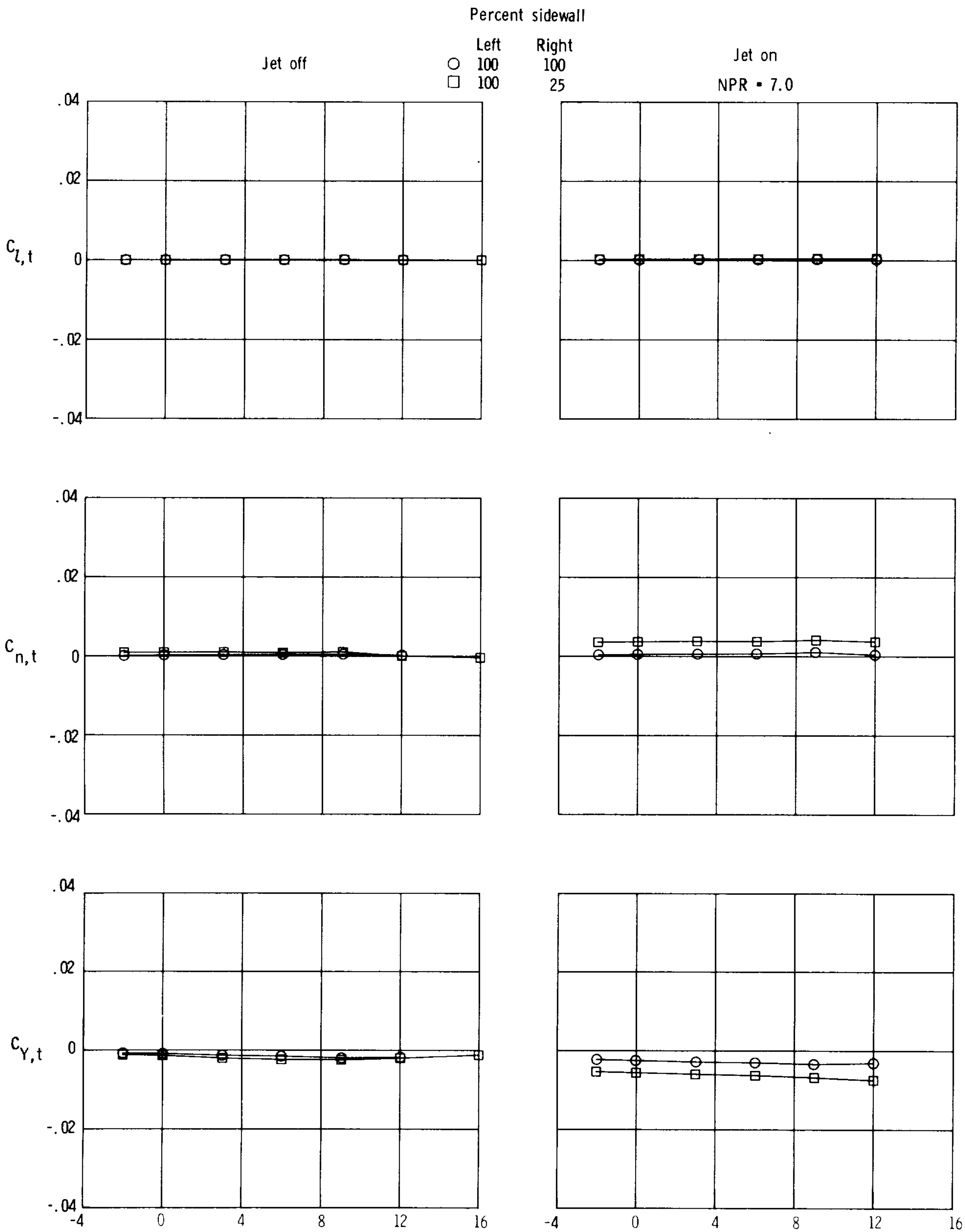
(b) $M = 0.60$.

Figure 18. Continued.



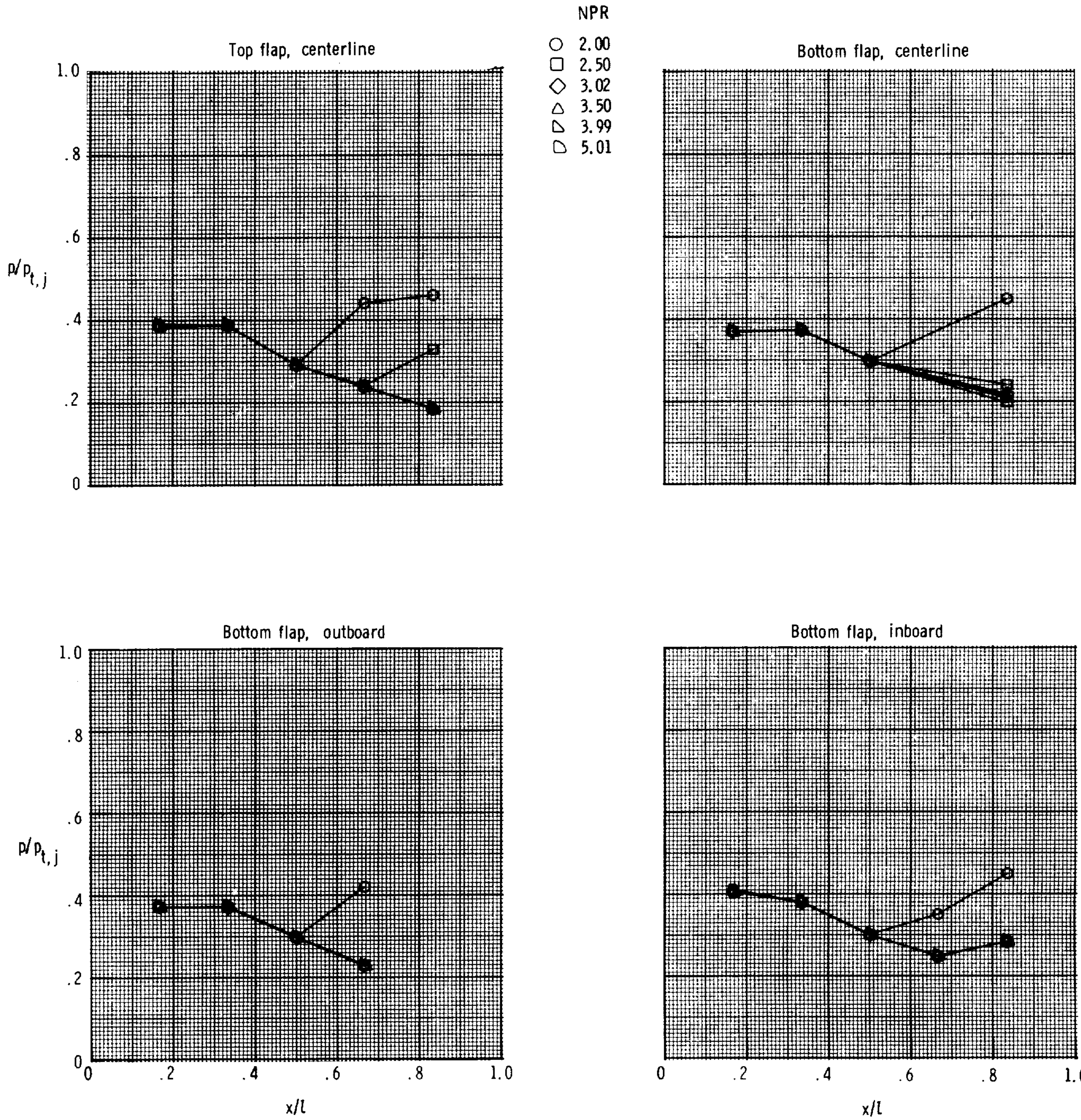
(c) $M = 0.90$.

Figure 18. Continued.



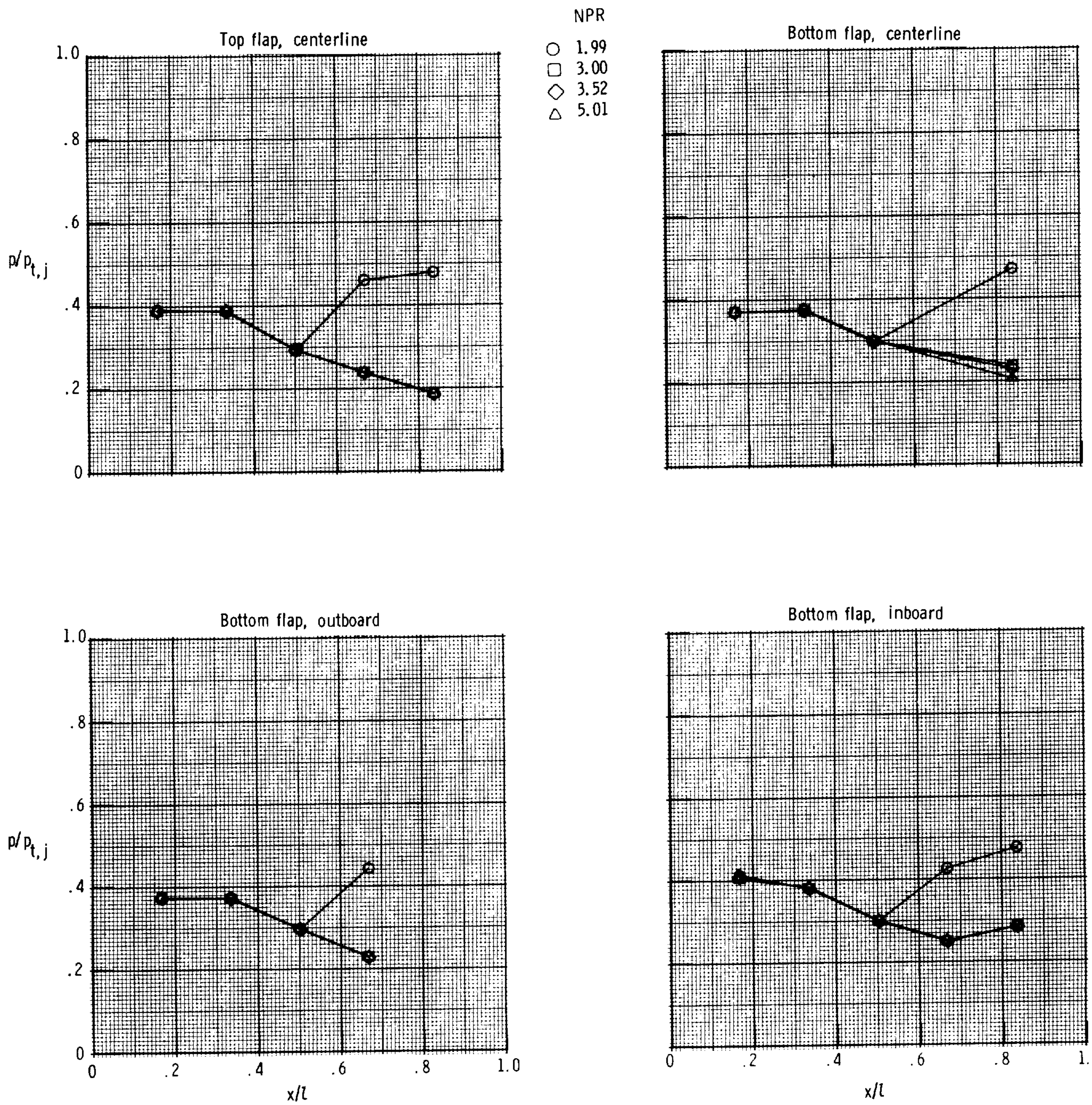
(d) $M = 1.20$.

Figure 18. Concluded.



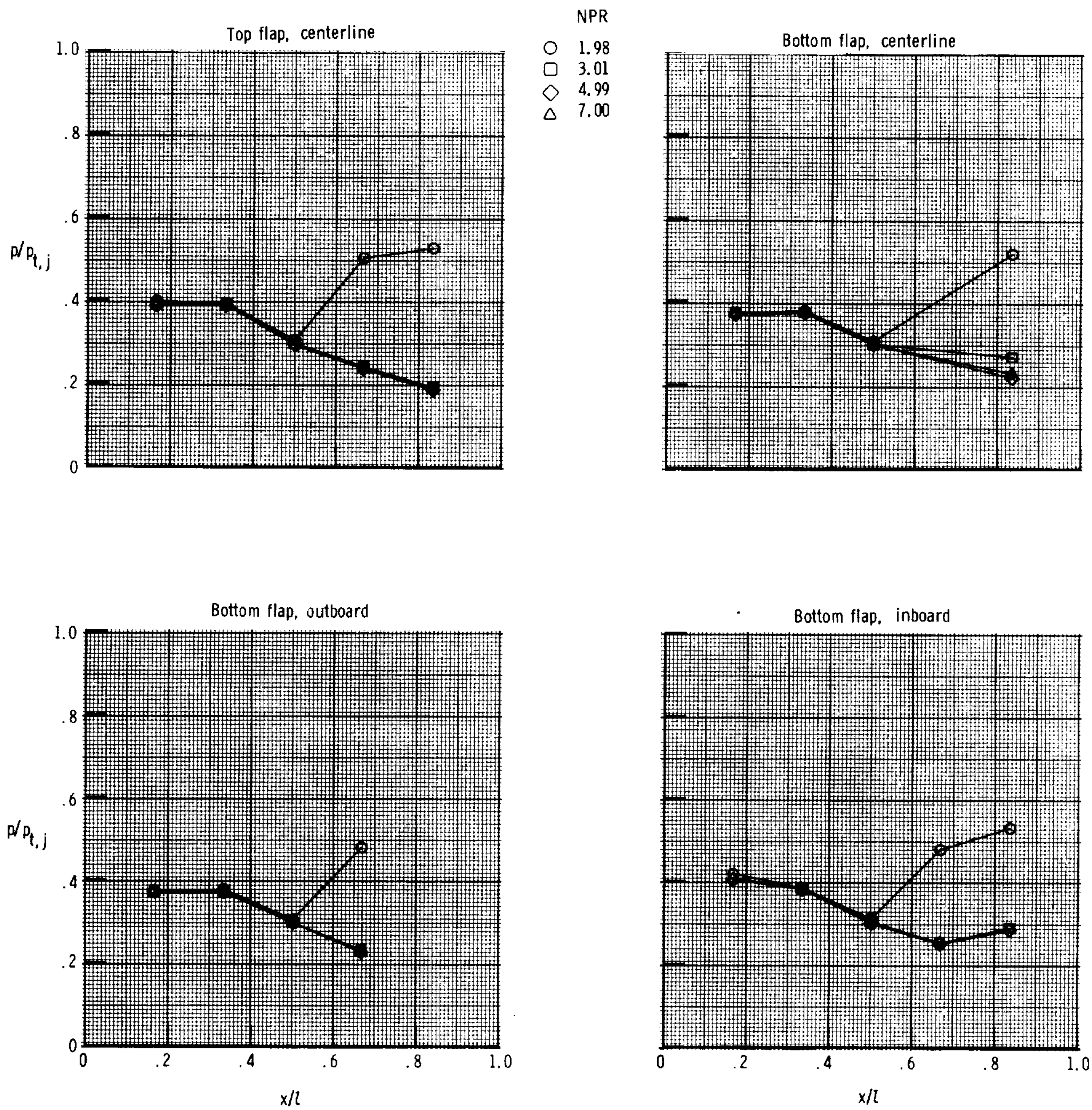
(a) $M = 0$.

Figure 19. Effect of NPR on internal static pressure distributions for A/B power nozzle with 100-percent sidewalls, $\delta_{v,p} = 0°$, and $\alpha = 0°$.



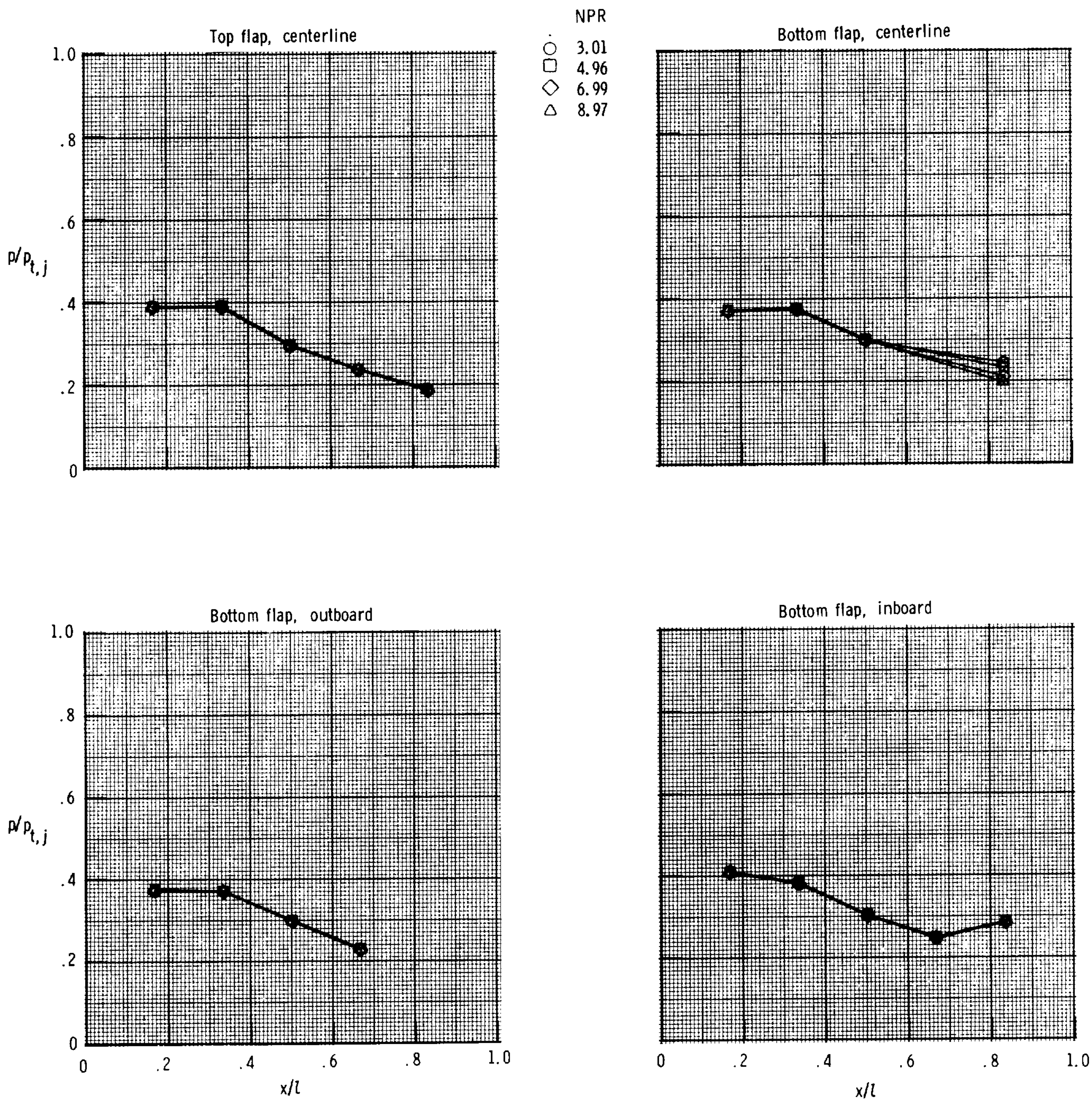
(b) $M = 0.60$.

Figure 19. Continued.



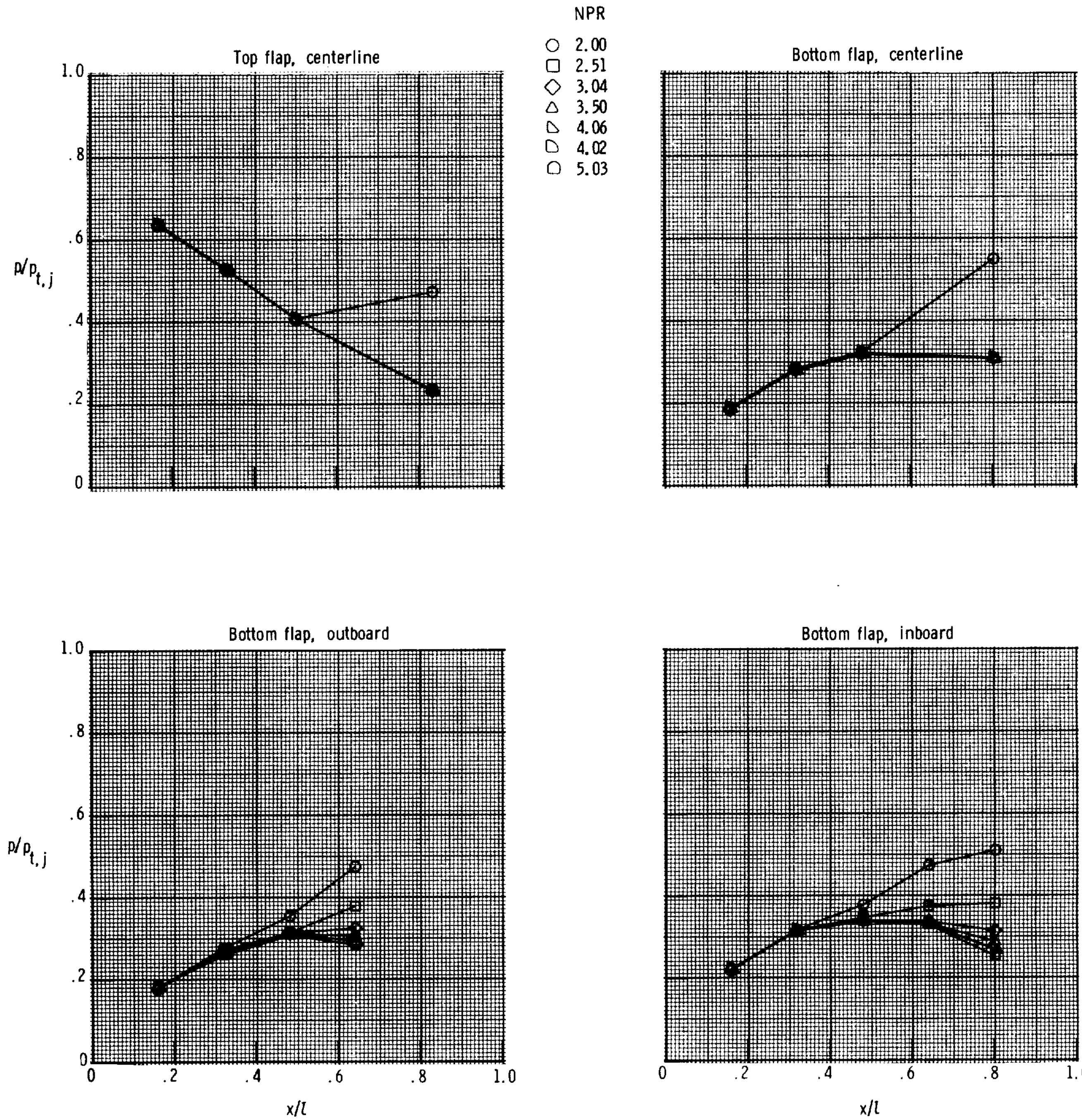
(c) $M = 0.90$.

Figure 19. Continued.



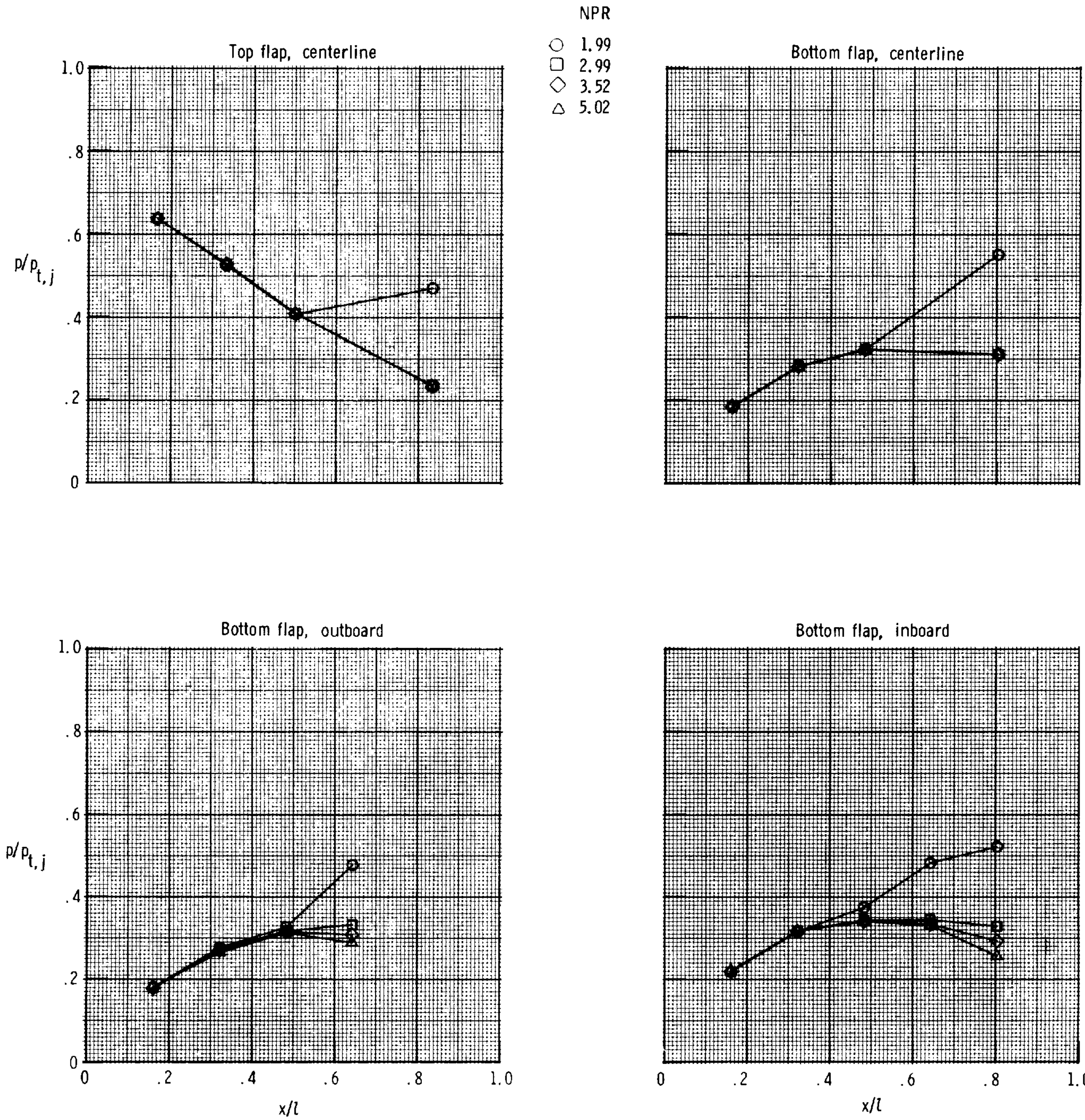
(d) $M = 1.20$.

Figure 19. Concluded.



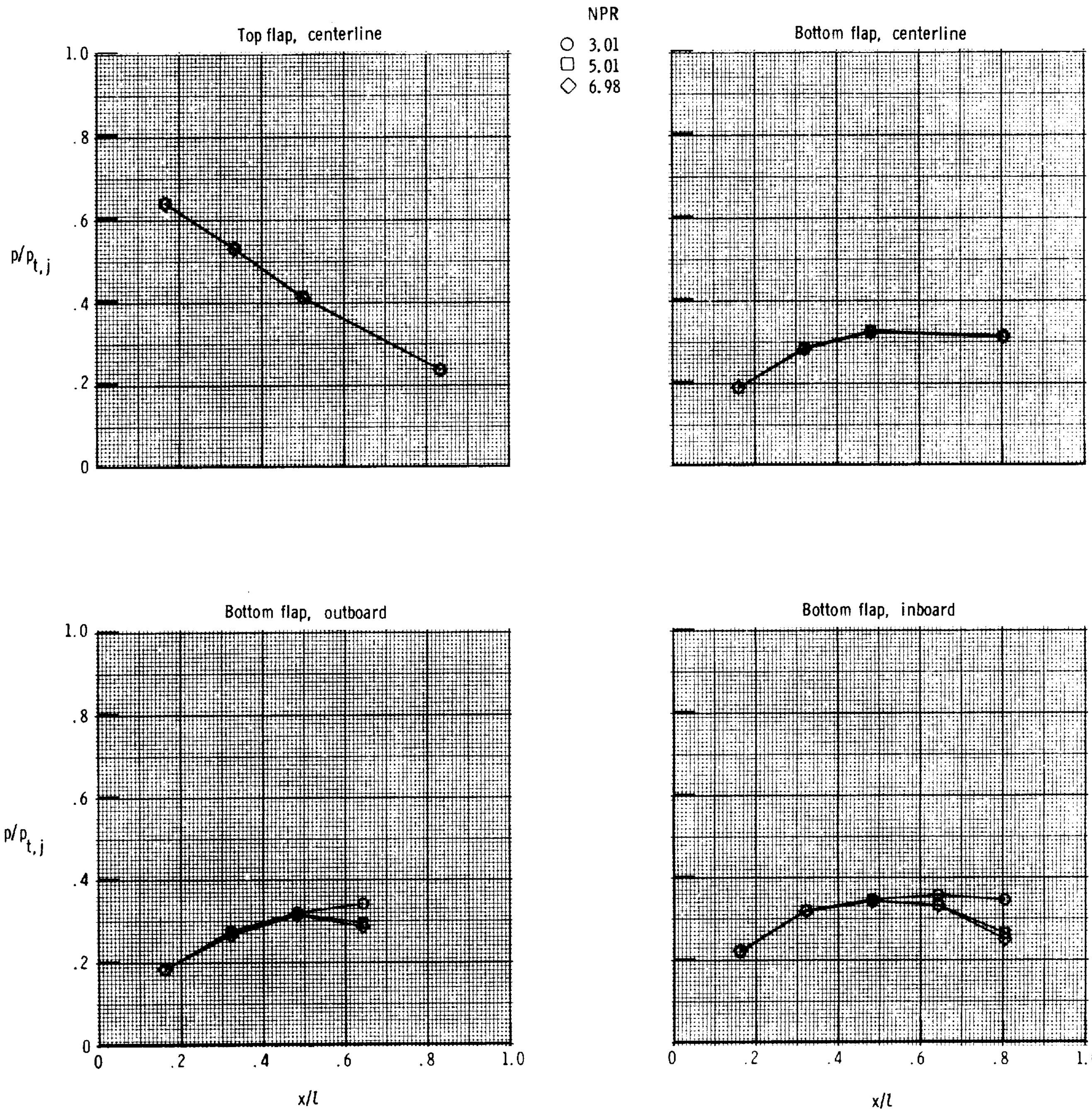
(a) $M = 0$.

Figure 20. Effect of NPR on internal static pressure distributions for A/B power nozzle with 100-percent sidewalls, $\delta_{v,p} = 15°$, and $\alpha = 0°$.



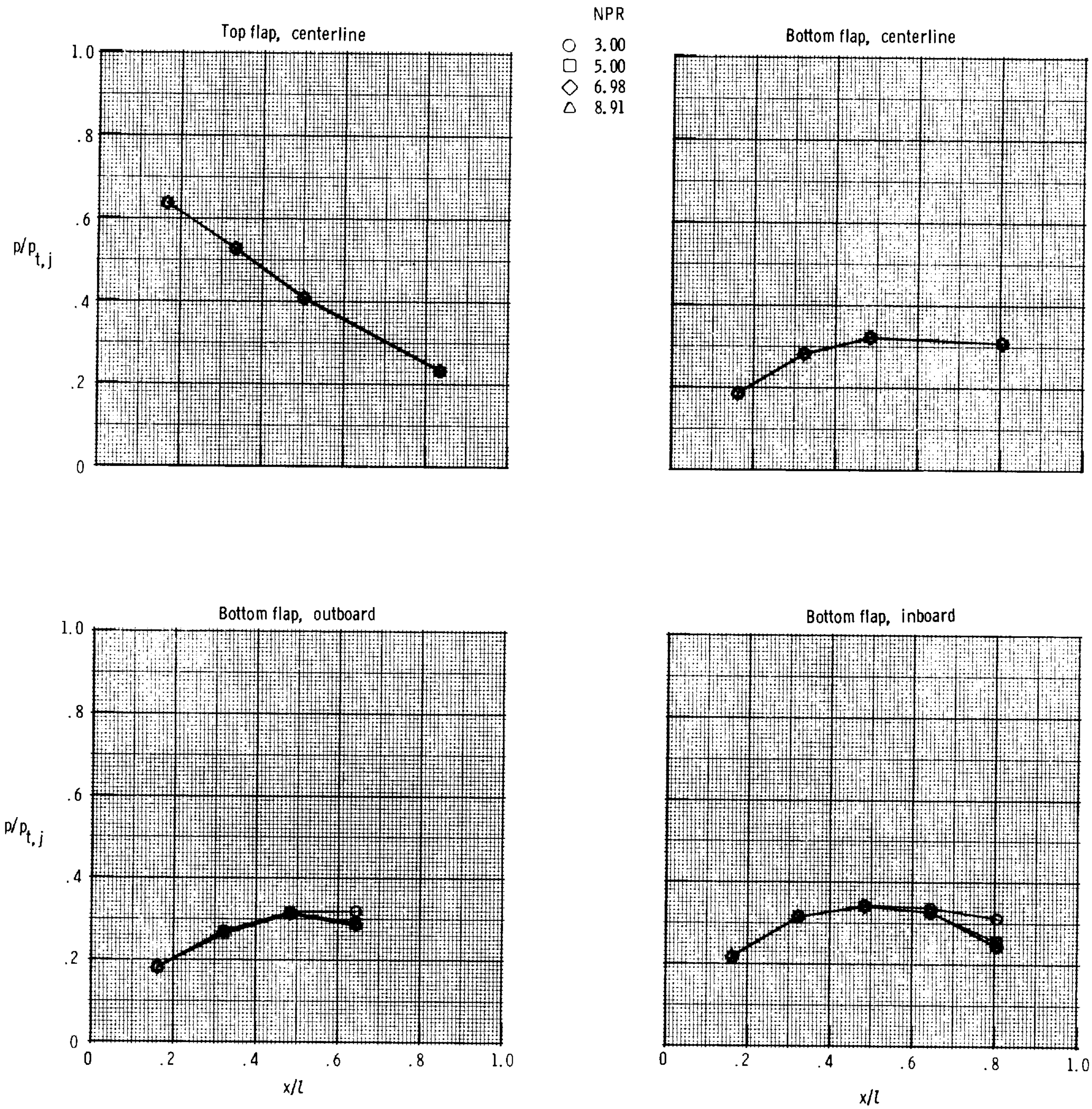
(b) $M = 0.60$.

Figure 20. Continued.



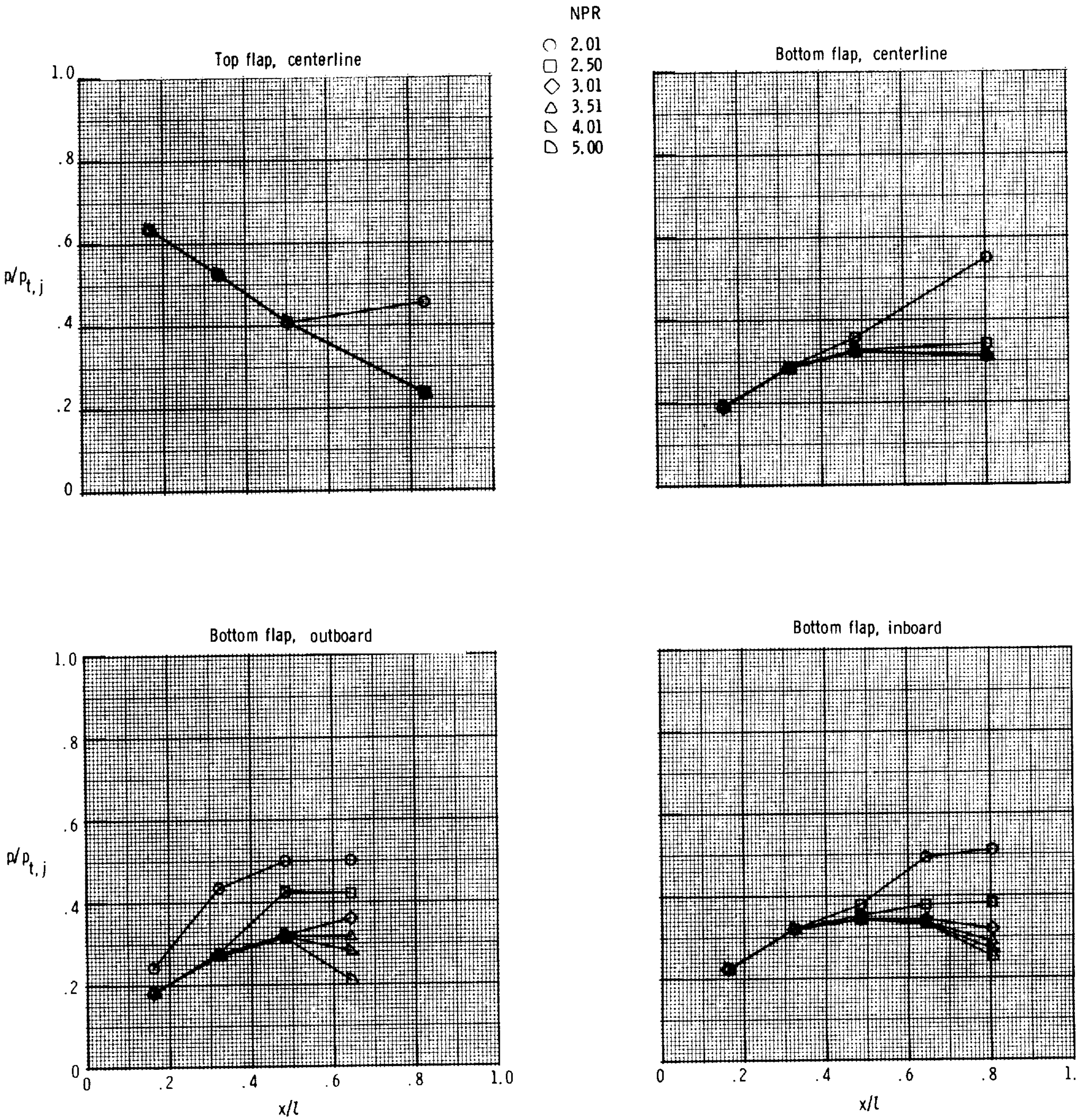
(c) $M = 0.90$.

Figure 20. Continued.



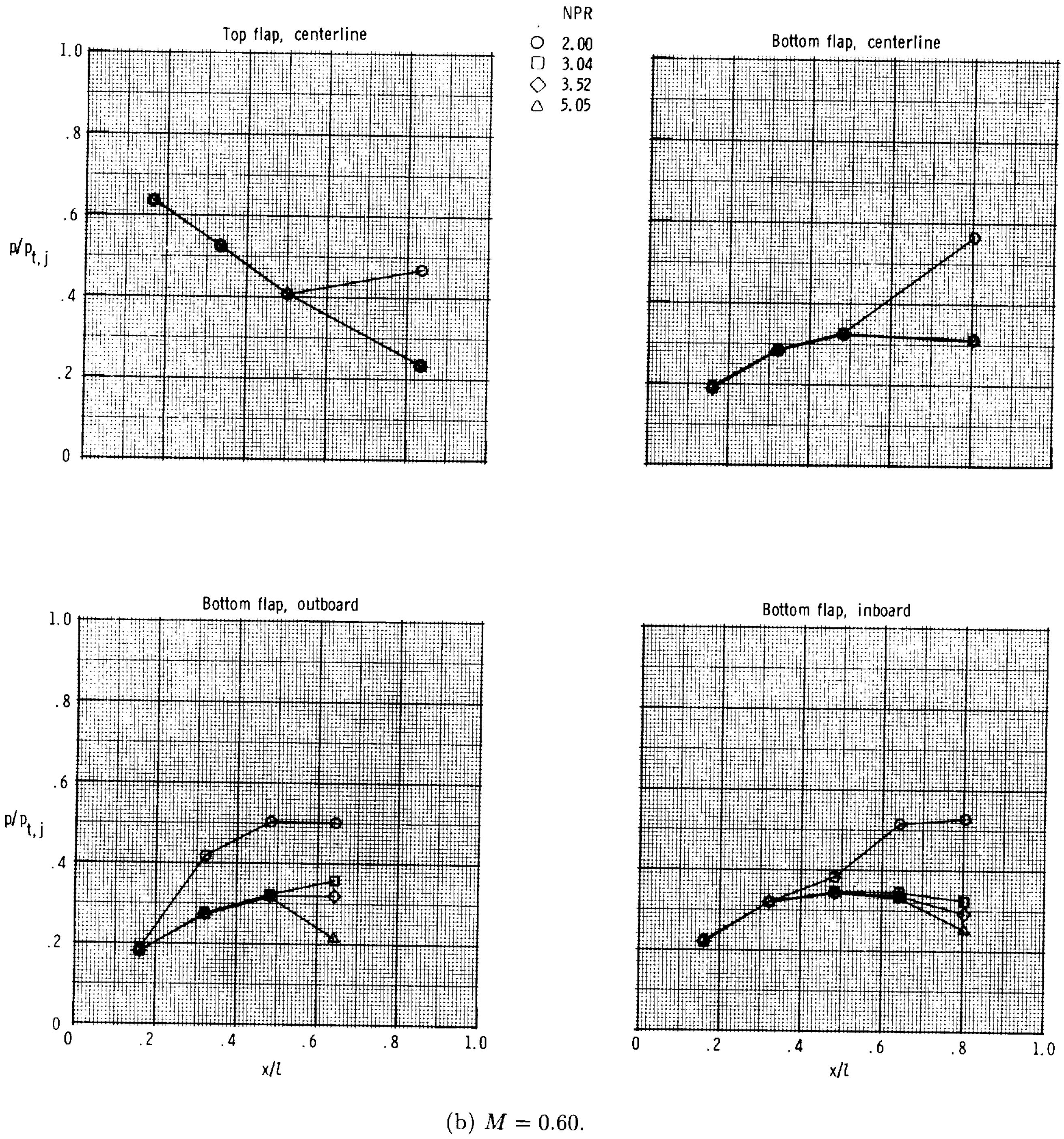
(d) $M = 1.20$.

Figure 20. Concluded.



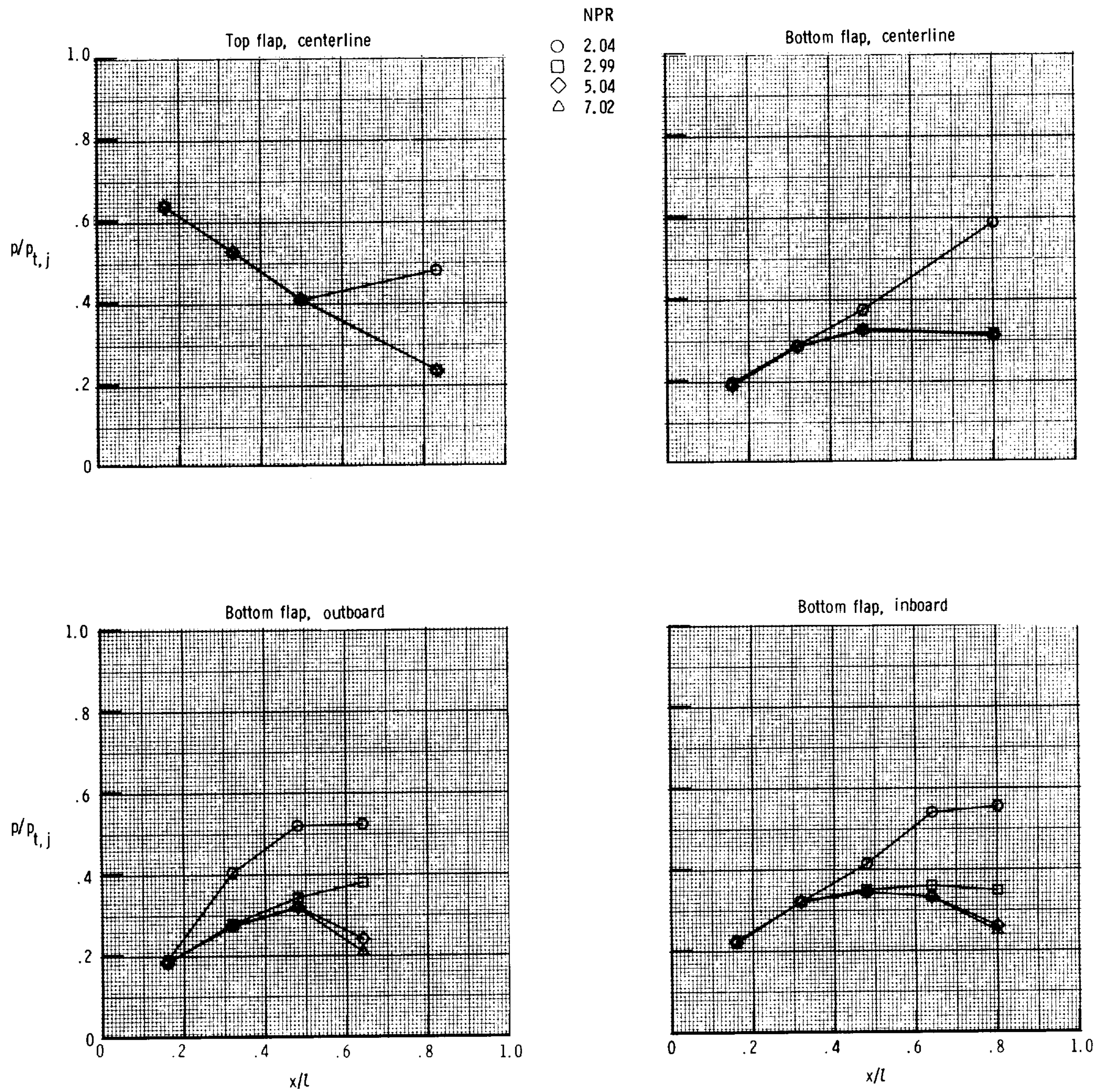
(a) $M = 0$.

Figure 21. Effect of NPR on internal static pressure distributions for A/B power nozzle with 50-percent sidewalls, $\delta_{v,p} = 15°$, and $\alpha = 0°$.



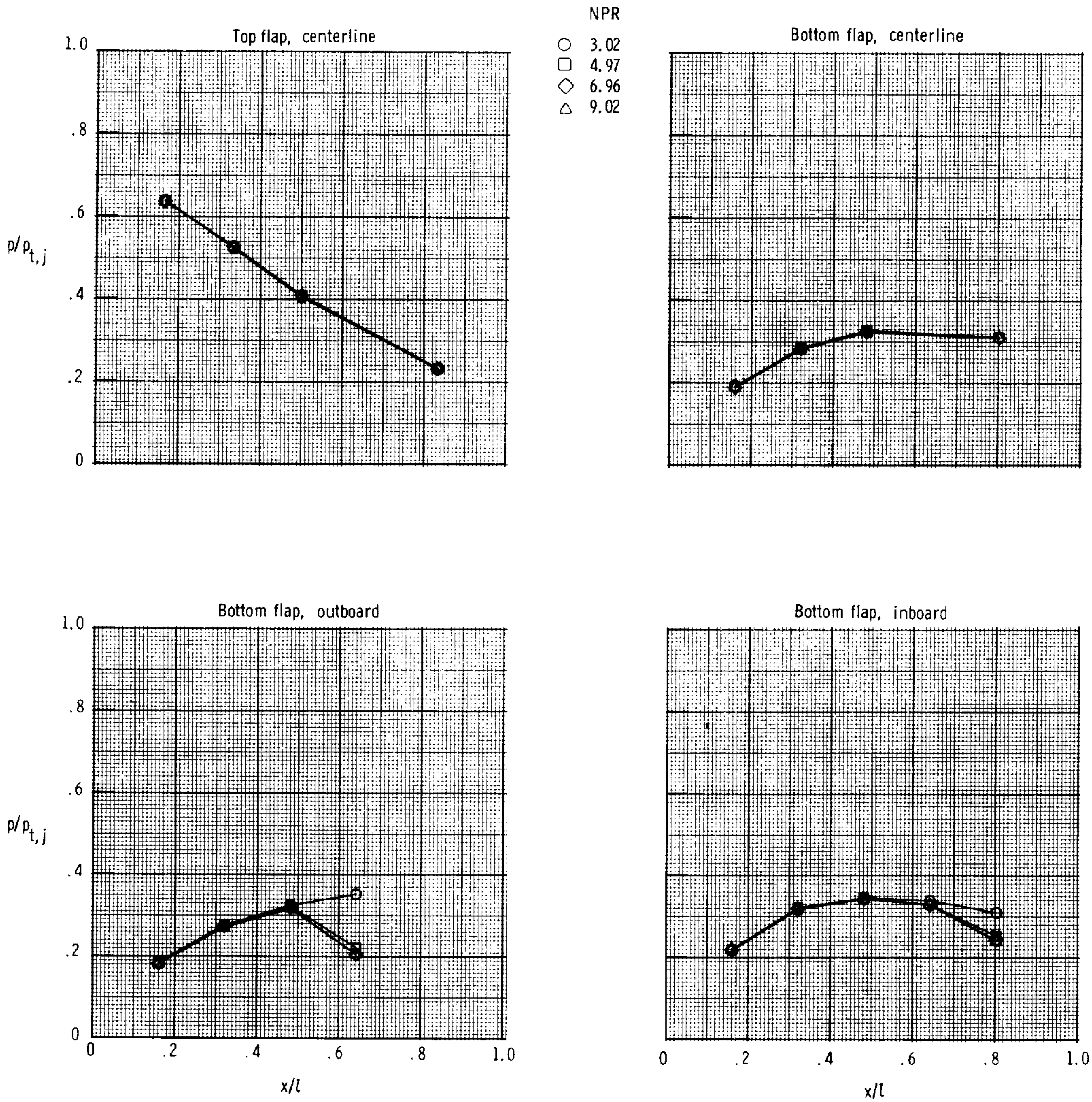
(b) $M = 0.60$.

Figure 21. Continued.



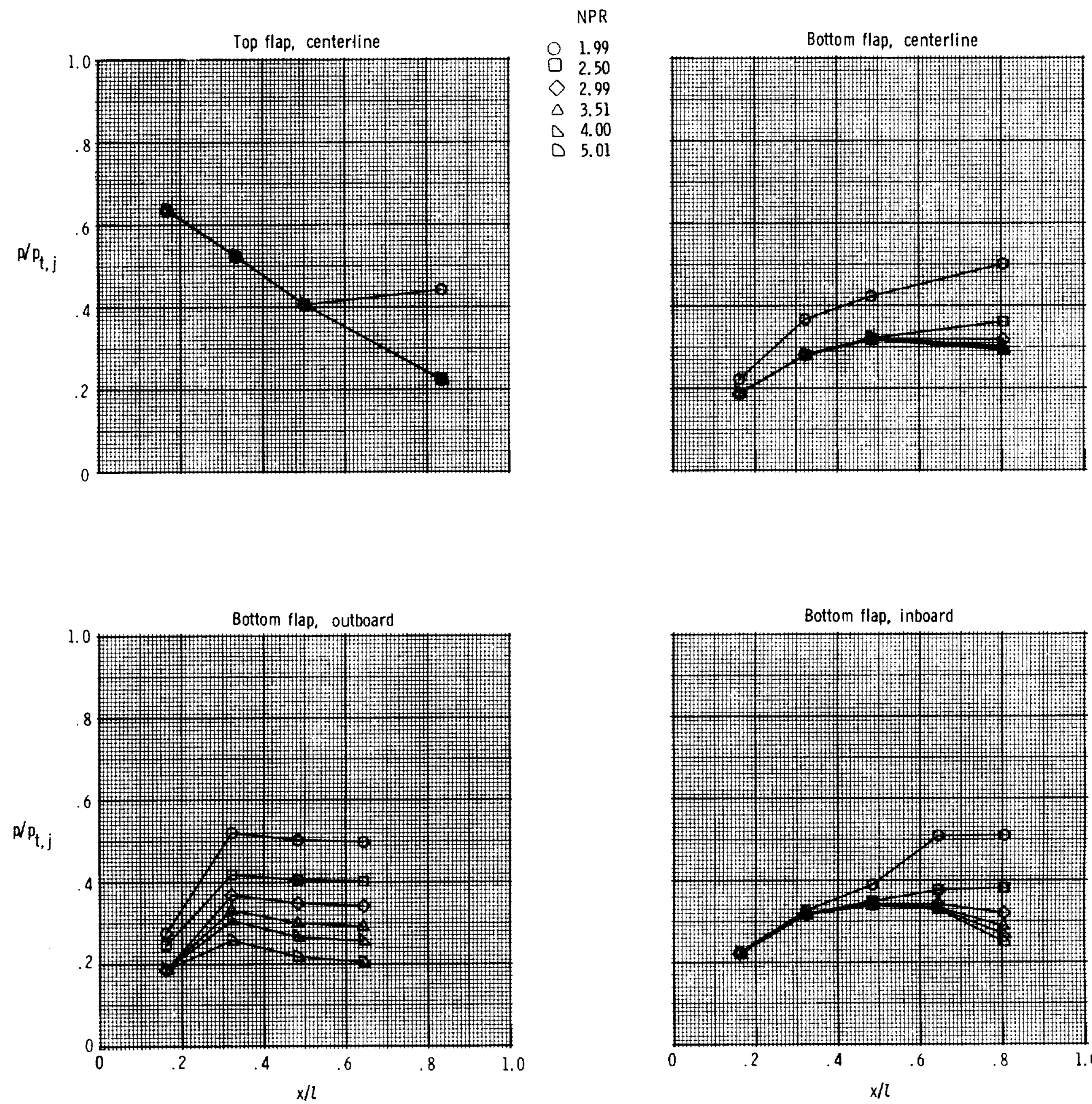
(c) $M = 0.90$.

Figure 21. Continued.



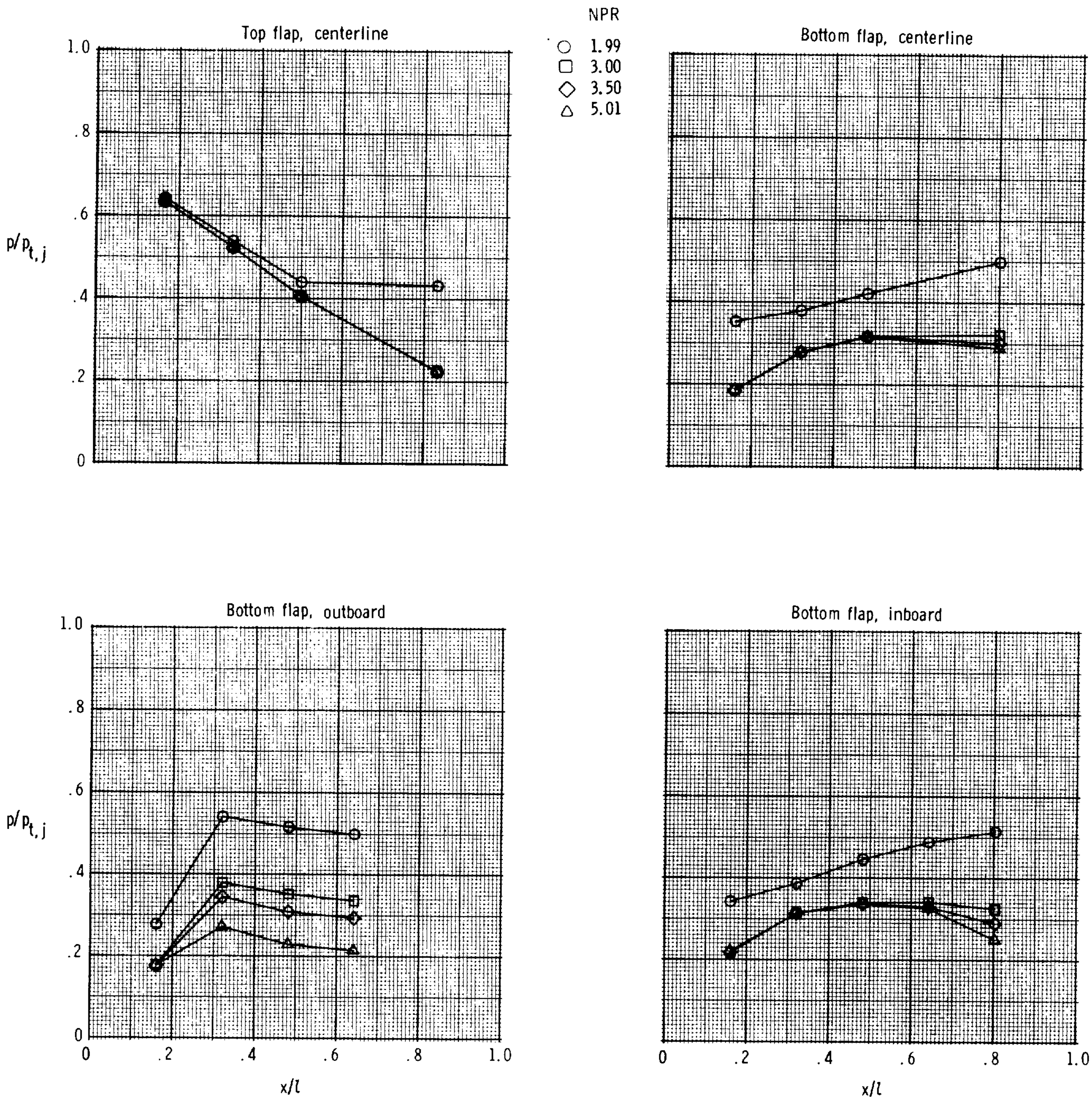
(d) $M = 1.20$.

Figure 21. Concluded.



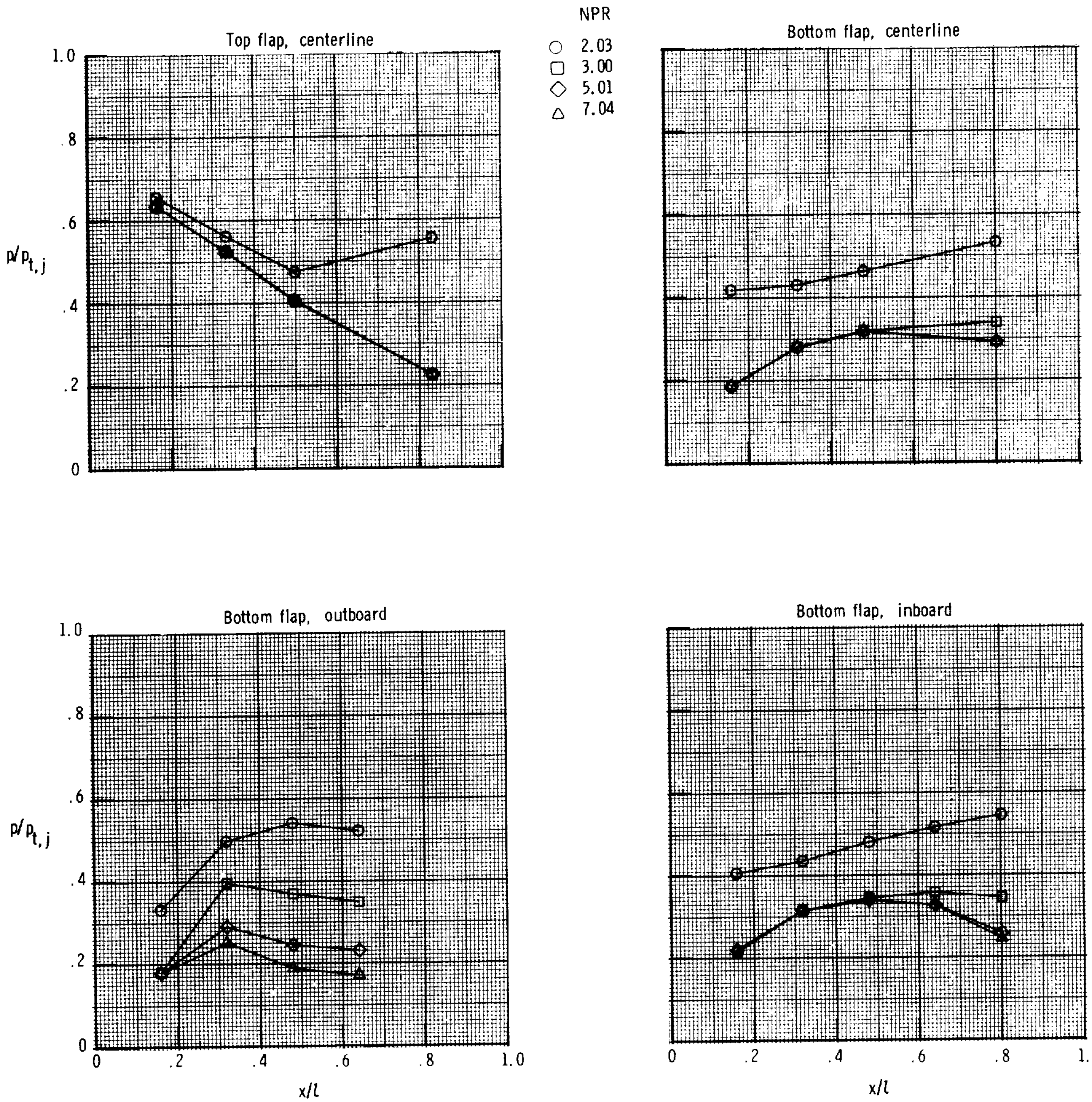
(a) $M = 0$.

Figure 22. Effect of NPR on internal static pressure distributions for A/B power nozzle with 25-percent sidewalls, $\delta_{v,p} = 15°$, and $\alpha = 0°$.



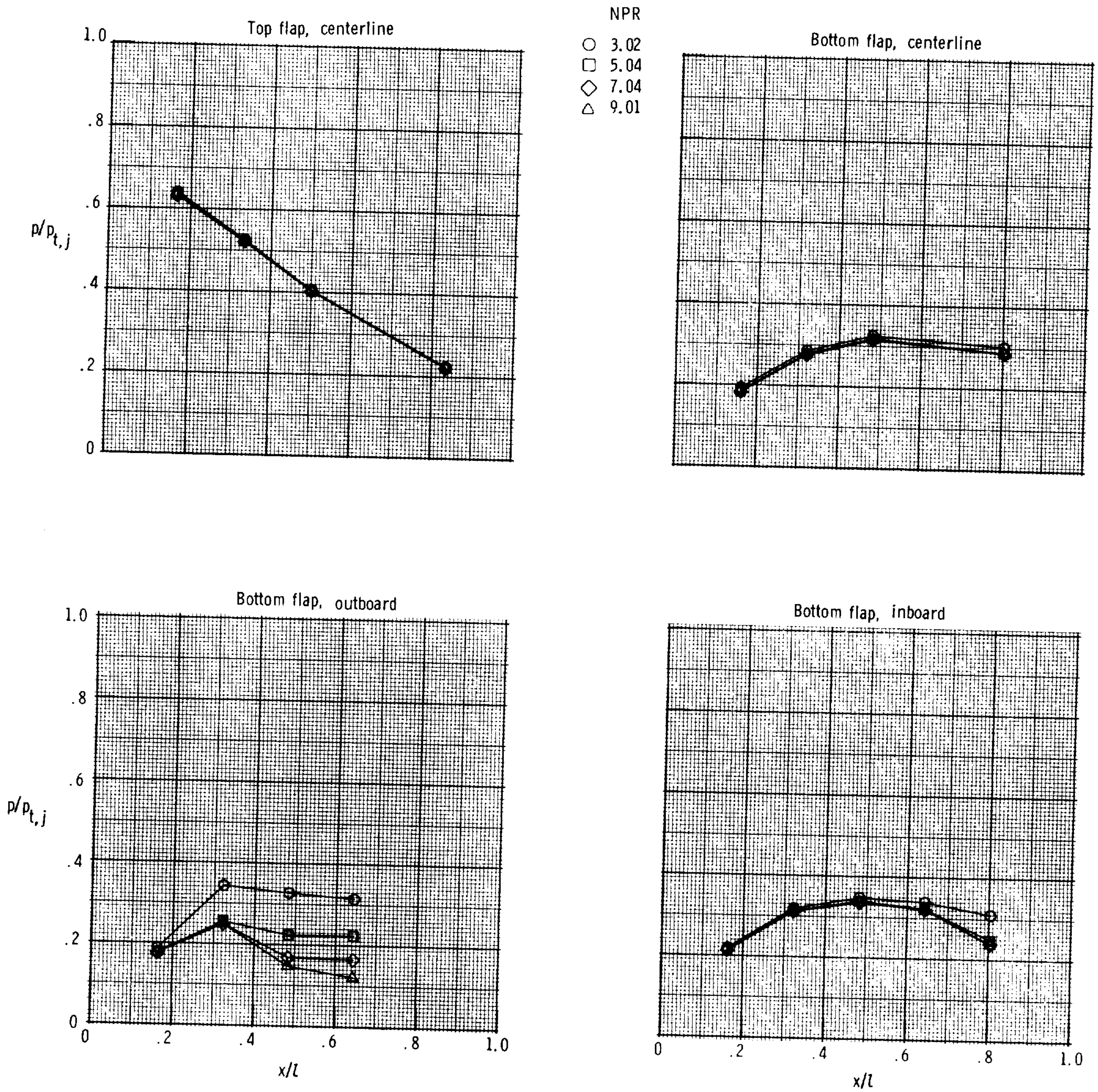
(b) $M = 0.60$.

Figure 22. Continued.



(c) $M = 0.90$.

Figure 22. Continued.



(d) $M = 1.20$.

Figure 22. Concluded.

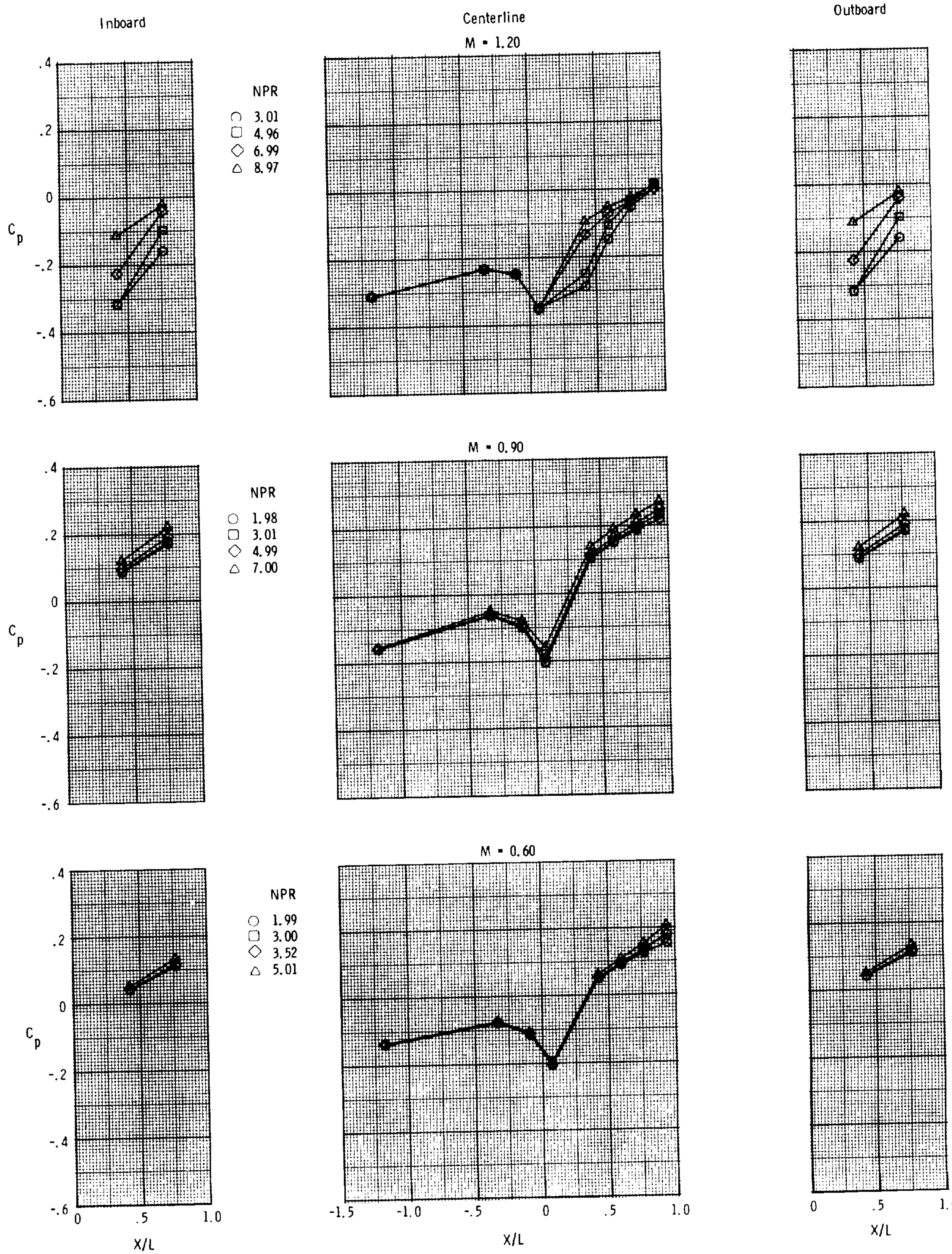


Figure 23. Effect of NPR on external static pressure distributions at test Mach numbers for A/B power nozzle with 100-percent sidewalls, $\delta_{v,p} = 0°$, and $\alpha = 0°$.

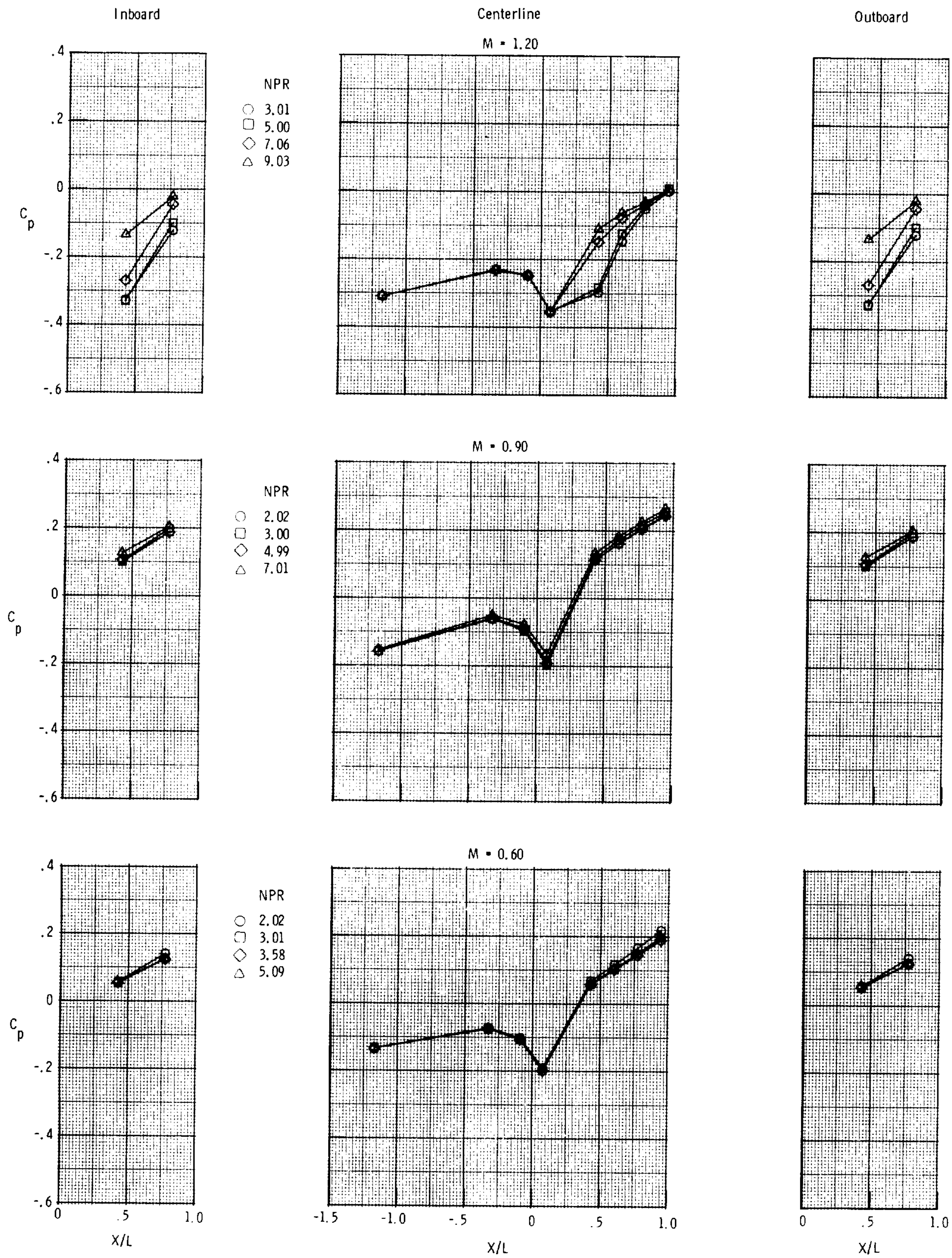


Figure 24. Effect of NPR on external static pressure distributions at test Mach numbers for A/B power nozzle with 50-percent sidewalls, $\delta_{v,p} = 0°$, and $\alpha = 0°$.

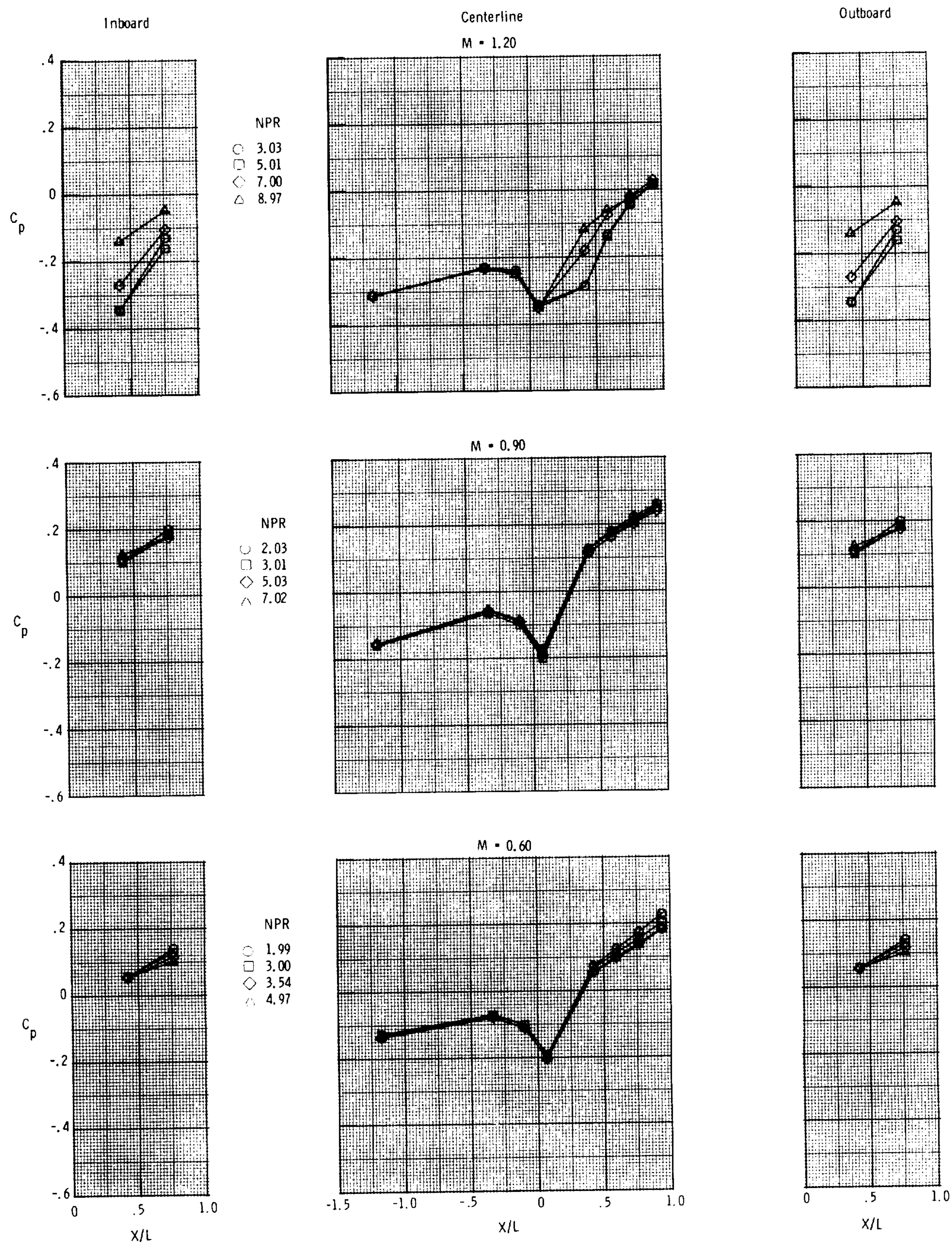


Figure 25. Effect of NPR on external static pressure distributions at test Mach numbers for A/B power nozzle with 25-percent sidewalls, $\delta_{v,p} = 0°$, and $\alpha = 0°$.

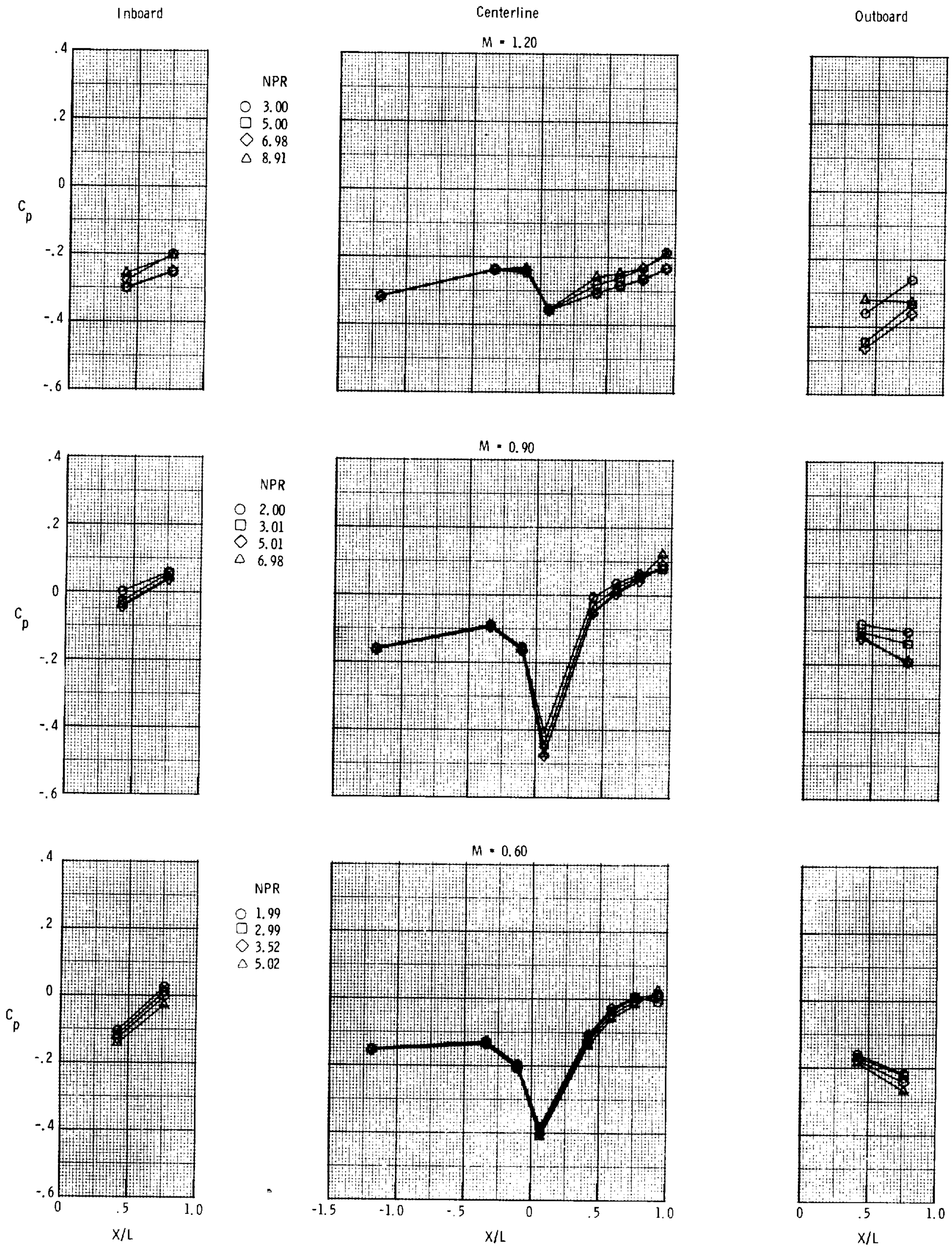


Figure 26. Effect of NPR on external static pressure distributions at test Mach numbers for A/B power nozzle with 100-percent sidewalls, $\delta_{v,p} = 15°$, and $\alpha = 0°$.

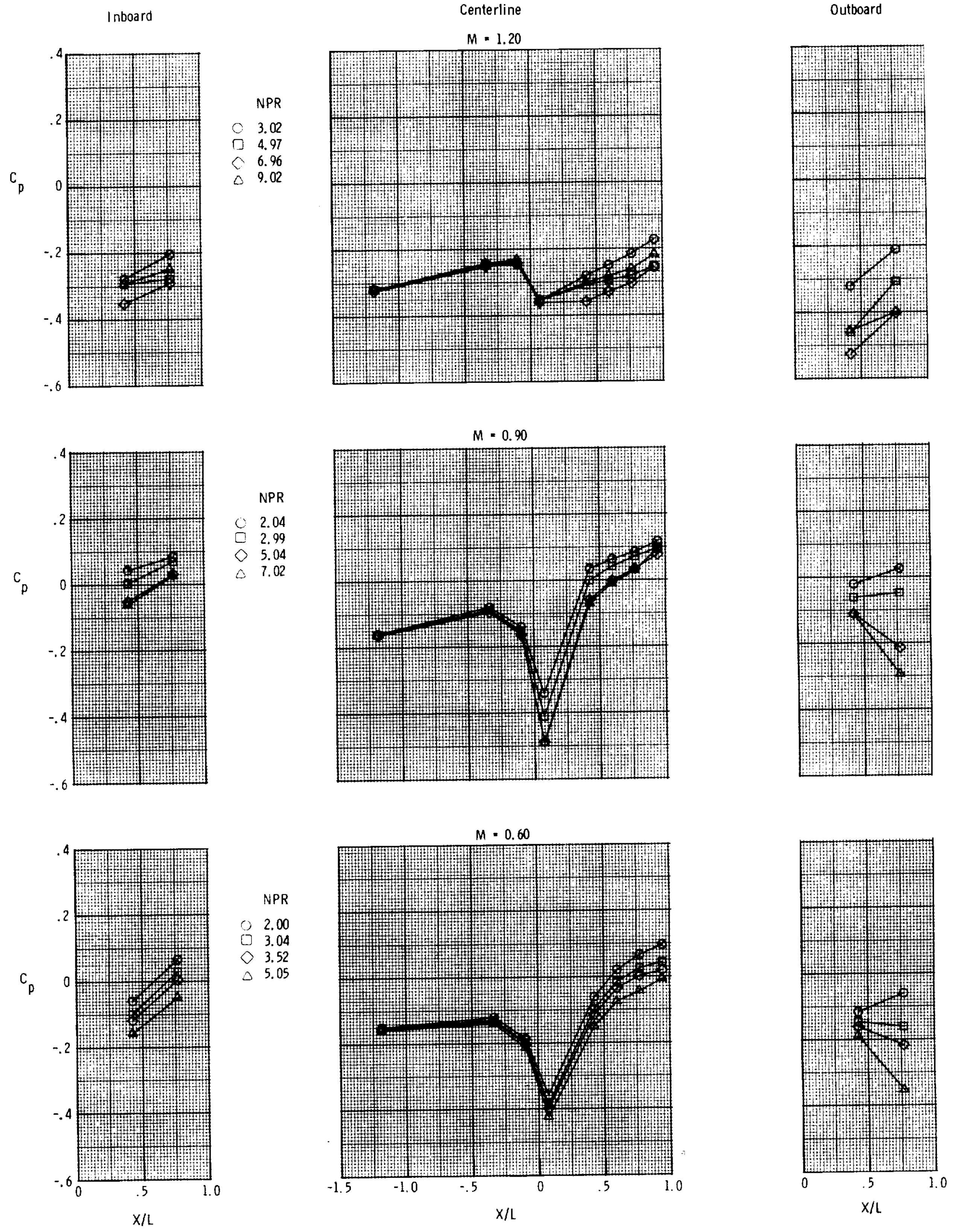


Figure 27. Effect of NPR on external static pressure distributions at test Mach numbers for A/B power nozzle with 50-percent sidewalls, $\delta_{v,p} = 15°$, and $\alpha = 0°$.

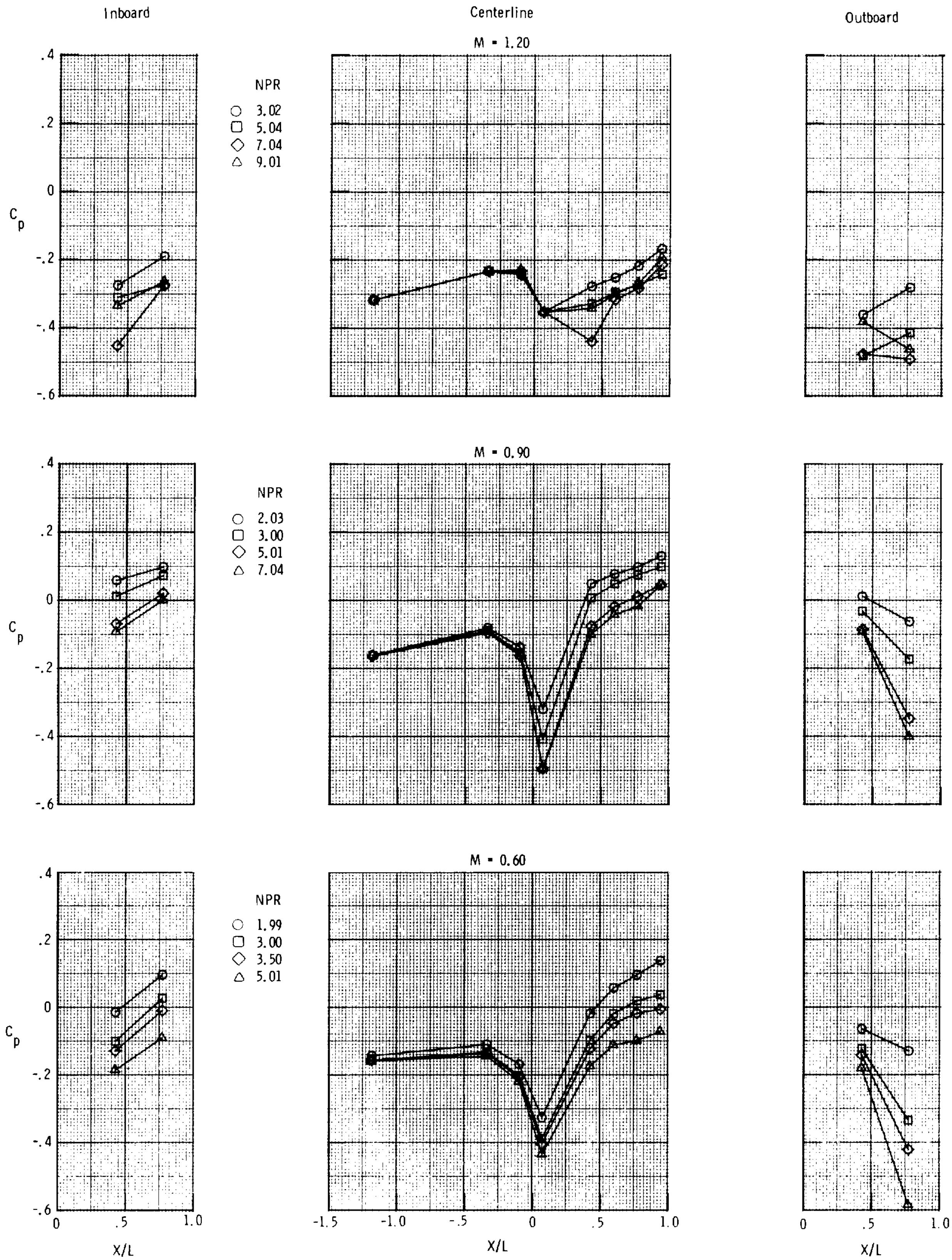


Figure 28. Effect of NPR on external static pressure distributions at test Mach numbers for A/B power nozzle with 25-percent sidewalls, $\delta_{v,p} = 15°$, and $\alpha = 0°$.

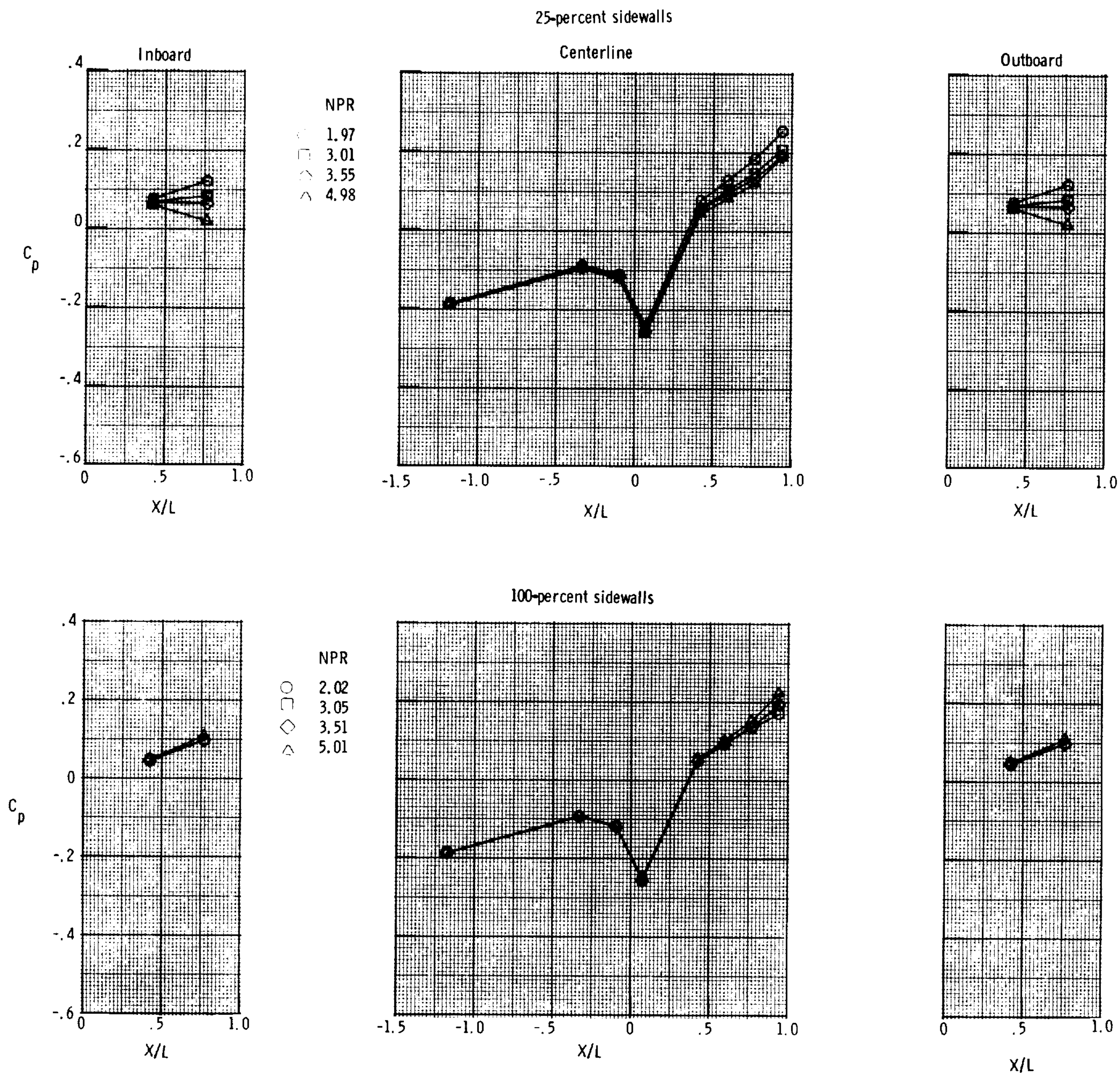


Figure 29. Effect of NPR on external static pressure distributions at $M = 0.60$ for A/B power nozzle with cutback sidewalls, $\delta_{v,p} = 0°$, and $\alpha = 20°$.

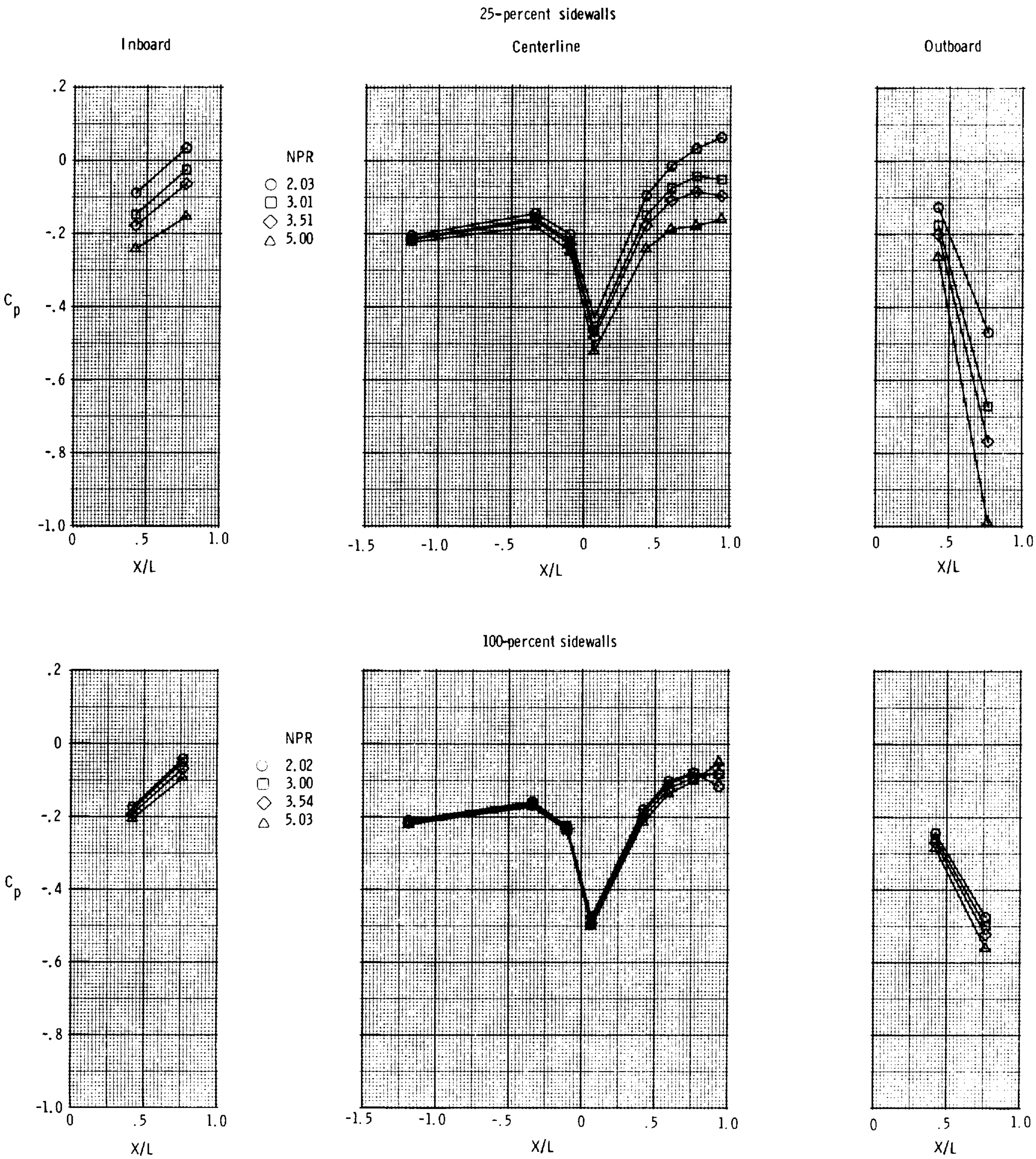


Figure 30. Effect of NPR on external static pressure distributions at $M = 0.60$ for A/B power nozzle with cutback sidewalls, $\delta_{v,p} = 15°$, and $\alpha = 20°$.

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16. Abstract

An investigation has been conducted in the Langley 16-Foot Transonic Tunnel to determine the thrust vectoring capability of subscale, two-dimensional convergent-divergent exhaust nozzles installed on a twin-engine general research fighter model. Pitch thrust vectoring was accomplished by downward rotation of nozzle upper and lower flaps. The effects of nozzle sidewall cutback were studied for both unvectored and pitch-vectored nozzles. A single cutback sidewall was employed for yaw thrust vectoring. This investigation was conducted at Mach numbers ranging from 0 to 1.20 and at angles of attack from −2° to 35°. High-pressure air was used to simulate the jet exhaust and provide values of nozzle pressure ratio up to 9.

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