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# Parametric Investigation of Single-Expansion-Ramp Nozzles at Mach Numbers From 0.60 to 1.20

Francis J. Capone,  
Richard J. Re,  
and E. Ann Bare

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Francis J. Capone,  
Richard J. Re,  
and E. Ann Bare  
*Langley Research Center  
Hampton, Virginia*

**NASA**

National Aeronautics and  
Space Administration

Office of Management

Scientific and Technical  
Information Program





## Summary

An investigation has been conducted in the Langley 16-Foot Transonic Tunnel to determine the effects of varying six nozzle geometric parameters on the internal and aeropropulsive performance characteristics of single-expansion-ramp nozzles. The single-expansion-ramp nozzle is a nonaxisymmetric, variable-area, internal/external expansion exhaust nozzle. The six nozzle geometric parameters that were varied included the nozzle upper ramp length and chordal angle, the nozzle lower flap length and chordal angle, and the axial and vertical locations of the nozzle throat. Both convergent-divergent and convergent nozzle configurations were tested. Some limited tests were made to study the effects of varying the curvature of the upper ramp internal and external surfaces and the lower flap external surface of one of the nozzles. This investigation was conducted at Mach numbers from 0.60 to 1.20, nozzle pressure ratios from 1.5 to 12, and angles of attack of  $0^\circ$  and  $\pm 6^\circ$ .

Maximum aeropropulsive performance at a particular Mach number was highly dependent on the operating nozzle pressure ratio. For example, as the nozzle upper ramp length or angle increased, some nozzles had higher performance at a Mach number of 0.90 because the nozzle design pressure was the same as the operating pressure ratio. Thus, selection of the various nozzle geometric parameters should be based on the mission requirements of the aircraft. A combination of large upper ramp and large lower flap boattail angles produced greater nozzle drag coefficients at Mach numbers greater than 0.80, primarily from shock-induced separation on the lower flap of the nozzle. At static conditions, the convergent nozzle had high and nearly constant values of resultant thrust ratio over the entire range of nozzle pressure ratios tested. However, these nozzles had much lower aeropropulsive performance than the convergent-divergent nozzle at Mach numbers greater than 0.60.

## Introduction

Many studies have been made of the integration of nonaxisymmetric nozzles into fighter aircraft configurations. Nonaxisymmetric nozzle designs are generally more amenable to the incorporation of thrust vectoring to provide forces and moments for additional capabilities in aircraft maneuver and control. A prerequisite for the evolution of practical nozzles for production aircraft is the establishment

of both an internal and aeropropulsive performance data base documenting the effects of nozzle internal and external geometry changes so that efficient nozzles can be selected.

One of the nonaxisymmetric nozzle types is the single-expansion-ramp nozzle (SERN). The SERN is a configuration originally developed with a hood-type jet deflector stowed in the expansion ramp which would be deployed to provide high vector angles (up to  $110^\circ$ ) for vertical takeoff and landing operations (refs. 1 and 2). Most experimental investigations conducted on the SERN have concentrated on the uninstalled and installed performance of a specific nozzle design at various nozzle power settings during cruise and vectored-thrust operating modes. (See refs. 3 to 6.) Although studies of the effects of systematic changes in nozzle geometry on internal performance have been conducted (refs. 7 to 11), no similar investigations of aeropropulsive performance have been undertaken. This paper summarizes the aeropropulsive performance characteristics of SERN configurations having various combinations of six parameters that affect the internal and external geometry of the nozzle. These parameters include the nozzle upper ramp length and chordal angle, the nozzle lower flap length and chordal angle, and the axial and vertical locations of the nozzle throat. Both convergent-divergent and convergent nozzles were tested. This investigation was conducted in the Langley 16-Foot Transonic Tunnel at Mach numbers from 0.60 to 1.20, nozzle pressure ratios from 1.5 to 12, and angles of attack of  $0^\circ$  and  $\pm 6^\circ$ .

## Symbols

All model forces and moments are referred to the stability axis system with the model moment reference center located at model station 29.39. A discussion of the data reduction procedure, definitions of the aerodynamic force and moment terms, and the propulsion relationships used herein are presented in references 12 and 13. The symbols used in the computer-generated tables are given in parentheses.

$A_e$	nozzle exit area, in <sup>2</sup>
$A_i$	internal area at metric break, in <sup>2</sup>
$A_m$	maximum model cross-sectional area, 40.635 in <sup>2</sup>
$A_t$	nozzle throat area, in <sup>2</sup>

$(A_e/A_t)_e$		external expansion ratio for ideally expanded flow (where $A_e$ is vertical displacement between end of nozzle ramp and lower flap times the nozzle width)	$D$	(D)	total centerbody/nozzle drag, lbf
			$D_f$		centerbody friction drag, lbf
			$D_n$	(DN)	nozzle drag, lbf
$(A_e/A_t)_i$		internal expansion ratio for ideally expanded flow (where $A_e$ is measured in vertical plane at end of nozzle lower flap)	$F$	(F)	thrust along stability axis, lbf
			$F_A$		axial force, lbf
			$F_{A,bal}$		total force measured by force balance, lbf
$C_{D,n}$	(CDN)	nozzle drag coefficient	$F_{A,mom}$		momentum tare axial force due to bellows, lbf
	(CFI)	ideal thrust coefficient, $\frac{F_i}{p_a A_m}$ or $\frac{F_i}{q_\infty A_m}$	$F_i$	(FI)	ideal isentropic gross thrust, lbf
	(CFJ)	thrust coefficient along body axis, $\frac{F_j}{p_a A_m}$	$F_j$	(FJ)	measured thrust along body axis, lbf
	(CFN)	jet normal-force coefficient, $\frac{F_N}{p_a A_m}$	$F_N$		measured jet normal force, lbf
	( $\hat{C}$ (F-D))	thrust-minus-drag coefficient, $\frac{F-D}{q_\infty A_m}$	$F_r$	(FR)	resultant gross thrust, $\sqrt{F_j^2 + F_N^2}$ , lbf
$C_L$	(CL)	total centerbody/nozzle lift coefficient, including thrust component, $\frac{\text{Lift}}{q_\infty A_m}$	$g$		gravitational constant ( $1g \approx 32.174 \text{ ft/sec}^2$ )
			$h_{t,n}$		nominal nozzle throat height, 1.24 in.
$C_{L,n}$	(CLCN)	centerbody/nozzle lift coefficient, $C_{L,n} \equiv C_L$ at NPR = 1 (jet off)	$L_n$		total length of upper ramp, in.
$C_m$	(CM)	total centerbody/nozzle pitching moment, including thrust component, $\frac{\text{Pitching moment}}{c q_\infty A_m}$	$l_f$		axial length of lower flap (see fig. 2), in.
			$l_r$		axial length of upper expansion ramp (see fig. 2), in.
$C_{m,n}$	(CMCN)	centerbody/nozzle pitching moment, $C_{m,n} \equiv C_m$ at NPR = 1 (jet off)	$M$	(M)	free-stream Mach number
	(CMJ)	jet pitching-moment coefficient, $\frac{\text{Jet pitching moment}}{p_a A_m}$	NPR	(NPR)	nozzle pressure ratio, $p_{t,j}/p_a$ or $p_{t,j}/p_\infty$
$C_{p,f}$		lower flap pressure coefficient, $\frac{p_f - p_\infty}{q_\infty}$	$p_a$		ambient pressure, psi
			$p_f$		lower flap static pressure, psi
$C_{p,r}$		upper ramp pressure coefficient, $\frac{p_r - p_\infty}{q_\infty}$	$p_i$		average internal static pressure, psi
			$p_r$		upper ramp static pressure, psi
$\bar{c}$		reference length (width of model at nozzle connect station), 6.800 in.	$p_{t,j}$		average jet total pressure, psi

$p_\infty$		free-stream static pressure, psi	$\delta_p$	(DELTAP)	resultant pitch-vector angle, $\tan^{-1} F_N/F_j$
$q_\infty$		free-stream dynamic pressure, psi	$\theta_f$		lower flap chordal angle (see fig. 2), deg
$R$		specific gas constant, 1716 ft <sup>2</sup> /sec <sup>2</sup> -°R	$\theta_r$		upper ramp chordal angle (see fig. 2), deg
$T_{t,j}$		average jet total temperature, °R	Subscripts:		
$W$		width of body, in.	des		design
$w_i$	(WI)	ideal weight-flow rate, lbf/sec	$e$		external
$w_p$	(WP)	measured weight-flow rate, lbf/sec	$i$		internal
$x$		axial distance measured from nozzle connect station (positive downstream), in.	Abbreviations:		
$x_t$		axial distance of nozzle throat from nozzle connect station (see fig. 2(a)), in.	C-D		convergent-divergent
$x'$		axial coordinate of nozzle sidewall (see fig. 2(b)), in.	rad		radius
$y$		vertical distance measured from horizontal model centerline (positive upward), in.	SERN		single-expansion-ramp nozzle
$y_t$		vertical distance of nozzle throat from horizontal centerline (see fig. 2(a)), in.	Sta.		fuselage station (axial location described by distance from model nose), in.
$z$		lateral distance measured from horizontal model centerline (positive to right), in.	<b>Nozzle Designs</b>		
$z'$		lateral coordinate of nozzle sidewall (see fig. 2(b)), in.	The single-expansion-ramp nozzle (SERN) is a nonaxisymmetric, variable-area, internal/external expansion exhaust system. Basic SERN nozzle components consist of (1) a two-dimensional upper ramp in which a portion of the flap surface downstream of the throat serves as an external expansion ramp, and (2) a relatively short two-dimensional lower flap. In some SERN designs, nozzle power setting (throat area) can be changed by varying the geometry of the convergent-divergent upper ramp assembly (refs. 1, 2, and 6). Nozzle expansion ratio can be varied by rotation of the lower flap. In other designs the upper ramp is either fixed or has only a variable geometry downstream of the nozzle throat. The lower flap may also be fixed, but generally it is variable to provide both power setting and expansion ratio control (refs. 3 to 5). Most SERN designs also provide for thrust vectoring capability through rotation of the entire external ramp surface in conjunction with rotation of the lower flap (refs. 2, 6, and 10). The SERN configurations of the present investigation represented nominally unvectored dry-power (cruise) nozzles.		
$\alpha$	(ALPHA)	angle of attack, deg	A sketch of a typical nozzle configuration is presented in figure 1. Six geometric parameters were chosen to define a nozzle because these parameters		
$\beta_f$		lower flap chordal boat-tail angle (see fig. 2), deg			
$\beta_r$		upper ramp chordal boat-tail angle (see fig. 2), deg			
$\gamma$		ratio of specific heats (1.3997 for air)			

were thought to have the largest effect on both internal and external nozzle performance. The nozzle geometric parameters that were varied for the upper ramps and lower flaps are illustrated in figure 1(a) and are listed in table 1 for each of the nozzles tested. The nozzle geometric parameters that affect nozzle internal performance include upper ramp length  $l_r$  and chordal angle  $\theta_r$ , and lower flap length  $l_f$  and chordal angle  $\theta_f$ . The geometric parameters that affect nozzle external performance are the axial location  $x_t$  and the vertical location  $y_t$  of the nozzle throat. Of special note is that varying the ramp and flap geometric parameters can also affect nozzle external performance because variation of these parameters can change the respective nozzle boattail angles. The upper ramp and lower flap external surfaces were defined by cubic curves from the nozzle connect station to the nozzle trailing edge. The ramp inner flow path from the nozzle connect station to just past the throat is defined by a series of straight lines and circular arcs. From just past the throat to the trailing edge, the ramp inner flow path is defined by a cubic curve. The flap inner flow path is defined by a series of straight lines and circular arcs. Coordinates for all the nozzles tested are presented in table 2.

All the nozzles had full sidewalls, and a typical sidewall is shown in figure 1(b). Each of the nozzles had a pair of sidewalls in which the upper contour matched the contour of the upper ramp. Likewise, the lower contour of each of the sidewalls matched the lower flap contour. All the sidewalls had the same boattail geometry along the plane of the nozzle centerline as illustrated in figure 1(b).

For nozzles 1 to 13, the six geometric parameters were varied one at a time, whereas for nozzles 14 to 29, these parameters were varied two at a time. These parameters were varied in a controlled manner as described in reference 14 so that empirical relations for the prediction of internal and external performance could be established for nozzles having a large number of geometric parameters. Nozzles 30 to 32 were defined by varying the curvature of either the upper ramp internal and external surfaces or the flap external surface relative to that of nozzle 1. Nozzles 33 to 37 were convergent SERN nozzles; that is, the internal expansion ratio of these nozzles was 1.0.

## Apparatus and Procedure

### Single-Engine Propulsion Simulation System

A sketch is presented in figure 2 of the single-engine air-powered simulation system with a typical nozzle configuration installed. The model was com-

posed of three major sections: a nose-forebody section, a centerbody section, and the nozzle. The nose-forebody section up to station 26.50 was nonmetric; that is, it was not attached to the strain gauge balance. Geometric details of this nose-forebody section can be found in reference 15. The centerbody section was made up of the low-pressure plenum, instrumentation section, and transition section (ref. 15). The centerbody section from stations 26.50 to 55.05 was essentially rectangular in cross section and had a constant width and height of 6.80 in. and 6.20 in., respectively. All sections downstream of station 26.50 were metric and mounted on the force balance. A flexible DuPont Teflon strip inserted into a circumferentially machined groove between the nose-forebody section and low-pressure plenum impeded flow into or out of the internal cavity.

An external high-pressure air system provided a continuous flow of clean, dry air at a controlled temperature of about 540°R at the nozzles. This high-pressure air was brought through the support strut by six tubes that connect to a high-pressure plenum chamber. As shown in figure 3, the air was then discharged perpendicularly into the model low-pressure plenum through eight multiholed sonic nozzles equally spaced around the high-pressure plenum. This method was designed to minimize any forces imposed by the transfer of axial momentum as the air passed from the nonmetric high-pressure plenum to the metric (mounted on the force balance) low-pressure plenum. Two flexible metal bellows were used as seals and served to compensate for axial forces caused by pressurization.

The air was then passed from the model low-pressure plenum through a choke plate, an instrumentation section, and a transition section which provided a smooth flow path for the airflow from the round low-pressure plenum to the rectangular nozzle entrance. All nozzle configurations were attached to the transition section at model station 55.05 and were tested in an inverted position (ramp on bottom). A photograph showing a typical SERN (nozzle 29) installed on the single-engine propulsion simulation system is shown in figure 4.

### Instrumentation

A six-component strain gauge balance was used to measure forces and moments on the model downstream of station 26.50. Flow conditions in the nozzle were determined from 10 total pressure probes and 1 total temperature probe located at station 45.65 in the instrumentation section aft of the choke plate. Nozzle total pressure and temperature are determined from the average of these measurements. The

weight flow of the high-pressure air supplied to the exhaust nozzle was measured by a critical-flow venturi (ref. 16). Eight internal static pressures, measured at the metric break, were used to account for pressure forces at this location. All the pressures noted above were measured with individual pressure transducers.

Static pressures were measured on the external surface of six of the nozzles. The orifice locations for each of these nozzles are given in table 3. The external orifices were arranged in three rows along the top of the upper ramp and in two rows on the bottom of the lower flap. These pressures were measured with electronically scanning pressure devices.

### Data Reduction

All data were recorded simultaneously on magnetic tape. Approximately 50 frames of data, taken at a rate of 10 frames per second, were taken for each data point; average values were used in data reduction computations. The average value of jet total pressure was also used in all computations. All aerodynamic coefficients were referenced to a model maximum cross-sectional area of 40.635 in<sup>2</sup>.

The balance force measurements from which thrust is subsequently obtained are initially corrected for model weight tares and balance interactions. Although the bellows arrangement was designed to eliminate pressure and momentum effects on the balance readings, small bellows tares on all balance components still exist. These tares result from a small pressure difference 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. As discussed in reference 12, these bellows tares were determined by testing calibration nozzles with a known performance over a range of nozzle pressure ratios with normal-force and pitching-moment loadings simulating the ranges expected for the test nozzles. The balance data were then corrected in a manner similar to that discussed in references 12 and 13.

At static conditions, the resultant gross thrust  $F_r$  used in the resultant thrust ratio  $F_r/F_i$  was then determined from the individual corrected forces  $F_j$  and  $F_N$ . Expansion of the flow over the surface of the upper ramp produces a resultant thrust force that is not aligned with the horizontal centerline and, hence, significant differences between  $F_r/F_i$  and  $F_j/F_i$  can occur. Resultant thrust vector angle  $\delta_p$  is presented for evaluation of the exhaust-flow turning capabilities of the various nozzles tested.

Nozzle discharge coefficient  $w_p/w_i$  is the ratio of measured weight flow to ideal weight flow, where ideal weight flow is based on jet total pressure  $p_{t,j}$ , jet total temperature  $T_{t,j}$ , and measured nozzle throat area. Nozzle discharge coefficient is then a measure of the ability of the nozzle to pass mass flow and is reduced by boundary-layer thickness and nonuniform flow in the throat. Using the measured weight flow, ideal thrust of the nozzle can be computed from the equation

$$F_i = w_p \sqrt{\frac{RT_{t,j}}{g^2} \left(\frac{2\gamma}{\gamma-1}\right) \left[1 - \left(\frac{1}{\text{NPR}}\right)^{(\gamma-1)/\gamma}\right]}$$

At wind-on conditions, thrust minus axial force was obtained from the equation

$$F_j - F_A = F_{A,\text{bal}} + (p_i - p_\infty)A_i - F_{A,\text{mom}} + D_f$$

where the first term  $F_{A,\text{bal}}$  includes all pressure and viscous forces (internal and external on the afterbody, nozzle, and thrust system). The second term accounts for the interior pressure forces acting at the metric break. The third term  $F_{A,\text{mom}}$  is the momentum tare force previously discussed. The last term  $D_f$  is the friction drag of the centerbody section from stations 26.50 to 55.05. Note that this term is included in the thrust-minus-drag term  $F - D$ .

The adjusted forces and moments measured by the force balance 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  $\alpha$ , which is the angle between the centerbody/nozzle centerline and the relative wind, was determined by applying terms for centerbody deflection (caused when the model and balance bend under aerodynamic load) and a tunnel 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.

The thrust-removed (nozzle) aerodynamic forces and moments were obtained by determining the components of thrust in axial force, normal force, and pitching moment and then 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.

## Wind Tunnel and Tests

The Langley 16-Foot Transonic Tunnel is 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, with test section plenum suction being used for speeds above a Mach number of 1.05. A complete description of this facility and operating characteristics can be found in reference 12.

This investigation was conducted at Mach numbers from 0.60 to 1.20 at nozzle pressure ratios from

1.5 to 12 depending on Mach number. All nozzle configurations were tested at an angle of attack of  $0^\circ$ , and selected configurations were also tested at angles of attack of  $-6^\circ$  and  $6^\circ$ . External pressures were measured on six of the nozzles in separate tests. The Reynolds number per foot varied from  $3.2 \times 10^6$  to  $4.0 \times 10^6$ . All tests were conducted with a 0.10-in-wide boundary-layer trip consisting of a strip of No. 120 silicon carbide grit sparsely distributed in a thin film of lacquer located 1.00 in. from the tip of the forebody nose.

## Presentation of Results

The results of this investigation are presented in both tabular and plotted form. Internal and aeropropulsive characteristics are presented for nozzles 1 to 37 in tables 4 to 40, respectively. Skin-friction drag coefficients for each of the nozzles are given in table 41. Basic and summary data are presented as follows:

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## Discussion of Results

The exhaust-flow expansion process for single-expansion-ramp nozzles occurs both internally and externally. That is, internal expansion of the flow occurs from the nozzle throat up to the end of the lower flap where it is contained by the internal surfaces of the nozzle and is controlled by the internal expansion ratio  $(A_e/A_t)_i$ . External expansion, which occurs downstream of the lower flap trailing edge, is bounded by the expansion ramp and the free (ambi-

ent/exhaust) boundary and is controlled by the external expansion ratio  $(A_e/A_t)_e$ . Thus, thrust performance is influenced by internal and external expansion ratios that tend to cause two performance peaks. Because these nozzles have external expansion surfaces that can be affected by external flow, aeropropulsive performance depends on Mach number, nozzle pressure ratio, and angle of attack. In addition, expansion of the flow over the surface of the external ramp produces a resultant thrust force that is not aligned with the horizontal centerline of the

nozzle and varies with nozzle pressure ratio. Therefore, when a single-expansion-ramp nozzle is integrated into an aircraft configuration, the vertical-force component on the ramp and its contribution as a pitching moment must be included as a trim control consideration.

Three types of data presentation are used to illustrate the effects of varying each of the nozzle geometric parameters. At static conditions, resultant gross thrust ratio  $F_r/F_i$ , thrust-vector angle  $\delta_p$ , and nozzle discharge coefficient  $w_p/w_i$  are presented as a function of nozzle pressure ratio. Resultant gross thrust  $F_r$  is equal to axial thrust  $F_j$  along the body axis when  $\delta_p = 0^\circ$ . Significant differences occur between  $F_r$  and  $F_i$  when the jet exhaust is turned from the axial direction, and the magnitudes of these differences are a function of  $\delta_p$ . Comparisons of data for nozzles with variable nozzle geometric parameters at wind-on conditions are made in terms of the usual aeropropulsive performance parameter  $(F - D_n)/F_i$  (used for axisymmetric nozzles) and nozzle drag coefficient  $C_{D,n}$ . Results are presented as a function of nozzle pressure ratio at each of the Mach numbers tested and are also summarized as a function of Mach number at a typical operating nozzle pressure ratio for each of the Mach numbers tested. This schedule of typical operating pressure ratios is given in table 42. Although discussion of the results at this schedule of NPR and Mach number would generally be applicable for other schedules, the relative difference between comparisons may vary.

Nozzle drag coefficient  $C_{D,n}$  is presented for each nozzle comparison at jet off (NPR = 1) and at the same jet-on conditions as the aeropropulsive performance. At power-on conditions, nozzle drag coefficients were obtained by subtracting the static thrust components from the thrust-minus-drag measurement. Because of this procedure, any effects of the external flow on the internal performance of the nozzles are reflected as a change in nozzle drag.

Variations in SERN nozzle geometry generally result in changes in nozzle internal and/or external expansion ratio, thereby shifting the pressure ratios for optimum performance (design condition). When such geometric variations are made, performance changes are expected, but they cannot always be described as being beneficial or detrimental since the nozzles cannot be compared on equal terms at a given pressure ratio. In addition, changes to the nozzle geometry also resulted in variations to both the upper ramp and lower flap boattail angles. These variations will affect external drag characteristics.

## Variation of Six Nozzle Geometric Parameters

**Effect of upper ramp length.** The effects of varying upper ramp length on nozzle internal and aeropropulsive performance are presented in figure 5. At static conditions (fig. 5(a)), these nozzles have nearly the same resultant thrust ratios at nozzle pressure ratios from 2 to about 4 because they have nearly the same internal expansion ratio. An NPR of 4 is slightly above the nozzle pressure ratio for optimum internal expansion (table 1). At pressure ratios above 4, peak nozzle resultant thrust is dependent on the nozzle pressure ratio for optimum external expansion. Figure 5(a) indicates that although nozzle 2 has probably reached its peak resultant thrust between an NPR of 4.5 and 5, nozzle 1 would reach its peak performance at an NPR somewhat greater than 7. Based on external expansion ratio, nozzle 3 would have its peak performance between nozzle pressure ratios of 10 and 12. As observed previously for SERN nozzles (refs. 8 to 10), the resultant thrust ratio levels remain near peak levels over a much wider range of nozzle pressure ratio than would be expected for a typical convergent-divergent nozzle. This performance characteristic, which results from the two separate-flow expansion processes (internal and external), can be a significant advantage for SERN nozzles because less (or no) expansion-ratio control may be required (particularly for an all-subsonic-mission aircraft) and reductions in exhaust-system weight and complexity can be achieved.

The nonlinear variation of resultant thrust-vector angle  $\delta_p$  with nozzle pressure ratio is characteristic of SERN nozzles and is caused by the changing compression-expansion wave patterns impinging on the ramp as NPR is varied. An axial-force (body axis) performance penalty would be associated with any value of resultant thrust-vector angle that is nonzero because the resultant thrust is being turned away from the axial direction. Since the ramp has a large, unopposed, normal projected area, values of normal force can change significantly with varying nozzle pressure ratio. Typical values of jet normal-force coefficient at static conditions and of total lift coefficient at wind-on conditions are included in the data tables for each of the nozzles tested. In addition, the resulting pitching-moment coefficients, also presented in the tables, would have to be considered in trimming an aircraft configuration that employed SERN nozzles.

Characteristics of nozzle discharge coefficient are also presented in figure 5(a). Nozzle discharge coefficient  $w_p/w_i$  is a measure of the ability of the



nozzle to pass mass flow, and this ability is reduced by boundary-layer thickness and nonuniform flow in the nozzle throat. Changes in nozzle geometry that occur downstream of the nozzle throat (supersonic exhaust) usually do not affect characteristics of nozzle discharge coefficient, as shown by the data in figure 5(a). The three nozzles shown in figure 5(a) have levels of  $w_p/w_i$  that are typical for this class of nozzles. As will be shown subsequently, the discharge coefficients of the other nozzles experienced little or no effect from varying the geometric parameters used to define the nozzles of this investigation. In addition, the external flow had essentially no effect on the discharge coefficient. (See the data tables.)

The variation of the aeropropulsive parameter  $(F - D_n)/F_i$  and nozzle drag coefficient  $C_{D,n}$  is also presented in figure 5 for Mach numbers from 0.60 to 1.20. As expected because of increased drag, the aeropropulsive performance for the three nozzles decreased with increasing Mach number. In general, the variation of nozzle drag coefficient with nozzle pressure ratio NPR for a particular nozzle is similar to that of axisymmetric nozzles, particularly at an angle of attack of  $0^\circ$ . Nozzle drag decreases with initial jet operation because a reduction occurs in the external flow expansion required at the nozzle exit as the exhaust flow fills the nozzle base region. This reduced expansion generally results in higher pressures on the nozzle boattail regions. This increase in nozzle boattail pressures is shown in figure 51 where external pressure distributions are given for nozzle 1. As nozzle pressure ratio is further increased, nozzle drag increases with a subsequent decrease in nozzle drag coefficient for additional increases in NPR. This variation in drag coefficient with increasing NPR is probably caused by exhaust-flow entrainment effects on the external nozzle flow at NPR = 2.5 to 4 and by a compression at the nozzle exit that is created by the increased thickness of the exhaust-flow plume at NPR > 4. These trends in nozzle drag coefficient that occur with increasing nozzle pressure ratio are typical for jet-powered models.

The effects of varying upper ramp length on the aeropropulsive parameter  $(F - D_n)/F_i$  and nozzle drag coefficient  $C_{D,n}$  are summarized in figures 6 and 7, respectively. Data are shown for  $\alpha = 0^\circ$  at the Mach number and NPR schedule given in table 42. The relative ranking of the three nozzles at  $M = 0.60$  and  $0.90$  is essentially the same as that shown at static conditions (fig. 5(a)). The lower performance of nozzle 2 at  $M = 0.60$  and of nozzle 1 at  $M = 0.90$  may be due in part to the more negative resultant thrust-vector angle of nozzle 2 at NPR = 3 and of nozzle 1 at NPR = 5.

At  $M = 0.95$  and  $1.20$ , which have scheduled nozzle pressure ratios of 7 and 8, respectively, nozzle 1 with an intermediate external expansion ratio had the highest aeropropulsive performance. This higher performance can be attributed to the fact that nozzle 1 is operating closer to design at these pressure ratios than either nozzles 2 or 3. At Mach numbers higher than those tested, which would also have a higher scheduled NPR, nozzle 3 (with the largest external expansion ratio) is expected to have the highest aeropropulsive performance because it operates closer to design than either nozzles 1 or 2. Except for  $M = 0.60$ , the aeropropulsive performance ranking of nozzles 1, 2, and 3 followed that expected from static (internal) thrust trends with varying expansion ratio. At  $M = 1.20$ , nozzle 1 also had the same performance as nozzle 3 at NPR = 10 and slightly less performance at NPR = 12 (fig. 5(j)). At NPR = 12, nozzle 3 is slightly underexpanded and is at an NPR slightly above that for optimum internal performance ( $(NPR_e)_{des} = 11.4$ ). This result suggests that less expansion ratio control may be required for SERN nozzles since little performance gain was achieved by increasing the external expansion ratio from 1.69 for nozzle 1 to 2.08 for nozzle 3 (for the Mach number range of the current investigation).

The aeropropulsive performance level of nozzle 2 at  $M = 1.20$  is significantly lower than that of either nozzles 1 or 3 (fig. 6). This lower performance for nozzle 2 results from a much higher drag coefficient at this Mach number (fig. 7). Since this configuration had the steepest upper ramp boattail angle, it probably had higher boattail pressure drag. In addition, nozzle wave drag could be higher than that of the other two nozzles because of its lower fineness ratio.

At Mach numbers from 0.60 to 0.90, increasing the upper ramp length increased the jet-off nozzle drag coefficient (fig. 7). Part of this increase (less than 20 percent) is due to differences in the skin-friction drag coefficient. (See table 41.) Figure 7 also shows small differences in the jet-on drag coefficients for all three nozzles at these same Mach numbers. At jet-off conditions, one should note that the drag on the expansion surface of the ramp is included in the nozzle drag coefficient term and, for this nozzle comparison, can be large for nozzle 3 which has the longest ramp. For  $M > 0.90$ , nozzle drag coefficient increased with decreasing ramp length (increasing ramp boattail angle), particularly at  $M = 1.20$ .

These three nozzles were also tested at angles of attack of  $-6^\circ$  and  $6^\circ$ , and the variation of the aeropropulsive parameter and nozzle drag coefficient with angle of attack is summarized in figures 8

and 9, respectively. In general for these three nozzles,  $(F - D_n)/F_i$  increased as  $\alpha$  was increased from  $-6^\circ$  to  $6^\circ$ . This increase was due mainly to a decrease in nozzle drag as angle of attack was increased (fig. 9).

**Effect of upper ramp angle.** The effects of varying upper ramp chordal angle on nozzle internal and aeropropulsive performance are shown in figure 10. As can be seen in figure 10(a), increasing the upper ramp chordal angle  $\theta_r$  lowered the resultant thrust ratio  $F_r/F_i$  over the entire NPR range tested. Similar results were obtained in reference 9 which also showed that the decrease in resultant thrust ratio resulted from a reduction in pressures on the upper ramp.

At subsonic Mach numbers, increasing the upper ramp angle also resulted in a decrease in aeropropulsive performance (figs. 10(b) to 10(e) and 11). With the absence of pressure measurements, assessing the extent of external flow effects on nozzle internal performance is difficult. However, for nozzle 5, these external flow effects may be detrimental because this nozzle had a much higher jet-on nozzle drag coefficient than either nozzles 1 or 4 (figs. 10(b) to 10(e) and 11). Lower nozzle drag was expected for nozzle 5 because it had the smallest upper ramp boattail angle. As noted previously, any external flow effects on nozzle internal (thrust) performance are charged to nozzle drag coefficient. Nozzle 4, which had the lowest ramp chordal angle, provided the highest aeropropulsive performance at subsonic Mach numbers below 0.95 (fig. 11). This result was caused by two factors. First, nozzle 4 generally had the lowest nozzle drag coefficient in this speed range (fig. 12), and second, this nozzle was operating close to its design nozzle pressure ratio in this speed range. (See tables 1 and 42.) These results indicate that the nozzle should be designed to operate at low values of upper ramp angles for the Mach numbers and nozzle pressure ratios tested. For those applications in which a variable upper ramp is required, such as for thrust vectoring, the upper ramp angle could be varied in order to optimize nozzle performance over a wide range of operating conditions.

Nozzle 1 had the highest aeropropulsive performance at  $M = 1.20$  of the three nozzles shown because it is operating near design pressure ratio. As seen in figure 10(f), the aeropropulsive performance for nozzle 1 was essentially the same as that of nozzle 5 at nozzle pressure ratios from 10 to 12 even though the design NPR for nozzle 5 was 10.65. This again indicates that SERN nozzles may operate efficiently at a lower expansion ratio than that required for full expansion of the exhaust flow.

**Effect of lower flap length.** The effects of varying lower flap length on nozzle internal and aeropropulsive performance and nozzle drag are shown in figures 13 to 15. At  $\text{NPR} > 3$ , there was an increase in nozzle internal performance as the lower flap length increased (fig. 13(a)) although the differences between nozzles 1 and 7 were small. Similar effects were found in references 8 and 9 where reference 9 showed that as the lower flap length was increased, pressures on the upper ramp also increased which would be expected to result in higher internal performance. In addition, reference 9 indicated that at nozzle pressure ratios below  $(\text{NPR}_i)_{\text{des}}$ , shock waves with some flow separation were present on the ramp and that these shocks moved farther upstream on the ramp as lower flap length was decreased. Consequently, these results imply that for nozzle 6, which has the shortest lower flap, more of the ramp is probably separated which would contribute to the lower internal performance for this nozzle when compared with that of nozzles 1 and 7. In addition, nozzle 6 had the lowest internal design nozzle pressure ratio of those shown in figure 9, and thus it was operating farther off design at  $\text{NPR} > 3$  than nozzles 1 and 7.

At forward speeds, nozzle 1 generally had higher aeropropulsive performance than either nozzles 6 or 7 at  $\text{NPR} > 3$  for all Mach numbers tested (figs. 13 and 14). The effects of varying lower flap length on nozzle drag (figs. 13 and 15) were small, but in general, nozzle 1 had the lowest nozzle drag.

A comparison of external pressure distributions between nozzles 1, 6, and 8 is presented in figure 52. In general, small differences exist between the pressure distributions over the external ramp. Nozzle 6 tends to have a slightly higher pressure recovery at jet-off conditions. On the lower flap, nozzle 6 had a greater expansion of the flow over the initial portion of the lower surface coupled with higher downstream pressure recovery than that of nozzle 1. The generally higher nozzle drag coefficient for nozzle 6 may in part be due to this region of low (negative) pressure coefficients acting on the larger axial projected area of the initial lower flap curvature.

**Effect of lower flap angle.** The effects of varying lower flap angle on nozzle internal and aeropropulsive performance and nozzle drag coefficient are presented in figures 16 to 18. The internal expansion ratios for these three nozzles differ widely, and as a result, peak internal performance occurs at different nozzle pressure ratios that correspond to the various expansion ratios (fig. 16(a)).

The effects of varying lower flap angle on aeropropulsive performance, shown in figure 17, follow

expected trends based on the results from static conditions. Nozzle 9 has the highest resultant thrust ratio at  $\text{NPR} = 3$  (fig. 16(a)) and the highest performance at  $M = 0.60$ . At  $M = 1.20$ , nozzle 8 has higher performance than nozzle 9 because nozzle 8 is now operating at an NPR closer to that required for optimum external expansion and also because nozzle 9 has a higher nozzle drag. However, the highest performance at  $M = 1.20$  was obtained with nozzle 1 which is operating near design for external expansion (that is,  $(\text{NPR})_{\text{des}} = 7.84$  versus scheduled  $\text{NPR} = 8$  at  $M = 1.20$ ) and also has lower nozzle drag than nozzle 9 and slightly lower drag than nozzle 8. For a fully variable SERN, the lower flap would most likely be movable, and thus the lower flap angle along with the upper ramp angle would be varied to maximize performance over a wide range of flight conditions. The effect of varying lower flap angle on nozzle drag coefficient (fig. 18) was small except for nozzle 9 which had significantly higher nozzle drag at  $M = 0.95$  and  $1.20$ .

A comparison of the external pressure distributions between nozzles 1 and 8 is presented in figure 52. Little or no difference occurred in the pressure distributions over the range of conditions tested.

#### *Effect of axial location of nozzle throat.*

The effects of varying the axial location of the nozzle throat on internal and aeropropulsive performance and nozzle drag coefficient are shown in figures 19 to 21. The axial location of the nozzle throat will probably have the most impact on the external performance of the nozzle because both the upper ramp and lower flap boattail angles can be significantly changed by varying this geometric parameter while internal and external expansion ratios remain constant. For example, low nozzle boattail angles, which are desirable for nozzles installed in an aircraft designed to cruise supersonically, would result as the axial location of the throat is increased.

As expected, figure 19(a) shows that the three nozzles have essentially the same internal performance. Thus, any changes to aeropropulsive performance from varying the axial location of the nozzle throat should be due to external flow effects only and will show up primarily as changes to nozzle drag coefficient.

As can be seen in figure 21, nozzles 10 and 11 had the same jet-off drag coefficients (somewhat higher than  $C_{D,n}$  for nozzle 1) at  $M = 0.60$  and  $0.80$ . At a scheduled NPR for these Mach numbers, the drag coefficient for nozzle 11 was considerably higher than that of either nozzles 1 or 10. This higher drag coefficient was due to less favorable jet effects because

nozzle 11 had the same jet-off drag coefficient as nozzle 10.

The jet-off nozzle drag coefficient for nozzle 10 at  $M = 0.90$  to  $1.20$  was significantly higher than that of either nozzles 1 or 11, and in fact, nozzle 10 had one of the highest jet-off drag coefficients measured of all the nozzles tested. This higher drag is believed to be a result of an increase in pressure drag due to the greater upper ramp and lower flap boattail angles of nozzle 10.

External pressures of nozzles 1 and 10 are presented in figure 53. At  $M = 0.60$  and  $0.80$ , nozzle 10 had a greater expansion of the flow over both the ramp and flap with recovery of the flow to higher positive pressures than nozzle 1. This greater recompression of the flow on nozzle 10 results in lower drag (or possibly a thrust) on the aft portion of the nozzle external surfaces which can compensate for the higher drag caused by the greater expansion (lower pressures) of the flow over the initial boattail surfaces. This would account for the small difference in nozzle drag between nozzles 10 and 1.

At Mach numbers greater than  $0.80$ , a marked difference was evident in the flow characteristics between nozzles 1 and 10, particularly on the lower flap. Although the flow over the upper ramp of nozzle 10 still expands more than on nozzle 1, the flow now recompresses to the same levels as nozzle 1. On the lower flap, nozzle 10 now has a strong expansion that is followed by a shock and flow separation. This flow separation is quite evident at  $M = 0.95$  at both jet-off and jet-on conditions (figs. 53(k) to 53(m)). These results would indicate that at subsonic speeds, larger lower flap boattail angles are probably undesirable.

The fact that nozzle 11 had the lowest drag coefficient at  $M = 1.20$  (fig. 21) was probably due to lower pressure drag because of the lower boattail angles of both the upper ramp and lower flap. Consequently, nozzle 11 had the highest aeropropulsive performance of all nozzles tested at  $M = 1.20$ .

The effects of angle of attack on aeropropulsive performance and nozzle drag are summarized in figures 22 and 23, respectively, for nozzles 1, 10, and 11. Generally, angle of attack had no effect on the relative differences between the three nozzles. That is, at  $M = 0.60$  nozzles 1 and 10 had the same performance but nozzle 11 had lower performance for the three angles of attack tested.

#### *Effect of vertical location of nozzle throat.*

The effects of varying the vertical location of the nozzle throat on internal and aeropropulsive performance and nozzle drag coefficient are presented in

figures 24 to 26. Varying the vertical location of the nozzle throat is a means of trading upper or lower nozzle boattail angles without having to make large extensions to the upper ramp or lower flap. Since all three nozzles had identical expansion ratios, it was expected that nozzles 1, 12, and 13 would have the same internal performance, but, as can be seen in figure 24(a), nozzle 13 had lower resultant thrust ratios up to  $NPR = 4$ . Because peak internal performance occurred at  $NPR \approx 4.5$  for nozzle 13 (versus  $NPR \approx 3.5$  for nozzles 1 and 12), it is apparent that this nozzle had a higher effective expansion ratio. The reason for this shift in effective expansion ratio is not known, but it may be due to the convergent section of the upper ramp being too short. As a result, performance at forward speeds is governed by both internal and external flow characteristics.

In general, the effects of varying the vertical location of the nozzle throat on either the aeropropulsive parameter or nozzle drag coefficient are small (figs. 25 and 26). Nozzle 13 had lower aeropropulsive performance at  $M = 0.60$  than either nozzles 1 or 12 (fig. 25) because this nozzle had lower internal performance at the scheduled  $NPR$  of 3 (fig. 24(a)). An upward movement of the nozzle throat location (nozzles 12 and 13) resulted in an increase in lower flap boattail angle and a decrease in upper ramp angle. As might be expected, these opposing changes in boattail angle appeared to contribute opposite effects on external drag so that the net effect on drag coefficient was small (fig. 26).

### Effect of Surface Shape Variations

Some limited tests were conducted in order to determine the effect of varying the shape of some of the nozzle surfaces without changing the basic six geometric parameters that defined a particular nozzle. This was accomplished on nozzle 1 by varying the curvature of either the upper ramp internal or external surfaces or the lower flap external surface which resulted in nozzles 30 to 32.

**Effect of upper ramp expansion surface.** The effects of varying the curvature of the upper ramp expansion surface on the internal and aeropropulsive performance and nozzle drag coefficients are presented in figures 27 to 29. The modification to the ramp expansion surface consisted of reducing the curvature of the surface relative to nozzle 1 which reduced the initial ramp expansion angle. As shown in figure 27(a), reducing the ramp curvature caused essentially no effect on the resultant thrust ratio; however, resultant thrust-vector angles were more negative. Similar effects of ramp curvature on thrust-vector angle were reported in reference 9.

At subsonic speeds the aeropropulsive performance of nozzle 30 was slightly higher than that of nozzle 1 (fig. 28) because nozzle 30 generally had lower nozzle drag coefficients at these speeds (fig. 29). This change in nozzle drag coefficient was most likely due to a favorable external-flow effect on the nozzle internal performance rather than to external drag characteristics because there was no geometric change to the external surfaces of the two nozzles. In general, the difference in either aeropropulsive performance or nozzle drag coefficient between nozzles 1 and 30 remained the same at each of the angles of attack tested. (Compare the results of tables 4 and 33.)

**Effect of varying upper ramp external surface.** The effects of varying the shape of the upper ramp external surface on the internal and aeropropulsive performance and nozzle drag characteristics are presented in figures 30 to 32. As expected, changing the curvature of the upper ramp external surface caused no effect on internal performance (fig. 30(a)). At subsonic speeds, nozzle drag coefficient was generally lower for nozzle 31 than for nozzle 1 (fig. 32), and as a result, nozzle 31 had higher aeropropulsive performance than nozzle 1 up to  $M = 0.80$  (fig. 31). Angle-of-attack effects (not shown graphically) were similar to those discussed previously for the upper ramp expansion surface. (Compare tables 4 and 34.)

**Effect of varying lower flap external shape.** The effects of varying the lower ramp external shape on internal and aeropropulsive performance and nozzle drag coefficients are shown in figures 33 to 35. The internal resultant thrust ratio for nozzle 32 was higher than that for nozzle 1 even though these two nozzles were supposed to have the same internal contours. (Compare tables 2(a) and 2(ff).) This difference in internal performance is attributed to geometry differences between the lower flaps for nozzles 1 and 32 because both nozzles used the same upper ramp piece when configured as a test nozzle. As shown in figure 35, nozzle 32 had higher jet-off and jet-on nozzle drag than nozzle 1, in particular at Mach numbers greater than 0.90. As a result, this nozzle generally had poorer aeropropulsive performance characteristics than nozzle 1 (figs. 33 and 34). The results at angle of attack (not shown) are once again the same as those already noted. (Compare tables 4 and 35.)

### Variation of Convergent Single-Expansion-Ramp Nozzles

Several convergent SERN's were investigated in order to determine the effects of nozzle geometry variations on both internal and aeropropulsive

performance of these types of nozzles. A convergent SERN is still an external expansion nozzle but the internal expansion ratio is 1 and all expansion occurs downstream of the lower flap exit. The use of a convergent SERN may be desirable for an all-subsonic-mission aircraft where little expansion ratio control may be required. For a fixed-geometry nozzle, significant reductions in exhaust-system weight and complexity can be achieved.

**Effect of upper ramp length.** The effects of varying nozzle upper ramp length on the internal and aeropropulsive performance and on nozzle drag coefficient are presented in figures 36 to 38. Increasing the upper ramp length decreased resultant thrust ratios at  $\text{NPR} > 2.5$  up to the maximum NPR tested (fig. 36(a)). Note that these two nozzles maintained nearly constant levels of resultant thrust ratio over the entire range of nozzle pressure ratios tested. This characteristic trend of internal performance for convergent SERN nozzles has been shown previously in reference 11. Aeropropulsive performance was lower for nozzle 33 (with a long upper ramp) up to  $M = 0.90$  (figs. 36 and 37) primarily because nozzle 34 has better thrust characteristics. However, at  $M = 0.95$  and  $1.20$ , nozzle 33 has higher aeropropulsive performance because this nozzle has lower nozzle drag coefficients than nozzle 34 (figs. 36 and 38). The higher nozzle drag for nozzle 34 probably results from higher boattail drag that develops on the shorter upper ramp of this nozzle at transonic and supersonic speeds.

**Effect of upper ramp angle.** The internal and aeropropulsive performance and nozzle drag characteristics that result from varying the nozzle upper ramp angle are shown in figures 39 to 41. At subsonic speeds, increasing the upper ramp angle generally decreased the resultant thrust ratio and aeropropulsive performance parameter and increased the nozzle drag coefficient. Similar effects were found for the convergent-divergent nozzles (figs. 10 to 12). At  $M = 1.20$ , increasing the upper ramp angle increased aeropropulsive performance at a nozzle pressure ratio near the scheduled value of 8 because of lower nozzle drag.

**Effect of lower flap length.** The effects of increasing lower flap length on internal and aeropropulsive performance and nozzle drag coefficient are presented in figures 42 to 44. Increasing the lower flap length resulted in a significant increase in resultant thrust ratio of about 2 percent over the entire range of nozzle pressure ratio tested (fig. 42(a)). This result is similar to that of reference 11 which also found

that variation of this parameter had the largest effects on nozzle internal performance. Nozzle 36 (with a long lower flap) also had higher aeropropulsive performance than nozzle 37 (fig. 43) over the entire Mach number range tested because nozzle 36 had higher static (or internal) performance.

**Effect of lower flap angle.** The effects of varying the lower flap angle on internal and aeropropulsive performance are presented in figures 45 to 47. Decreasing the lower flap angle, that is, going from  $-4.00^\circ$  (nozzle 33) to  $-18.00^\circ$  (nozzle 37), resulted in small increases in both resultant thrust ratio (fig. 45(a)) and aeropropulsive performance (fig. 46). Similar results were found for the convergent-divergent SERN nozzles.

**Comparison between convergent and convergent-divergent nozzles.** A comparison of internal and aeropropulsive performance between convergent and convergent-divergent SERN nozzles is presented in figures 48 to 50. Nozzle 36 (convergent) had higher internal performance than nozzle 1 (C-D) up to about  $\text{NPR} = 3.5$  (which is about the nozzle pressure ratio for optimum internal expansion for nozzle 1) and then essentially the same performance up to about  $\text{NPR} = 7$ . (Both nozzles had the same external expansion ratios.) Except for  $\text{NPR} < 2.5$ , nozzle 33 (convergent) had the lowest internal performance of the three nozzles considered.

A comparison of aeropropulsive performance between the convergent-divergent and the convergent SERN nozzles is shown in figure 49. At the scheduled NPR (3) for  $M = 0.60$ , nozzle 36 (convergent) had the highest aeropropulsive performance mainly because this nozzle had the highest internal performance at this nozzle pressure ratio. However, at all other test conditions, nozzle 1 (C-D) had significantly higher performance than either of the convergent SERN nozzles, 33 or 36. Part of this lower performance is attributed to these two nozzles having much higher nozzle drag at both jet-off and jet-on conditions (fig. 50). The reason for this much higher drag for both nozzles 33 and 36 is evident in the pressure distributions presented in figure 54. The flow over the upper ramp for all three nozzles has essentially the same characteristics showing similar initial expansion of the flow followed by a strong pressure recovery to relatively high positive pressures. However, the expansion of the flow over the lower flap for both nozzles 33 and 36 is much stronger with the expansion peak occurring farther downstream on the flap. At Mach numbers greater than 0.60, evidence exists

of a shock on the flap with some resulting shock-induced separation, especially at  $M = 0.90$  and  $0.95$ . At these conditions, the initial expansion of the flow over the lower flap of nozzle 1 is followed by a strong recovery to positive pressures which, acting on the aft-facing nozzle boattail, will decrease nozzle drag relative to the other nozzles.

## Concluding Remarks

An investigation conducted in the Langley 16-Foot Transonic Tunnel has determined the effects of varying six nozzle geometric parameters on the internal and aeropropulsive performance characteristics of single-expansion-ramp nozzles. These parameters included the nozzle upper ramp length and chordal angle, the nozzle lower flap length and chordal angle, and the axial and vertical locations of the nozzle throat. Both convergent-divergent and convergent nozzle configurations were tested. Some limited tests were made to study the effects of varying the curvature of the upper ramp internal and external surfaces and the lower flap external surface of one of the nozzles. This investigation was conducted at Mach numbers from 0.60 to 1.20, nozzle pressure ratios from 1.5 to 12 and angles of attack of  $0^\circ$  and  $\pm 6^\circ$ .

Maximum aeropropulsive performance at a particular Mach number was highly dependent on the operating nozzle pressure ratio. For example, as upper ramp length or angle increased, some nozzles had higher performance at a Mach number of 0.90 because the nozzle design pressure ratio was the same as the operating pressure ratio. Thus, selection of the various nozzle geometric parameters should be based on the mission requirements of the aircraft. Because of the two separate exhaust-flow expansion processes, less external expansion ratio control may be required for single-expansion-ramp nozzles. A combination of large upper ramp and large lower flap boattail angles produced greater nozzle drag coefficients at Mach numbers greater than 0.80, primarily from shock-induced separation on the lower flap of the nozzle. An increase in both resultant thrust ratio and aeropropulsive performance resulted from increasing the flap length of the convergent single-expansion-ramp nozzle. At static conditions, the convergent nozzles had high and nearly constant values of resultant thrust ratio over the entire range of nozzle pressure ratio tested. However, these nozzles had much lower aeropropulsive performance than the convergent-divergent nozzle at Mach numbers greater than 0.60. Varying the external shape of either the upper ramp or the lower flap of one of the nozzles re-

sulted in small changes to either aeropropulsive performance or nozzle drag.

NASA Langley Research Center  
Hampton, VA 23681-0001  
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Table 1. Nozzle Geometric Parameters

Nozzle	$l_r/h_{t,n}$	$\theta_r$ , deg	$\beta_r$ , deg	$l_f/h_{t,n}$	$\theta_f$ , deg	$\beta_f$ , deg	$x_f/h_{t,n}$	$y_f/h_{t,n}$	$(A_w/A_t)_i$	$(A_w/A_t)_e$	$(NPR)_i$ , des	$(NPR)_e$ , des
1	4.50	8.75	8.15	0.90	0.00	11.28	7.25	0.12	1.19	1.69	3.78	7.84
2	2.00	8.75	12.60	.90	0.00	11.28	7.25	.12	1.18	1.31	3.70	4.72
3	7.00	8.75	5.20	.90	0.00	11.28	7.25	.12	1.20	2.08	3.86	11.40
4	4.50	5.00	9.57	.90	0.00	11.28	7.25	.12	1.13	1.39	3.30	5.35
5	4.50	12.50	6.69	.90	0.00	11.28	7.25	.12	1.25	2.00	4.25	10.65
6	4.50	8.75	8.15	.40	0.00	11.99	7.25	.12	1.08	1.69	2.89	7.84
7	4.50	8.75	8.15	1.40	0.00	10.64	7.25	.12	1.30	1.69	4.64	7.84
8	4.50	8.75	8.15	.90	10.00	12.34	7.25	.12	1.35	1.85	5.03	9.26
9	4.50	8.75	8.15	.90	-10.00	12.34	7.25	.12	1.03	1.53	2.42	6.49
10	4.50	8.75	10.59	.90	0.00	16.75	4.50	.12	1.19	1.69	3.78	7.84
11	4.50	8.75	6.62	.90	0.00	8.47	10.00	.12	1.19	1.69	3.78	7.84
12	4.50	8.75	12.28	.90	0.00	5.26	7.25	-.75	1.19	1.69	3.78	7.84
13	4.50	8.75	3.93	.90	0.00	17.05	7.25	1.00	1.19	1.69	3.78	7.84
14	2.94	6.41	10.05	1.21	6.25	16.81	5.53	.67	1.35	1.46	5.03	5.92
15	6.06	11.09	3.17	1.21	6.25	16.81	5.53	.67	1.44	2.32	5.75	13.77
16	2.94	11.09	8.43	1.21	-6.25	18.86	5.53	.67	1.17	1.44	2.61	5.75
17	6.06	6.41	5.67	1.21	-6.25	18.86	5.53	.67	1.08	1.55	2.89	6.66
18	2.94	11.09	15.48	1.21	6.25	8.00	5.53	-.42	1.44	1.71	5.75	8.02
19	6.06	6.41	10.95	1.21	6.25	8.00	5.53	-.42	1.35	1.81	5.03	8.90
20	2.94	6.41	17.01	1.21	-6.25	10.20	5.53	-.42	1.06	1.20	2.72	3.86
21	6.06	11.09	8.51	1.21	-6.25	10.20	5.53	-.42	1.18	2.06	3.70	12.31
22	2.94	11.09	6.19	1.21	6.25	11.31	8.97	.67	1.44	1.71	5.75	8.02
23	6.06	6.41	4.37	1.21	6.25	11.31	8.97	.67	1.35	1.81	5.03	8.90
24	2.94	6.41	7.39	1.21	-6.25	12.47	8.97	.67	1.06	1.20	2.72	3.86
25	6.06	11.09	2.44	1.21	-6.25	12.47	8.97	.67	1.18	2.06	3.70	12.31
26	2.94	6.41	11.77	1.21	6.25	5.31	8.97	-.42	1.32	1.46	4.79	5.92
27	6.06	11.09	6.57	1.21	6.25	5.31	8.97	-.42	1.47	2.32	6.00	13.77
28	2.94	11.09	11.46	1.21	-6.25	6.79	8.97	-.42	1.17	1.44	2.61	5.75
29	6.06	6.41	8.47	1.21	-6.25	6.79	8.97	-.42	1.08	1.55	2.89	6.66
30	4.50	8.75	8.15	.90	0.00	11.28	7.25	.12	1.19	1.69	3.78	7.84
31	4.50	8.75	8.15	.90	0.00	11.28	7.25	.12	1.19	1.69	3.78	7.84
32	4.50	8.75	8.15	.90	0.00	11.28	7.25	.12	1.19	1.69	3.78	7.84
33	4.50	8.75	8.15	0.00	-4.00	12.63	7.25	.12	1.00	1.69	1.89	7.84
34	2.00	8.75	12.60	0.00	-4.00	12.63	7.25	.12	1.00	1.31	1.89	4.72
35	4.50	5.00	9.57	0.00	-4.00	12.63	7.25	.12	1.00	1.16	1.89	3.54
36	4.50	8.75	8.15	.73	-21.00	12.40	7.25	.12	1.00	1.57	1.89	6.82
37	4.50	8.75	8.15	0.00	-18.00	12.63	7.25	.12	1.00	1.69	1.89	7.84



Table 2. Nozzle Coordinates

[The symbol *s* denotes a straight-line contour between two indicated coordinates]

(a) Nozzle 1

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.095		<i>s</i>
1.197	3.080	6.580	1.944
1.796	3.057	7.110	1.724
2.395	3.024		<i>s</i>
2.994	2.983	8.460	0.375
3.592	2.934	8.990	0.155
4.191	2.877	9.168	0.176
4.790	2.812	9.265	0.200
5.389	2.741	9.361	0.223
5.988	2.663	9.458	0.246
6.586	2.579	9.554	0.269
7.185	2.489	9.650	0.292
7.784	2.394	9.747	0.314
8.383	2.293	9.843	0.336
8.982	2.188	9.940	0.357
9.580	2.078	10.036	0.379
10.179	1.964	10.133	0.400
10.778	1.847	10.712	0.521
11.377	1.726	11.387	0.649
11.975	1.603	11.966	0.746
12.574	1.477	12.544	0.830
13.173	1.349	13.123	0.901
13.772	1.219	13.798	0.966
14.370	1.088	14.377	1.004
14.570	1.044	14.570	1.014
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.594	-3.090		<i>s</i>
1.189	-3.062	6.244	-1.944
1.783	-3.016	6.489	-1.903
2.378	-2.953		<i>s</i>
2.972	-2.874	8.746	-1.126
3.567	-2.781	8.990	-1.085
4.161	-2.675		<i>s</i>
4.756	-2.557	10.106	-1.085
5.350	-2.427		
5.945	-2.287		radius 3 = 0.750
6.539	-2.138		radius 4 = 0.750
7.134	-1.981		
7.728	-1.818		
8.326	-1.648		
8.917	-1.474		
9.512	-1.296		
10.106	-1.115		

Table 2. Continued

(b) Nozzle 2

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.583	3.090		s
1.166	3.063	6.602	1.944
1.750	3.017	7.476	1.358
2.333	2.956		s
2.916	2.878	8.460	0.375
3.499	2.787	8.990	0.155
4.082	2.681	9.168	0.176
4.666	2.563	9.260	0.199
5.249	2.433	9.352	0.220
5.832	2.292	9.444	0.242
6.415	2.142	9.536	0.263
6.999	1.983	9.628	0.283
7.582	1.815	9.721	0.302
8.165	1.641	9.813	0.321
8.748	1.461	9.905	0.340
9.332	1.275	9.997	0.358
9.915	1.086	10.273	0.407
10.498	0.893	10.457	0.436
11.081	0.698	11.102	0.513
11.470	0.567	11.470	0.537
		radius 1 = 0.750	
		radius 2 = 2.000	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.594	-3.090		s
1.189	-3.062	6.244	-1.944
1.783	-3.016	6.489	-1.903
2.378	-2.953		s
2.972	-2.874	8.746	-1.126
3.567	-2.781	8.990	-1.085
4.161	-2.675		s
4.756	-2.557	10.106	-1.085
5.350	-2.427		
5.945	-2.287	radius 3 = 0.750	
6.539	-2.138	radius 4 = 0.750	
7.134	-1.981		
7.728	-1.818		
8.326	-1.648		
8.917	-1.474		
9.512	-1.296		
10.106	-1.115		

Table 2. Continued

(c) Nozzle 3

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.596	3.098		
1.191	3.090	6.580	1.944
1.787	3.079	7.110	1.724
2.382	3.062		
2.978	3.042	8.460	0.375
3.574	3.017	8.990	0.155
4.169	2.988	9.168	0.176
4.765	2.955	9.266	0.200
5.360	2.918	9.364	0.224
5.956	2.878	9.461	0.248
6.552	2.834	9.559	0.271
7.147	2.787	9.657	0.294
7.743	2.736	9.755	0.317
8.339	2.682	9.852	0.340
8.934	2.625	9.950	0.363
9.530	2.565	10.048	0.385
10.126	2.502	10.146	0.408
10.721	2.437	10.732	0.538
11.317	2.369	11.318	0.662
11.912	2.299	11.904	0.779
12.508	2.226	12.490	0.889
13.104	2.151	13.175	1.008
13.699	2.075	13.663	1.086
14.295	1.996	14.250	1.172
14.890	1.916	14.836	1.249
15.486	1.834	15.422	1.318
16.082	1.750	16.106	1.386
16.677	1.665	16.693	1.434
17.293	1.579	17.279	1.472
17.670	1.521	17.670	1.491

radius 1 = 0.750  
radius 2 = 0.750

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.594	-3.090		
1.189	-3.062	6.244	-1.944
1.783	-3.016	6.489	-1.903
2.378	-2.953		
2.972	-2.874	8.746	-1.126
3.567	-2.781	8.990	-1.085
4.161	-2.675		
4.756	-2.557	10.106	-1.085
5.350	-2.427		
5.945	-2.287		
6.539	-2.138		
7.134	-1.981		
7.728	-1.818		
8.326	-1.648		
8.917	-1.474		
9.512	-1.296		
10.106	-1.115		

radius 3 = 0.750  
radius 4 = 0.750

Table 2. Continued

(d) Nozzle 4

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.094		
1.198	3.077	6.580	1.944
1.796	3.048	7.110	1.724
2.395	3.010		
2.994	2.961	8.460	0.375
3.592	2.902	8.990	0.155
4.191	2.834	9.120	0.166
4.790	2.758	9.220	0.184
5.389	2.673	9.320	0.201
5.988	2.580	9.420	0.217
6.586	2.481	9.520	0.233
7.185	2.374	9.619	0.248
7.784	2.261	9.719	0.264
8.383	2.142	9.819	0.278
8.982	2.017	9.919	0.292
9.580	1.888	10.018	0.306
10.179	1.753	10.118	0.319
10.778	1.615	10.717	0.391
11.377	1.473	11.316	0.451
11.975	1.328	11.915	0.500
12.574	1.180	12.514	0.541
13.173	1.030	13.113	0.575
13.772	0.878	13.712	0.605
14.370	0.724	14.310	0.632
14.570	0.673	14.570	0.643
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.594	-3.090		
1.189	-3.062	6.244	-1.944
1.783	-3.016	6.489	-1.903
2.378	-2.953		
2.972	-2.874	8.746	-1.126
3.567	-2.781	8.990	-1.085
4.161	-2.675		
4.756	-2.557	10.106	-1.085
5.350	-2.427		
5.945	-2.287		
6.539	-2.138		
7.134	-1.981		
7.728	-1.818		
8.326	-1.648		
8.917	-1.474		
9.512	-1.296		
10.106	-1.115		
		radius 3 = 0.750	
		radius 4 = 0.750	

Table 2. Continued

(e) Nozzle 5

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.094		s
1.197	3.084	6.580	1.944
1.796	3.065	7.110	1.724
2.395	3.039		s
2.994	3.006	8.460	0.375
3.592	2.967	8.990	0.155
4.191	2.921	9.215	0.190
4.790	2.869	9.311	0.220
5.389	2.812	9.407	0.250
5.988	2.749	9.502	0.280
6.586	2.681	9.580	0.310
7.185	2.608	9.694	0.340
7.784	2.530	9.789	0.370
8.383	2.449	9.885	0.400
8.982	2.363	9.980	0.429
9.580	2.274	10.076	0.459
10.179	2.181	10.172	0.488
10.778	2.085	10.745	0.660
11.377	1.986	11.319	0.823
11.975	1.884	11.988	0.996
12.574	1.781	12.562	1.126
13.173	1.675	13.136	1.235
13.772	1.568	13.709	1.319
14.370	1.459	14.379	1.382
14.570	1.422	14.570	1.392
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.594	-3.090		s
1.189	-3.062	6.244	-1.944
1.783	-3.016	6.489	-1.903
2.378	-2.953		s
2.972	-2.874	8.746	-1.126
3.567	-2.781	8.990	-1.085
4.161	-2.675		s
4.756	-2.557	10.106	-1.085
5.350	-2.427		
5.945	-2.287		radius 3 = 0.750
6.539	-2.138		radius 4 = 0.750
7.134	-1.981		
7.728	-1.818		
8.326	-1.648		
8.917	-1.474		
9.512	-1.296		
10.106	-1.115		

Table 2. Continued  
(f) Nozzle 6

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.095		s
1.197	3.080	6.580	1.944
1.796	3.057	7.110	1.724
2.395	3.024		s
2.994	2.983	8.460	0.375
3.592	2.934	8.990	0.155
4.191	2.877	9.168	0.176
4.790	2.812	9.265	0.200
5.389	2.741	9.361	0.223
5.988	2.663	9.458	0.246
6.586	2.579	9.554	0.269
7.185	2.489	9.650	0.292
7.784	2.394	9.747	0.314
8.383	2.293	9.843	0.336
8.982	2.188	9.940	0.357
9.580	2.078	10.036	0.379
10.179	1.964	10.133	0.400
10.778	1.847	10.712	0.521
11.377	1.726	11.387	0.649
11.975	1.603	11.966	0.746
12.574	1.477	12.544	0.830
13.173	1.349	13.123	0.901
13.772	1.219	13.798	0.966
14.370	1.088	14.377	1.004
14.570	1.044	14.570	1.014
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.593	-3.089		s
1.186	-3.057	5.587	-1.944
1.779	-3.005	5.781	-1.918
2.372	-2.934		s
2.964	-2.846	8.796	-1.111
3.557	-2.743	8.990	-1.085
4.150	-2.624		s
4.743	-2.492	9.486	-1.085
5.336	-2.349		
5.929	-2.194		radius 3 = 0.750
6.522	-2.030		radius 4 = 0.750
7.114	-1.858		
7.707	-1.679		
8.300	-1.495		
8.893	-1.306		
9.486	-1.115		

Table 2. Continued

(g) Nozzle 7

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.095		
1.197	3.080	6.580	1.944
1.796	3.057	7.110	1.724
2.395	3.024		
2.994	2.983	8.460	0.375
3.592	2.934	8.990	0.155
4.191	2.877	9.168	0.176
4.790	2.812	9.265	0.200
5.389	2.741	9.361	0.223
5.988	2.663	9.458	0.246
6.586	2.579	9.554	0.269
7.185	2.489	9.650	0.292
7.784	2.394	9.747	0.314
8.383	2.293	9.843	0.336
8.982	2.188	9.940	0.357
9.580	2.078	10.036	0.379
10.179	1.964	10.133	0.400
10.778	1.847	10.712	0.521
11.377	1.726	11.387	0.649
11.975	1.603	11.966	0.746
12.574	1.477	12.544	0.830
13.173	1.349	13.123	0.901
13.772	1.219	13.798	0.966
14.370	1.088	14.377	1.004
14.570	1.044	14.570	1.014
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.596	-3.091		
1.192	-3.066	6.244	-1.944
1.788	-3.024	6.489	-1.903
2.384	-2.968		
2.979	-2.898	8.746	-1.126
3.575	-2.814	8.990	-1.085
4.171	-2.719		
4.767	-2.612	10.726	-1.085
5.363	-2.494		
5.959	-2.367	radius 3 = 0.750	
6.555	-2.231	radius 4 = 0.750	
7.150	-2.088		
7.746	-1.938		
8.342	-1.781		
8.938	-1.620		
9.534	-1.455		
10.130	-1.286		
10.726	-1.115		

Table 2. Continued

(h) Nozzle 8

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.095		
1.197	3.080	6.580	1.944
1.796	3.057	7.110	1.724
2.395	3.024		
2.994	2.983	8.460	0.375
3.592	2.934	8.990	0.155
4.191	2.877	9.168	0.176
4.790	2.812	9.265	0.200
5.389	2.741	9.361	0.223
5.988	2.663	9.458	0.246
6.586	2.579	9.554	0.269
7.185	2.489	9.650	0.292
7.784	2.394	9.747	0.314
8.383	2.293	9.843	0.336
8.982	2.188	9.940	0.357
9.580	2.078	10.036	0.379
10.179	1.964	10.133	0.400
10.778	1.847	10.712	0.521
11.377	1.726	11.387	0.649
11.975	1.603	11.966	0.746
12.574	1.477	12.544	0.830
13.173	1.349	13.123	0.901
13.772	1.219	13.798	0.966
14.370	1.088	14.377	1.004
14.570	1.044	14.570	1.014
radius 1 = 0.750 radius 2 = 0.750			

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.594	-3.091		
1.189	-3.066	5.956	-1.944
1.783	-3.024	6.176	-1.911
2.378	-2.968		
2.972	-2.897	8.771	-1.118
3.567	-2.814	8.990	-1.085
4.161	-2.719		
4.756	-2.612	9.120	-1.096
5.350	-2.496		
5.945	-2.370	10.106	-1.282
6.539	-2.236		
7.134	-2.094		
7.728	-1.946		
8.326	-1.794		
8.917	-1.636		
9.511	-1.475		
10.106	-1.312		
radius 3 = 0.750 radius 4 = 0.075			



Table 2. Continued

(i) Nozzle 9

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.095		
1.197	3.080	6.580	1.944
1.796	3.057	7.110	1.724
2.395	3.024		
2.994	2.983	8.460	0.375
3.592	2.934	8.990	0.155
4.191	2.877	9.168	0.176
4.790	2.812	9.265	0.200
5.389	2.741	9.361	0.223
5.988	2.663	9.458	0.246
6.586	2.579	9.554	0.269
7.185	2.489	9.650	0.292
7.784	2.394	9.747	0.314
8.383	2.293	9.843	0.336
8.982	2.188	9.940	0.357
9.580	2.078	10.036	0.379
10.179	1.964	10.133	0.400
10.778	1.847	10.712	0.521
11.377	1.726	11.387	0.649
11.975	1.603	11.966	0.746
12.574	1.477	12.544	0.830
13.173	1.349	13.123	0.901
13.772	1.219	13.798	0.966
14.370	1.088	14.377	1.004
14.570	1.044	14.570	1.014
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.594	-3.089		
1.189	-3.058	5.587	-1.944
1.783	-3.007	5.781	-1.918
2.378	-2.938		
3.170	-2.819	8.796	-1.111
3.765	-2.712	8.860	-1.016
4.359	-2.590		
4.954	-2.455	10.106	-0.888
5.548	-2.309		
6.143	-2.152	radius 3 = 0.750	
6.737	-1.985	radius 4 = 0.750	
7.332	-1.810		
7.926	-1.628		
8.521	-1.439		
9.115	-1.247		
9.710	-1.050		
10.106	-0.918		

Table 2. Continued

(j) Nozzle 10

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.598	3.092		s
1.196	3.067	3.170	1.944
1.794	3.026	3.700	1.724
2.391	2.971		s
2.989	2.902	5.050	0.375
3.587	2.821	5.580	0.155
4.185	2.727	5.758	0.176
4.783	2.623	5.855	0.200
5.381	2.508	6.144	0.269
5.979	2.383	6.434	0.336
6.576	2.250	6.723	0.400
7.174	2.110	7.109	0.482
7.772	1.963	7.784	0.614
8.370	1.810	8.363	0.715
8.968	1.651	8.941	0.804
9.566	1.490	9.520	0.879
10.164	1.324	10.195	0.949
10.761	1.156	10.774	0.993
11.160	1.044	11.160	1.014
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.591	-3.078		s
1.182	-3.015	3.690	-1.944
1.772	-2.915	4.065	-1.844
2.363	-2.780		s
2.954	-2.616	5.205	-1.186
3.545	-2.425	5.580	-1.085
4.136	-2.212		s
4.727	-1.980	6.696	-1.085
5.317	-1.732		
5.908	-1.472	radius 3 = 0.750	
6.499	-1.205	radius 4 = 0.750	
6.696	-1.115		

Table 2. Continued

(k) Nozzle 11

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.097		s
1.199	3.087	9.990	1.944
1.798	3.072	10.520	1.724
2.397	3.051		s
2.997	3.024	11.870	0.375
3.596	2.991	12.400	0.155
4.195	2.953	12.578	0.176
4.794	2.910	12.675	0.200
5.394	2.862	12.771	0.223
5.993	2.810	12.868	0.246
6.593	2.752	12.964	0.269
7.192	2.690	13.060	0.292
7.791	2.625	13.157	0.314
8.590	2.531	13.254	0.336
9.190	2.456	13.350	0.357
9.789	2.378	13.446	0.379
10.388	2.296	13.543	0.400
10.988	2.211	13.639	0.421
11.587	2.123	13.736	0.442
12.186	2.032	13.832	0.462
12.786	1.938	13.929	0.482
13.385	1.842	14.205	0.502
13.984	1.744	14.314	0.560
14.584	1.643	14.604	0.614
15.183	1.541	15.183	0.715
15.782	1.437	15.761	0.804
16.382	1.331	16.340	0.879
16.981	1.224	16.919	0.941
17.580	1.116	17.594	0.993
17.980	1.044	17.980	1.014
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.596	-3.094		s
1.192	-3.079	8.201	-1.944
1.789	-3.052	8.357	-1.928
2.385	-3.017		s
2.981	-2.971	12.244	-1.101
3.578	-2.918	12.400	-1.085
4.174	-2.856		s
4.770	-2.785	13.516	-1.085
5.367	-2.078		
5.963	-2.623	radius 3 = 0.750	
6.559	-2.531	radius 4 = 0.750	
7.156	-2.434		
7.752	-2.330		
8.348	-2.221		
8.944	-2.107		
9.451	-1.989		
10.137	-1.866		
10.733	-1.740		
11.330	-1.610		
11.926	-1.478		
12.522	-1.344		
13.118	-1.207		
13.516	-1.115		

Table 2. Continued

(1) Nozzle 12

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.092		s
1.198	3.070	5.495	1.944
1.796	3.032	6.025	1.724
2.395	2.982		s
2.994	2.918	8.460	-0.710
3.592	2.841	8.990	-0.930
4.191	2.753	9.168	-0.908
4.790	2.653	9.265	-0.885
5.389	2.543	9.361	-0.862
5.988	2.422	9.458	-0.839
6.586	2.292	9.554	-0.816
7.185	2.154	9.650	-0.793
7.784	2.006	9.747	-0.771
8.383	1.852	9.843	-0.749
8.982	1.690	9.940	-0.728
9.580	1.523	10.036	-0.706
10.179	1.349	10.133	-0.685
10.778	1.170	10.712	-0.564
11.376	0.987	11.387	-0.436
11.975	0.800	11.966	-0.339
12.574	0.609	12.544	-0.254
13.173	0.416	13.123	-0.184
13.772	0.221	13.798	-0.119
14.171	0.090	14.184	-0.092
14.570	-0.041	14.570	-0.071
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.594	-3.096		s
1.189	-3.084	6.450	-1.944
1.783	-3.064	6.825	-2.044
2.378	-3.037		s
2.972	-3.004	7.125	-2.218
3.567	-2.963	7.500	-2.318
4.161	-2.917		s
4.756	-2.865	7.578	-2.314
5.350	-2.808		s
5.945	-2.745	8.912	-2.174
6.539	-2.678		s
7.133	-2.607	8.990	-2.170
7.728	-2.532		s
8.323	-2.453	10.106	-2.170
8.917	-2.371		
9.512	-2.287	radius 3 = 0.750	
10.106	-2.200	radius 4 = 0.750	

Table 2. Continued

(m) Nozzle 13

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.098		
1.198	3.092	7.665	1.944
1.796	3.082	8.195	1.724
2.395	3.068		
2.994	3.050	8.460	1.460
3.593	3.028	8.990	1.240
4.191	3.004	9.168	1.262
4.790	2.975	9.265	1.285
5.389	2.944	9.361	1.308
5.988	2.909	9.458	1.331
6.586	2.871	9.554	1.354
7.185	2.830	9.650	1.376
7.784	2.787	9.747	1.399
8.383	2.740	9.843	1.421
8.982	2.691	9.940	1.442
9.580	2.640	10.036	1.464
10.179	2.586	10.133	1.485
10.778	2.530	10.712	1.606
11.376	2.471	11.387	1.734
11.975	2.411	11.966	1.831
12.574	2.439	12.544	1.915
13.173	2.284	13.123	1.986
13.772	2.219	13.798	2.051
14.370	2.152	14.377	2.089
14.570	2.129	14.570	2.099
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.594	-3.085		
1.189	-3.041	4.105	-1.944
1.783	-2.969	4.398	-1.884
2.378	-2.872		
2.973	-2.750	8.697	-0.060
3.567	-2.606	8.990	0.000
4.161	-2.442		
4.756	-2.258	10.106	0.000
5.350	-2.057		
5.945	-1.841		
6.539	-1.610		
7.134	-1.368		
7.728	-1.114		
8.322	-0.852		
8.917	-0.583		
9.512	-0.308		
10.106	-0.030		
		radius 3 = 0.750	
		radius 4 = 0.750	

Table 2. Continued

(n) Nozzle 14

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.594	3.092		s
1.189	3.067	5.123	1.944
1.783	3.027	5.653	1.724
2.377	2.973		s
2.971	2.905	6.327	1.050
2.566	2.825	6.857	0.831
4.160	2.733	7.006	0.846
4.754	2.631	7.103	0.865
5.349	2.518	7.200	0.884
5.943	2.397	7.297	0.902
6.537	2.268	7.394	0.919
7.131	2.132	7.588	0.953
7.726	1.989	7.782	0.984
8.320	1.842	8.364	1.066
8.914	1.690	8.946	1.132
9.310	1.586	9.335	1.167
9.509	1.534	9.529	1.183
9.905	1.429	9.917	1.209
10.103	1.376	10.111	1.221
10.499	1.270	10.449	1.240
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.199	-3.100		s
1.194	-3.029	4.050	-1.944
1.792	-2.945	4.458	-1.823
2.389	-2.830		s
2.986	-2.689	6.449	-0.530
3.583	-2.523	6.857	-0.409
4.181	-2.335		s
4.778	-2.127	6.939	-0.414
5.375	-1.902		s
5.972	-1.662	8.361	-0.574
6.596	-1.410		
7.167	-1.148	radius 3 = 0.750	
7.764	-0.878	radius 4 = 0.750	
8.361	-0.604		

Table 2. Continued

(o) Nozzle 15

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.098		s
1.198	3.094	5.123	1.944
1.797	3.086	5.653	1.724
2.396	3.075		s
2.995	3.061	6.327	1.050
3.594	3.045	6.857	0.831
4.193	3.026	7.065	0.860
4.792	3.003	7.162	0.888
5.391	2.979	7.260	0.916
5.990	2.951	7.358	0.944
6.589	2.292	7.455	0.972
7.188	2.889	7.552	1.000
7.787	2.854	7.747	1.055
8.386	2.818	8.332	1.217
8.984	2.778	8.917	1.374
9.584	2.737	9.599	1.548
10.182	2.693	10.184	1.687
10.781	2.648	10.769	1.816
11.380	2.600	11.354	1.934
11.979	2.550	11.938	2.039
12.578	2.499	12.523	2.129
13.177	2.446	13.108	2.204
13.776	2.391	13.790	2.269
14.375	2.334	14.375	2.304
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.199	-3.100		s
1.194	-3.029	4.050	-1.944
1.792	-2.945	4.458	-1.823
2.389	-2.830		s
2.986	-2.689	6.449	-0.530
3.583	-2.523	6.857	-0.409
4.181	-2.335		s
4.778	-2.127	6.939	-0.414
5.375	-1.902		s
5.972	-1.662	8.361	-0.574
6.596	-1.410		
7.167	-1.148	radius 3 = 0.750	
7.764	-0.878	radius 4 = 0.750	
8.361	-0.604		

Table 2. Continued

(p) Nozzle 16

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.594	3.093		s
1.188	3.073	5.123	1.944
1.783	3.040	5.653	1.724
2.377	2.995		s
2.971	2.939	6.327	1.050
3.566	2.873	6.857	0.831
4.160	2.797	7.065	0.860
4.754	2.712	7.160	0.888
5.349	2.619	7.256	0.915
5.943	2.518	7.351	0.942
6.537	2.411	7.447	0.969
7.131	2.297	7.542	0.996
7.726	2.178	7.733	1.048
8.320	2.055	8.305	1.197
8.914	1.928	8.877	1.328
9.509	1.797	9.545	1.450
10.103	1.664	10.118	1.519
10.499	1.575	10.499	1.545
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.597	-3.080		s
1.194	-3.020	3.797	-1.944
1.792	-2.925	4.172	-1.844
2.389	-2.796		s
2.986	-2.637	6.482	-0.510
3.583	-2.449	6.776	-0.414
4.181	-2.367		s
4.778	-2.002	8.361	-0.244
5.375	-1.747	radius 3 = 0.750	
5.972	-1.475	radius 4 = 0.750	
6.570	-1.190		
7.167	-0.892		
7.764	-0.586		
8.361	-0.274		



Table 2. Continued

(q) Nozzle 17

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.097		S
1.198	3.087	5.123	1.944
1.797	3.071	5.653	1.724
2.396	3.049		S
2.995	3.022	6.327	1.050
3.594	2.988	6.857	0.831
4.193	2.950	7.006	0.846
4.792	2.906	7.104	0.865
5.391	2.858	7.202	0.885
5.990	2.805	7.300	0.904
6.589	2.748	7.399	0.922
7.188	2.686	7.595	0.959
7.787	2.620	7.792	0.995
8.386	2.551	8.381	1.096
8.984	2.479	8.971	1.188
9.584	2.403	9.560	1.270
10.182	2.324	10.150	1.345
10.781	2.242	10.740	1.411
11.380	2.158	11.329	1.470
11.979	2.071	11.919	1.523
12.578	1.982	12.508	1.568
13.177	1.892	13.196	1.614
13.776	1.799	13.786	1.647
14.176	1.737	14.178	1.666
14.375	1.705	14.375	1.675
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.597	-3.080		S
1.194	-3.020	3.797	-1.944
1.792	-2.925	4.172	-1.844
2.389	-2.796		S
2.986	-2.637	6.482	-0.510
3.583	-2.449	6.776	-0.414
4.181	-2.367		S
4.778	-2.002	8.361	-0.244
5.375	-1.747		
5.972	-1.475	radius 3 = 0.750	
6.570	-1.190	radius 4 = 0.750	
7.167	-0.892		
7.764	-0.586		
8.361	-0.274		

Table 2. Continued

(r) Nozzle 18

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.594	3.087		s
1.188	3.048	3.771	1.944
1.783	2.984	4.302	1.724
2.377	2.898		s
2.971	2.791	6.327	-0.301
3.566	2.664	6.857	-0.521
4.160	2.518	7.065	-0.491
4.754	2.356	7.160	-0.464
5.348	2.179	7.256	-0.437
5.943	1.987	7.351	-0.410
6.537	1.784	7.542	-0.356
7.131	1.570	7.542	-0.356
7.728	1.346	7.733	-0.303
8.320	1.114	8.305	-0.154
8.914	0.877	8.877	-0.024
9.509	0.634	9.545	0.097
10.103	0.388	10.117	0.167
10.499	0.223	10.499	0.193
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.597	-3.091		s
1.194	-3.068	6.120	-1.944
1.792	-3.030	6.413	-1.884
2.389	-2.979		s
2.986	-2.915	6.564	-1.820
3.583	-2.840	6.857	-1.761
4.181	-2.755		s
4.778	-2.660	6.939	-1.765
5.375	-2.557		s
5.972	-2.447	8.361	-1.926
6.570	-2.331		
7.167	-2.210	radius 3 = 0.750	
7.764	-2.084	radius 4 = 0.750	
8.361	-1.956		

Table 2. Continued

(s) Nozzle 19

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.940
0.599	3.093		s
1.198	3.073	3.772	1.944
1.797	3.040	4.302	1.724
2.396	2.994		s
2.995	2.937	6.327	-0.301
3.594	2.869	6.857	-0.521
4.193	2.790	7.006	-0.506
4.792	2.700	7.104	-0.486
5.391	2.602	7.202	-0.467
5.990	2.494	7.300	-0.448
6.589	2.378	7.399	-0.429
7.188	2.254	7.595	-0.392
7.787	2.123	7.792	-0.356
8.386	1.985	8.381	-0.256
8.984	1.840	8.971	-0.164
9.584	1.690	9.560	-0.081
10.182	1.536	10.150	-0.007
10.781	1.376	10.740	0.060
11.380	1.212	11.329	0.119
11.979	1.045	11.919	0.171
12.578	0.875	12.606	0.224
13.177	0.703	13.196	0.262
13.776	0.529	13.788	0.296
14.375	0.354	14.375	0.324
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.597	-3.091		s
1.194	-3.068	6.120	-1.944
1.792	-3.030	6.413	-1.884
2.389	-2.979		s
2.986	-2.915	6.564	-1.820
3.583	-2.840	6.857	-1.761
4.181	-2.755		s
4.778	-2.660	6.939	-1.765
5.375	-2.557		s
5.972	-2.447	8.361	-1.926
6.570	-2.331		
7.167	-2.210	radius 3 = 0.750	
7.764	-2.084	radius 4 = 0.750	
8.361	-1.956		

Table 2. Continued

(t) Nozzle 20

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.594	3.085		s
1.188	3.042	3.772	1.944
1.783	2.972	4.302	1.724
2.377	2.877		s
2.971	2.758	6.327	-0.301
3.566	2.618	6.857	-0.521
4.160	2.457	7.006	-0.506
4.754	2.278	7.103	-0.487
5.348	2.082	7.200	-0.467
5.943	1.870	7.297	-0.450
6.537	1.645	7.394	-0.432
7.131	1.408	7.588	-0.399
7.726	1.161	7.819	-0.367
8.320	0.905	8.364	-0.285
8.914	0.642	8.946	-0.220
9.509	0.373	9.529	-0.169
10.103	0.101	10.111	-0.131
10.499	-0.082	10.499	-0.112
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.597	-3.089		s
1.194	-3.059	5.144	-1.944
1.792	-3.009	5.226	-1.940
2.389	-2.942		s
2.986	-2.859	8.361	-1.596
3.583	-2.762		
4.181	-2.651	radius 3 = 0.000	
4.778	-2.528	radius 4 = 0.750	
5.375	-2.396		
5.972	-2.254		
6.570	-2.105		
7.167	-1.949		
7.764	-1.789		
8.361	-1.626		

Table 2. Continued

(u) Nozzle 21

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.095		s
1.198	3.079	3.772	1.944
1.797	3.054	4.302	1.724
2.396	3.020		s
2.995	2.976	6.327	-0.301
3.594	2.924	6.857	-0.521
4.193	2.864	7.065	-0.491
4.792	2.796	7.162	-0.463
5.391	2.720	7.260	-0.435
5.988	2.638	7.358	-0.407
6.589	2.549	7.455	-0.380
7.188	2.454	7.552	-0.352
7.787	2.535	7.747	-0.297
8.386	2.247	8.332	-0.134
8.984	2.136	8.917	0.022
9.584	2.021	9.599	0.196
10.182	1.901	10.184	0.335
10.781	1.778	10.769	0.465
11.380	1.651	11.354	0.582
11.979	1.522	11.938	0.687
12.578	1.390	12.523	0.778
13.177	1.256	13.206	0.863
13.776	1.120	13.790	0.917
14.375	0.983	14.357	0.953
radius 1 = 0.750 radius 2 = 4.000			

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.597	-3.089		s
1.194	-3.059	5.144	-1.944
1.792	-3.009	5.226	-1.940
2.389	-2.942		s
2.986	-2.859	8.361	-1.596
3.583	-2.762		
4.181	-2.651		
4.778	-2.528		
5.375	-2.396		
5.972	-2.254		
6.570	-2.105		
7.167	-1.949		
7.764	-1.789		
8.361	-1.626		
radius 3 = 0.000 radius 4 = 0.750			

Table 2. Continued

(v) Nozzle 22

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.598	3.097		s
1.197	3.086	9.388	1.944
1.796	3.070	9.919	1.724
2.394	3.047		s
2.993	3.018	10.592	1.050
3.591	2.983	11.123	0.831
4.190	2.943	11.331	0.860
4.788	2.989	11.426	0.888
5.387	2.847	11.521	0.915
5.986	2.792	11.617	0.942
6.584	2.732	11.712	0.969
7.183	2.667	11.807	0.996
7.814	2.599	11.903	1.022
8.380	2.526	11.998	1.048
8.978	2.450	12.094	1.074
9.577	2.371	12.284	1.124
10.176	2.288	12.475	1.173
10.774	2.203	12.666	1.220
11.373	2.114	12.857	1.265
11.971	2.024	13.048	1.308
12.570	1.931	13.334	1.366
13.168	1.836	13.620	1.418
13.767	1.739	13.906	1.463
14.366	1.641	14.383	1.519
14.765	1.575	14.765	1.545
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.601	-3.092		s
1.202	-3.068	6.415	-1.944
1.804	-3.030	6.659	-1.903
2.405	-2.977		s
3.006	-2.910	10.879	-0.450
3.608	-2.831	11.123	-0.409
4.409	-2.707		s
5.011	-2.601	11.204	-0.414
5.612	-2.485		s
6.213	-2.359	12.627	-0.574
6.814	-2.224		
7.416	-2.081	radius 3 = 0.750	
8.017	-1.930	radius 4 = 0.750	
8.618	-1.773		
9.220	-1.609		
9.821	-1.440		
10.422	-1.267		
11.023	-1.090		
11.625	-0.910		
12.226	-0.727		
12.627	-0.604		

Table 2. Continued

(w) Nozzle 23

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.601	3.098		s
1.203	3.092	9.388	1.944
1.804	3.083	9.919	1.724
2.406	3.070		s
3.006	3.054	10.592	1.050
3.608	3.034	11.123	0.831
4.209	3.012	11.271	0.846
4.810	2.986	11.369	0.865
5.412	2.956	11.468	0.885
6.013	2.924	11.566	0.904
6.614	2.889	11.664	0.922
7.216	2.851	11.762	0.941
7.817	2.810	11.861	0.959
8.418	2.767	11.959	0.978
9.020	2.721	12.057	0.995
9.621	2.672	12.254	1.030
10.222	2.621	12.450	1.064
10.824	2.568	12.647	1.096
11.425	2.512	12.843	1.128
12.026	2.455	13.040	1.158
12.628	2.395	13.236	1.188
13.229	2.334	13.531	1.230
13.830	2.270	13.826	1.270
14.432	2.205	14.416	1.345
15.033	2.138	15.005	1.411
15.634	2.069	15.693	1.480
16.236	1.999	16.282	1.531
16.837	1.928	16.872	1.575
17.438	1.855	17.462	1.614
18.040	1.781	18.051	1.647
18.641	1.705	18.641	1.675
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.601	-3.092		s
1.202	-3.068	6.415	-1.944
1.804	-3.030	6.659	-1.903
2.405	-2.977		s
3.006	-2.910	10.879	-0.450
3.608	-2.831	11.123	-0.409
4.409	-2.707		s
5.011	-2.601	11.204	-0.414
5.612	-2.485		s
6.213	-2.359	12.627	-0.574
6.814	-2.224		
7.416	-2.081		radius 3 = 0.750
8.017	-1.930		radius 4 = 0.750
8.618	-1.773		
9.220	-1.609		
9.821	-1.440		
10.422	-1.267		
11.023	-1.090		
11.625	-0.910		
12.226	-0.727		
12.627	-0.604		

Table 2. Continued

(x) Nozzle 24

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.096		s
1.197	3.083	9.388	1.944
1.796	3.063	9.919	1.724
2.394	3.035		s
2.993	3.000	10.592	1.050
3.591	2.957	11.123	0.831
4.190	2.908	11.271	0.845
4.788	2.853	11.368	0.865
5.387	2.792	11.465	0.884
5.986	2.725	11.562	0.902
6.584	2.652	11.659	0.919
7.183	2.574	11.756	0.936
7.781	2.491	11.853	0.953
8.380	2.404	11.950	0.969
8.978	2.313	12.048	0.984
9.577	2.217	12.144	0.999
10.176	2.118	12.242	1.014
10.774	2.016	12.338	1.028
11.373	1.910	12.532	1.054
11.971	1.802	12.727	1.078
12.570	1.691	12.921	1.101
13.168	1.578	13.115	1.122
13.767	1.464	13.794	1.183
14.366	1.348	14.376	1.221
14.765	1.270	14.765	1.239
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.601	-3.091		s
1.202	-3.064	5.879	-1.944
1.804	-3.020	6.098	-1.911
2.405	-2.960		s
3.006	-2.885	10.904	-0.442
3.608	-2.795	11.041	-0.414
4.209	-2.692		s
4.810	-2.576	12.627	-0.244
5.412	-2.447		
6.013	-2.308	radius 3 = 0.750	
6.614	-2.158	radius 4 = 0.750	
7.215	-1.999		
7.817	-1.831		
8.418	-1.656		
9.019	-1.473		
9.620	-1.284		
10.222	-1.089		
10.823	-0.890		
11.424	-0.688		
12.026	-0.482		
12.627	-0.274		



Table 2. Continued

(y) Nozzle 25

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.601	3.099		s
1.203	3.096	9.388	1.944
1.804	3.092	9.919	1.724
2.405	3.086		s
3.006	3.079	10.592	1.050
3.608	3.069	11.123	0.881
4.209	3.058	11.331	0.860
4.810	3.046	11.428	0.888
5.412	3.031	11.526	0.916
6.013	3.016	11.623	0.944
6.614	2.998	11.720	0.972
7.216	2.979	11.818	1.000
7.817	2.958	11.916	1.027
8.418	2.936	12.013	1.055
9.020	2.913	12.110	1.082
9.621	2.887	12.208	1.110
10.222	2.861	12.305	1.137
10.824	2.832	12.500	1.190
11.425	2.803	12.598	1.217
12.026	2.771	12.793	1.270
12.628	2.739	12.988	1.322
13.229	2.704	13.280	1.399
13.830	2.669	13.865	1.548
14.432	2.632	14.450	1.687
15.033	2.594	15.034	1.816
15.634	2.554	15.619	1.934
16.236	2.513	16.204	2.039
16.837	2.470	16.886	2.143
17.438	2.426	17.471	2.214
18.040	2.381	18.056	2.269
18.641	2.334	18.641	2.304
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.601	-3.091		s
1.202	-3.064	5.879	-1.944
1.804	-3.020	6.098	-1.911
2.405	-2.960		s
3.006	-2.885	10.904	-0.442
3.608	-2.795	11.041	-0.414
4.209	-2.692		s
4.810	-2.576	12.627	-0.244
5.412	-2.447		
6.013	-2.308	radius 3 = 0.750	
6.614	-2.158	radius 4 = 0.750	
7.215	-1.999		
7.817	-1.831		
8.418	-1.656		
9.019	-1.473		
9.620	-1.284		
10.222	-1.089		
10.823	-0.890		
11.424	-0.688		
12.026	-0.482		
12.627	-0.274		

Table 2. Continued

(z) Nozzle 26

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.092		s
1.197	3.070	6.691	1.944
1.796	3.033	9.519	0.772
2.394	2.983		s
2.993	2.920	10.592	-0.301
3.591	2.844	11.123	-0.521
4.190	2.757	11.271	-0.506
4.788	2.658	11.368	-0.487
5.387	2.549	11.465	-0.468
5.986	2.430	11.562	-0.450
6.584	2.302	11.659	-0.432
7.183	2.164	11.756	-0.415
7.781	2.019	11.853	-0.399
8.380	1.866	11.950	-0.383
8.978	1.706	12.048	-0.367
9.577	1.539	12.338	-0.324
10.176	1.367	12.533	-0.298
10.774	1.189	12.727	-0.273
11.373	1.007	12.921	-0.250
11.971	0.821	13.212	-0.220
12.570	0.632	13.503	-0.192
13.168	0.440	13.794	-0.169
13.767	0.245	14.085	-0.148
14.366	0.049	14.376	-0.131
14.765	-0.082	14.765	-0.112
radius 1 = 0.750 radius 2 = 0.750			

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.601	-3.096		s
1.202	-3.086	10.386	-1.944
1.804	-3.070	10.679	-1.884
2.405	-3.047		s
3.006	-3.018	10.830	-1.820
3.608	-2.984	11.123	-1.761
4.209	-2.944		s
4.810	-2.899	11.204	-1.756
5.412	-2.849		s
6.013	-2.794	12.627	-1.926
6.614	-2.735		
7.215	-2.672	radius 3 = 0.750 radius 4 = 0.750	
7.817	-2.604		
8.418	-2.533		
9.019	-2.459		
9.620	-2.382		
10.222	-2.301		
10.823	-2.218		
11.424	-2.133		
12.026	-2.045		
12.627	-1.956		

Table 2. Continued

(aa) Nozzle 27

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.601	3.097		
1.203	3.088	8.037	1.944
1.804	3.073	8.567	1.724
2.405	3.052		
3.006	3.026	10.592	-0.301
3.608	2.995	11.123	-0.521
4.209	2.958	11.331	-0.491
4.810	2.917	11.428	-0.463
5.419	2.870	11.526	-0.435
6.013	2.819	11.623	-0.407
6.614	2.764	11.720	-0.380
7.216	2.704	11.818	-0.352
7.817	2.640	11.916	-0.324
8.418	2.572	12.013	-0.297
9.020	2.501	12.110	-0.269
9.621	2.426	12.305	-0.215
10.222	2.347	12.500	-0.161
10.824	2.265	12.695	-0.108
11.425	2.180	12.890	-0.055
12.026	2.092	12.988	-0.029
12.628	2.002	13.280	0.048
13.229	1.908	13.572	0.123
13.830	1.813	13.865	0.196
14.432	1.715	14.450	0.335
15.033	1.615	15.034	0.465
15.634	1.513	15.619	0.582
16.236	1.410	16.204	0.687
16.837	1.305	16.886	0.791
17.438	1.199	17.471	0.863
18.040	1.091	18.056	0.917
18.641	0.983	18.641	0.952

radius 1 = 0.750  
radius 2 = 0.750

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.601	-3.096		
1.202	-3.086	10.386	-1.944
1.804	-3.070	10.679	-1.884
2.405	-3.047		
3.006	-3.018	10.830	-1.820
3.608	-2.984	11.123	-1.761
4.209	-2.944		
4.810	-2.899	11.204	-1.756
5.412	-2.849		
6.013	-2.794	12.627	-1.926
6.614	-2.735		
7.215	-2.672		
7.817	-2.604		
8.418	-2.533		
9.019	-2.459		
9.620	-2.382		
10.222	-2.301		
10.823	-2.218		
11.424	-2.133		
12.026	-2.045		
12.627	-1.956		

radius 3 = 0.750  
radius 4 = 0.750

Table 2. Continued

(bb) Nozzle 28

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.093		s
1.197	3.073	7.105	1.944
1.796	3.040	9.226	1.065
2.394	2.995		s
2.993	2.938	10.592	-0.301
3.591	2.870	11.123	-0.521
4.190	2.791	11.331	-0.491
4.788	2.702	11.426	-0.464
5.387	2.604	11.521	-0.437
5.986	2.496	11.617	-0.410
6.584	2.380	11.712	-0.383
7.183	2.256	11.808	-0.356
7.781	2.125	11.903	-0.330
8.380	1.986	11.998	-0.303
8.978	1.842	12.094	-0.278
9.577	1.691	12.189	-0.252
10.177	1.536	12.284	-0.227
10.774	1.375	12.380	-0.202
11.373	1.210	12.571	-0.154
11.971	1.042	12.761	-0.109
12.570	0.870	12.952	-0.065
13.168	0.696	13.143	-0.024
13.767	0.520	13.715	0.082
14.366	0.342	14.383	0.167
14.765	0.223	14.765	0.193
		radius 1 = 0.750	
		radius 2 = 3.000	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.601	-3.095		s
1.202	-3.082	9.327	-1.944
1.804	-30.60	9.409	-1.940
2.405	-3.030		s
3.006	-2.992	12.627	-1.596
3.608	-2.946	radius 3 = 0.000	
4.209	-2.894	radius 4 = 0.750	
4.810	-2.835		
5.412	-2.769		
6.013	-2.698		
6.614	-2.621		
7.215	-2.539		
7.817	-2.452		
8.418	-2.360		
9.019	-2.265		
9.620	-2.165		
10.222	-2.063		
10.823	-1.957		
11.424	-1.849		
12.026	-1.738		
12.627	-1.626		

Table 2. Continued

(cc) Nozzle 29

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.601	3.096		s
1.203	3.084	8.037	1.944
1.804	3.064	8.567	1.724
2.405	3.037		s
3.006	3.002	10.592	-0.301
3.608	2.960	11.123	-0.521
4.209	2.912	11.271	-0.506
4.810	2.857	11.369	-0.486
5.412	2.796	11.468	-0.467
6.013	2.729	11.566	-0.448
6.614	2.656	11.664	-0.429
7.216	2.577	11.762	-0.410
7.817	2.493	11.861	-0.392
8.418	2.404	11.959	-0.374
9.020	2.310	12.057	-0.356
9.621	2.212	12.156	-0.339
10.222	2.109	12.254	-0.322
10.824	2.002	12.352	-0.305
11.425	1.892	12.647	-0.256
12.026	1.778	12.843	-0.224
12.628	1.660	13.040	-0.193
13.229	1.540	13.236	-0.164
13.830	1.416	13.826	-0.081
14.432	1.290	14.416	-0.007
15.033	1.161	15.005	0.060
15.634	1.031	15.693	0.128
16.236	0.898	16.282	0.179
16.837	0.764	16.872	0.223
17.438	0.628	17.462	0.262
18.040	0.491	18.051	0.296
18.641	0.354	18.641	0.324
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.601	-3.095		s
1.202	-3.082	9.327	-1.944
1.804	-3.060	9.409	-1.940
2.405	-3.030		s
3.006	-2.992	12.627	-1.596
3.608	-2.946		
4.209	-2.894		radius 3 = 0.000
4.810	-2.835		radius 4 = 0.750
5.412	-2.769		
6.013	-2.698		
6.614	-2.621		
7.215	-2.539		
7.817	-2.452		
8.418	-2.360		
9.019	-2.265		
9.620	-2.165		
10.222	-2.063		
10.823	-1.957		
11.424	-1.849		
12.026	-1.738		
12.627	-1.626		

Table 2. Continued

(dd) Nozzle 30

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.095		s
1.197	3.080	6.580	1.944
1.796	3.057	7.110	1.724
2.395	3.024		s
2.994	2.983	8.460	0.375
3.592	2.934	8.990	0.155
4.191	2.877	9.168	0.177
4.790	2.812	9.242	0.194
5.389	2.741	9.316	0.212
5.988	2.663	9.390	0.230
6.586	2.579	9.464	0.247
7.185	2.489	9.538	0.264
7.784	2.394	9.612	0.280
8.383	2.293	9.686	0.297
8.582	2.258	9.760	0.313
9.181	2.152	9.834	0.329
9.780	2.040	9.908	0.345
10.379	1.926	10.352	0.434
10.977	1.807	10.944	0.542
11.576	1.685	11.536	0.637
12.175	1.561	12.128	0.724
12.774	1.434	12.794	0.811
13.372	1.306	13.386	0.882
13.971	1.175	13.978	0.949
14.570	1.044	14.570	1.014
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.594	-3.090		s
1.189	-3.062	6.244	-1.944
1.783	-3.016	6.489	-1.903
2.378	-2.953		s
2.972	-2.874	8.746	-1.126
3.567	-2.781	8.990	-1.085
4.161	-2.675		s
4.756	-2.557	10.106	-1.085
5.350	-2.427	radius 3 = 0.750 radius 4 = 0.750	
5.945	-2.287		
6.539	-2.138		
7.134	-1.981		
7.728	-1.818		
8.326	-1.648		
8.917	-1.474		
9.512	-1.296		
10.106	-1.115		

Table 2. Continued

(ce) Nozzle 31

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.600	3.099		s
1.200	3.097	6.580	1.944
1.800	3.091	7.110	1.724
2.400	3.080		s
3.000	3.063	8.460	0.375
3.600	3.038	8.990	0.155
4.200	3.005	9.168	0.177
4.800	2.961	9.265	0.200
5.400	2.905	9.361	0.223
6.000	2.836	9.458	0.246
6.600	2.752	9.651	0.292
7.000	2.688	9.844	0.336
7.400	2.616	10.036	0.379
7.600	2.577	10.615	0.502
7.800	2.536	11.194	0.614
8.000	2.493	11.773	0.715
		12.351	0.804
	s	12.930	0.879
		13.509	0.941
		14.088	0.987
14.570	1.044	14.570	1.014
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.594	-3.090		s
1.189	-3.062	6.244	-1.944
1.783	-3.016	6.489	-1.903
2.378	-2.953		s
2.972	-2.874	8.746	-1.126
3.567	-2.781	8.990	-1.085
4.161	-2.675		s
4.756	-2.557	10.106	-1.085
5.350	-2.427		
5.945	-2.287	radius 3 = 0.750	
6.539	-2.138	radius 4 = 0.750	
7.134	-1.981		
7.728	-1.818		
8.326	-1.648		
8.917	-1.474		
9.512	-1.296		
10.106	-1.115		

Table 2. Continued

(ff) Nozzle 32

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.095		s
1.197	3.080	6.580	1.944
1.796	3.057	7.110	1.724
2.395	3.024		s
2.994	2.983	8.460	0.375
3.592	2.934	8.990	0.155
4.191	2.877	9.168	0.176
4.790	2.812	9.265	0.200
5.389	2.741	9.361	0.223
5.988	2.663	9.458	0.246
6.586	2.579	9.554	0.269
7.185	2.489	9.650	0.292
7.784	2.394	9.747	0.314
8.383	2.293	9.843	0.336
8.982	2.188	9.940	0.357
9.580	2.078	10.036	0.379
10.179	1.964	10.133	0.400
10.778	1.847	10.712	0.521
11.377	1.726	11.387	0.649
11.975	1.603	11.966	0.746
12.574	1.477	12.544	0.830
13.173	1.349	13.123	0.901
13.772	1.219	13.798	0.966
14.370	1.088	14.377	1.004
14.570	1.044	14.570	1.014
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.601	-3.095		s
1.202	-3.082	9.327	-1.944
1.804	-30.60	9.409	-1.940
2.405	-3.030		s
3.006	-2.992	12.627	-1.596
3.608	-2.946		
4.209	-2.894	radius 3 = 0.000	
4.810	-2.835	radius 4 = 0.750	
5.412	-2.769		
6.013	-2.698		
6.614	-2.621		
7.215	-2.539		
7.817	-2.452		
8.418	-2.360		
9.019	-2.265		
9.620	-2.165		
10.222	-2.063		
10.823	-1.957		
11.424	-1.849		
12.026	-1.738		
12.627	-1.626		



Table 2. Continued  
(gg) Nozzle 33

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.095		s
1.197	3.080	6.580	1.944
1.796	3.057	7.110	1.724
2.395	3.024		s
2.994	2.983	8.460	0.375
3.592	2.934	8.990	0.155
4.191	2.877	9.168	0.176
4.790	2.812	9.265	0.200
5.389	2.741	9.361	0.223
5.988	2.663	9.458	0.246
6.586	2.579	9.554	0.269
7.185	2.489	9.650	0.292
7.784	2.394	9.747	0.314
8.383	2.293	9.843	0.336
8.982	2.188	9.940	0.357
9.580	2.078	10.036	0.379
10.179	1.964	10.133	0.400
10.778	1.847	10.712	0.521
11.377	1.726	11.387	0.649
11.975	1.603	11.966	0.746
12.574	1.477	12.544	0.830
13.173	1.349	13.123	0.901
13.772	1.219	13.798	0.966
14.370	1.088	14.377	1.004
14.570	1.044	14.570	1.014
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.599	-3.087		s
1.199	-3.051	4.886	-1.944
1.798	-2.992	5.143	-1.899
2.379	-2.912		s
2.997	-2.813	6.744	-1.316
3.596	-2.697	7.000	-1.271
4.195	-2.564		s
4.795	-2.417	7.870	-1.271
5.394	-2.257	8.000	-1.260
5.993	-2.085		s
6.593	-1.904	8.990	-1.085
7.192	-1.715		
7.791	-1.520		radius 3 = 0.000
8.391	-1.317		radius 4 = 0.000
8.990	-1.115		

Table 2. Continued  
(hh) Nozzle 34

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.583	3.090		s
1.166	3.063	6.602	1.944
1.750	3.017	7.476	1.358
2.333	2.956		s
2.916	2.878	8.460	0.375
3.499	2.787	8.990	0.155
4.082	2.681	9.168	0.176
4.666	2.563	9.260	0.199
5.249	2.433	9.352	0.220
5.832	2.292	9.444	0.242
6.415	2.142	9.536	0.263
6.999	1.983	9.628	0.283
7.582	1.815	9.721	0.302
8.165	1.641	9.813	0.321
8.748	1.461	9.905	0.340
9.332	1.275	9.997	0.358
9.915	1.086	10.273	0.407
10.498	0.893	10.457	0.436
11.081	0.698	11.102	0.513
11.470	0.567	11.470	0.537
		radius 1 = 0.750	
		radius 2 = 2.000	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.599	-3.087		s
1.199	-3.051	4.886	-1.944
1.798	-2.992	5.143	-1.899
2.379	-2.912		s
2.997	-2.813	6.744	-1.316
3.596	-2.697	7.000	-1.271
4.195	-2.564		s
4.795	-2.417	7.870	-1.471
5.394	-2.257	8.000	-1.26C
5.993	-2.085		s
6.593	-1.904	8.990	-1.085
7.192	-1.715		
7.791	-1.520		radius 3 = 0.000
8.391	-1.319		radius 4 = 0.000
8.990	-1.115		

Table 2. Continued

(ii) Nozzle 35

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.094		s
1.198	3.077	6.580	1.944
1.796	3.048	7.110	1.724
2.395	3.010		s
2.994	2.960	8.460	0.375
3.593	2.902	8.990	0.155
4.191	2.834	9.081	0.161
4.790	2.758	9.277	0.184
5.389	2.673	9.473	0.208
5.988	2.580	9.669	0.231
6.586	2.481	9.865	0.254
7.185	2.374	10.062	0.276
7.784	2.261	10.258	0.298
8.383	2.142	10.453	0.320
8.982	2.017	10.650	0.340
9.580	1.888	10.846	0.362
10.179	1.753	11.042	0.381
10.778	1.615	11.434	0.420
11.376	1.473	11.826	0.456
11.975	1.328	12.218	0.490
12.574	1.180	12.610	0.522
13.173	1.030	13.198	0.566
13.772	0.878	13.786	0.603
14.171	0.776	14.178	0.624
14.570	0.673	14.570	0.643
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.599	-3.087		s
1.199	-3.051	4.886	-1.944
1.798	-2.992	5.143	-1.899
2.379	-2.912		s
2.997	-2.813	6.744	-1.316
3.596	-2.697	7.000	-1.271
4.195	-2.564		s
4.795	-2.417	7.870	-1.271
5.394	-2.257	8.000	-1.260
5.993	-2.085		s
6.593	-1.904	8.990	-1.085
7.192	-1.715		
7.791	-1.520	radius 3 = 0.000	
8.391	-1.319	radius 4 = 0.000	
8.990	-1.115		

Table 2. Continued

(jj) Nozzle 36

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.599	3.095		s
1.197	3.080	6.580	1.944
1.796	3.057	7.110	1.724
2.395	3.024		s
2.994	2.983	8.460	0.375
3.592	2.934	8.990	0.155
4.191	2.877	9.168	0.176
4.790	2.812	9.265	0.200
5.389	2.741	9.361	0.223
5.988	2.663	9.458	0.246
6.586	2.579	9.554	0.269
7.185	2.489	9.650	0.292
7.784	2.394	9.747	0.314
8.383	2.293	9.843	0.336
8.982	2.188	9.940	0.357
9.580	2.078	10.036	0.379
10.179	1.964	10.133	0.400
10.778	1.847	10.712	0.521
11.377	1.726	11.387	0.649
11.975	1.603	11.966	0.746
12.574	1.477	12.544	0.830
13.173	1.349	13.123	0.901
13.772	1.219	13.798	0.966
14.370	1.088	14.377	1.004
14.570	1.044	14.570	1.014
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.591	-3.089		s
1.183	-3.057	5.290	-1.944
1.774	-3.005	5.665	-1.844
2.366	-2.935		s
2.957	-2.847	6.625	-1.289
3.548	-2.743	7.000	-1.189
4.140	-2.625		s
4.731	-2.492	8.806	-1.189
5.322	-2.348	9.000	-1.163
5.914	-2.192		s
6.505	-2.027	9.856	-0.934
7.096	-1.853		
7.688	-1.672		
8.279	-1.484		
8.870	-1.292		
9.462	-1.096		
9.856	-0.964		
		radius 3 = 0.000	
		radius 4 = 0.000	

Table 2. Concluded

(kk) Nozzle 37

Upper ramp coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	3.100	0.000	1.944
0.598	3.092		s
1.196	3.067	3.170	1.944
1.794	3.026	3.700	1.724
2.391	2.971		s
2.989	2.902	5.050	0.375
3.587	2.821	5.580	0.155
4.185	2.727	5.758	0.176
4.783	2.623	5.855	0.200
5.381	2.508	6.144	0.269
5.979	2.383	6.434	0.336
6.576	2.250	6.723	0.400
7.174	2.110	7.109	0.482
7.772	1.963	7.784	0.614
8.370	1.810	8.363	0.715
8.968	1.651	8.941	0.804
9.566	1.490	9.520	0.879
10.164	1.324	10.195	0.949
10.761	1.156	10.774	0.993
11.160	1.044	11.160	1.014
		radius 1 = 0.750	
		radius 2 = 0.750	

Lower flap coordinates			
External surface		Internal surface	
x, in.	y, in.	x, in.	y, in.
0.000	-3.100	0.000	-1.944
0.599	-3.087		s
1.199	-3.051	5.041	-1.944
1.798	-2.992	5.334	-1.884
2.397	-2.912		s
2.997	-2.813	6.707	-1.302
3.596	-2.697	7.000	-1.242
4.195	-2.564		s
4.795	-2.417	8.306	-1.242
5.394	-2.257	8.500	-1.216
5.993	-2.085		s
6.592	-1.904	8.990	-1.085
7.192	-1.715		
7.791	-1.519		
8.391	-1.319		
8.990	-1.115		
		radius 3 = 0.000	
		radius 4 = 0.000	

Table 3. Pressure Orifice Locations on External Surface of Nozzles  
(a) Nozzles 1 and 6

Nozzle 1

$x/L_n$	Upper ramp surface at values of $z/(W/2)$ of—			
	0	0.34	0.68	0.78
0.053	x	x		
.105			x	
.158	x	x	x	
.211	x		x	
.263	x	x	x	
.316	x		x	
.368	x	x	x	
.421			x	
.474	x	x		
.526	x			
.579	x	x	x	
.632	x		x	
.684	x	x	x	
.737	x		x	
.760				x
.789	x	x	x	
.811				x
.842	x		x	
.863				x
.895	x	x		
.914				x
.947	x		x	

Nozzle 6

$x/L_n$	Upper ramp surface at values of $z/(W/2)$ of—			
	0	0.34	0.68	0.78
0.053	x			
.105			x	
.158	x	x	x	
.211	x		x	
.263	x	x	x	
.316	x		x	
.368	x	x	x	
.421			x	
.474	x	x		
.526	x		x	
.579			x	
.632			x	
.684	x	x	x	
.737	x		x	
.760				x
.789	x	x	x	
.811				x
.842	x		x	
.863				x
.895	x	x	x	
.914				x
.947		x	x	

$x/L_n$	Lower flap surface at values of $z/(W/2)$ of—	
	0	0.68
0.063	x	x
.126	x	x
.189	x	x
.252	x	x
.315	x	x
.378	x	x
.442		x
.505	x	x
.568	x	x
.631	x	x

$x/L_n$	Lower flap surface at values of $z/(W/2)$ of—	
	0	0.68
0.063	x	x
.118	x	x
.178	x	x
.237	x	x
.296	x	x
.355	x	x
.415		x
.475	x	x
.533	x	x
.592	x	x

Table 3. Continued  
 (b) Nozzles 8 and 10

Nozzle 8

$x/L_n$	Upper ramp surface at values of $z/(W/2)$ of—			
	0	0.34	0.68	0.78
0.053	x	x		
.105			x	
.158	x	x	x	
.211	x		x	
.263	x	x	x	
.316	x		x	
.368	x	x	x	
.421			x	
.474	x	x		
.526	x		x	
.579		x	x	
.632	x		x	
.684	x	x	x	
.737	x		x	
.760				x
.789	x	x	x	
.811				x
.842			x	
.863				x
.895	x	x		
.914				x
.947		x	x	

Nozzle 10

$x/L_n$	Upper ramp surface at values of $z/(W/2)$ of—			
	0	0.34	0.68	0.78
0.053	x	x		
.105			x	
.158	x	x	x	
.211	x		x	
.263	x	x	x	
.316	x		x	
.368	x	x	x	
.421			x	
.474	x	x	x	
.526	x		x	
.579		x	x	
.632	x		x	
.684	x	x	x	
.737	x		x	
.760				x
.789	x	x	x	
.811				x
.842	x		x	
.863				x
.895	x	x	x	
.914				x
.947	x	x	x	

$x/L_n$	Lower flap surface at values of $z/(W/2)$ of—	
	0	0.68
0.063	x	x
.126	x	x
.189	x	x
.252	x	x
.315	x	x
.378	x	x
.442		x
.505	x	x
.568	x	x
.631	x	x

$x/L_n$	Lower flap surface at values of $z/(W/2)$ of—	
	0	0.68
0.063	x	x
.118	x	x
.178	x	x
.237	x	x
.296	x	x
.355	x	x
.415		x
.475	x	x
.533	x	x
.592	x	x

Table 3. Concluded  
(c) Nozzles 33 and 36

Nozzle 33

$x/L_n$	Upper ramp surface at values of $z/(W/2)$ of—			
	0	0.34	0.68	0.78
0.053	x	x		
.105			x	
.158	x	x	x	
.211	x		x	
.263	x	x	x	
.316	x		x	
.368	x	x	x	
.421			x	
.474	x	x	x	
.526	x		x	
.579	x	x	x	
.632	x		x	
.684	x	x	x	
.737	x		x	
.760				x
.789	x	x	x	
.811				x
.842	x		x	
.863				x
.895	x	x		
.914				x
.947	x	x	x	

Nozzle 36

$x/L_n$	Upper ramp surface at values of $z/(W/2)$ of—			
	0	0.34	0.68	0.78
0.053	x	x		
.105			x	
.158	x	x	x	
.211	x		x	
.263	x	x	x	
.316	x		x	
.368	x	x	x	
.421			x	
.474	x	x	x	
.526	x		x	
.579	x	x	x	
.632	x		x	
.684	x	x	x	
.737	x		x	
.760				x
.789	x	x	x	
.811				x
.842	x		x	
.863				x
.895	x	x	x	
.914				x
.947	x	x	x	

$x/L_n$	Lower flap surface at values of $z/(W/2)$ of—	
	0	0.68
0.063	x	x
.126	x	x
.189	x	x
.252	x	x
.315	x	x
.378	x	x
.442		x
.505	x	x
.568	x	x
.631	x	x

$x/L_n$	Lower flap surface at values of $z/(W/2)$ of—	
	0	0.68
0.056	x	x
.112	x	x
.168	x	x
.224	x	x
.280	x	x
.337	x	x
.393		x
.449	x	x
.505	x	x
.561	x	x



Table 4. Static and Aeropropulsive Characteristics for Nozzle 1

[Parts (c) and (d) come from repeat runs]

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	-0.02	1.54	1.0196	0.9096	0.9060	-5.14	0.1278	-0.0115	0.0615	0.1411
0.000	-0.01	2.02	0.9868	0.9366	0.9353	-3.00	0.2163	-0.0113	0.0535	0.2312
0.000	0.00	2.50	0.9848	0.9651	0.9641	-2.62	0.3103	-0.0142	0.0649	0.3218
0.000	0.01	2.98	0.9844	0.9740	0.9722	-3.47	0.4025	-0.0244	0.1198	0.4140
0.000	-0.03	3.45	0.9860	0.9822	0.9822	-0.71	0.4979	-0.0062	0.0144	0.5069
0.000	0.00	3.96	0.9852	0.9794	0.9784	-2.56	0.5939	-0.0265	0.1290	0.6070
0.000	-0.01	4.47	0.9849	0.9788	0.9758	-4.47	0.6910	-0.0540	0.2739	0.7082
0.000	-0.03	4.99	0.9843	0.9779	0.9741	-5.03	0.7911	-0.0697	0.3693	0.8122
0.000	-0.03	6.01	0.9848	0.9783	0.9752	-4.59	0.9973	-0.0800	0.4495	1.0227
0.000	-0.06	6.99	0.9840	0.9802	0.9793	-2.47	1.1993	-0.0518	0.3218	1.2247

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
1.201	-0.03	0.92	0.0000	0.0000	0.2099	-0.1413	0.5068	0.0000	-0.2532	-0.1413	0.5068	0.0041
1.199	-0.01	1.50	1.0102	-0.2934	0.1572	-0.0583	0.1392	-0.6286	-0.0814	-0.0698	0.2010	0.1295
1.199	-0.01	2.10	0.9789	0.2366	0.1724	-0.0980	0.3234	0.0579	0.0141	-0.1092	0.3752	0.2429
1.198	-0.01	4.04	0.9828	0.7028	0.1722	-0.1279	0.4930	0.6326	0.3914	-0.1546	0.6221	0.6188
1.198	-0.02	6.00	0.9830	0.8285	0.1505	-0.0500	0.0946	0.7856	0.7967	-0.1302	0.5433	1.0141
1.198	-0.04	8.00	0.9833	0.8845	0.1376	-0.0002	-0.1413	0.8540	1.2210	-0.0236	0.0474	1.4296
1.201	-0.02	10.01	0.9835	0.9053	0.1346	0.0928	-0.6395	0.8818	1.6298	0.1274	-0.7120	1.8483
1.201	-0.03	12.01	0.9834	0.9148	0.1348	0.1680	-1.0439	0.8957	2.0388	0.2591	-1.3753	2.2761
0.953	0.00	1.06	0.0000	0.0000	0.0914	-0.1346	0.2447	0.0000	-0.1369	-0.1346	0.2447	0.0048
0.945	-0.02	2.01	0.9852	0.7654	0.0628	-0.1245	0.1201	0.6411	0.2348	-0.1427	0.2058	0.3663
0.950	-0.02	3.02	0.9859	0.8661	0.0704	-0.1229	0.1377	0.7979	0.5328	-0.1619	0.3278	0.6678
0.950	-0.01	5.01	0.9837	0.9247	0.0642	-0.1333	0.2724	0.8895	1.1495	-0.2443	0.8599	1.2923
0.952	-0.02	6.99	0.9846	0.9478	0.0596	-0.1311	0.3473	0.9242	1.7844	-0.2135	0.8544	1.9307
0.951	-0.01	9.02	0.9832	0.9641	0.0416	-0.0258	0.2722	0.9467	2.4703	-0.0155	-0.1836	2.6094
0.904	5.98	1.06	0.0000	0.0000	0.0583	-0.1058	0.1529	0.0000	-0.1042	-0.1058	0.1529	0.0050
0.900	6.00	2.04	0.9856	0.8341	0.0431	-0.0736	0.0308	0.7235	0.3005	-0.0526	0.1243	0.4154
0.901	6.00	3.03	0.9852	0.9114	0.0461	-0.0677	-0.0093	0.8498	0.6341	-0.0347	0.2023	0.7462
0.902	6.00	5.01	0.9845	0.9529	0.0349	-0.0876	0.1748	0.9209	1.3203	-0.0637	0.8260	1.4337
0.902	5.97	6.96	0.9846	0.9631	0.0314	-0.0755	0.1701	0.9417	2.0171	0.0506	0.8260	1.4337
0.898	5.99	9.00	0.9836	0.9625	0.0333	-0.0638	-0.6122	0.9468	2.7620	0.3728	-0.5076	2.9173
0.899	-0.03	1.05	0.0000	0.0000	0.0644	-0.1544	0.2212	0.0000	-0.1103	-0.1544	0.2212	0.0051
0.898	-0.01	1.52	1.0140	0.7765	0.0330	-0.1009	-0.0079	0.5841	0.1396	-0.1213	0.1019	0.2389
0.898	-0.01	2.02	0.9886	0.8307	0.0426	-0.1190	0.0764	0.7191	0.2959	-0.1391	0.1709	0.4115
0.898	-0.01	3.04	0.9855	0.9088	0.0477	-0.1112	0.0281	0.8479	0.6393	-0.1548	0.2413	0.7540
0.898	0.02	4.01	0.9854	0.9434	0.0438	-0.0775	-0.1666	0.9013	0.9850	-0.1242	0.0627	1.0928
0.899	0.00	4.99	0.9844	0.9448	0.0418	-0.1272	0.1840	0.9128	1.3133	-0.2510	0.8398	1.4386
0.898	-0.04	6.98	0.9845	0.9621	0.0360	-0.1224	0.2163	0.9408	2.0354	-0.2162	0.7891	2.1634
0.900	-0.02	9.00	0.9839	0.9733	0.0177	-0.0057	-0.5048	0.9575	2.7829	0.0156	-0.4010	2.9065
0.899	-6.03	1.03	0.0000	0.0000	0.1147	-0.2070	0.2911	0.0000	-0.1606	-0.2070	0.2911	0.0051
0.898	-6.00	2.03	0.9859	0.7325	0.0801	-0.1797	0.1692	0.6210	0.2560	-0.2399	0.2637	0.4122
0.897	-6.00	3.03	0.9854	0.8483	0.0849	-0.1796	0.1677	0.7873	0.5938	-0.2995	0.3813	0.7542
0.898	-6.02	5.00	0.9844	0.9069	0.0756	-0.1838	0.2772	0.8750	1.2610	-0.4545	0.9348	1.4411
0.900	-6.02	7.01	0.9842	0.9383	0.0672	-0.1679	0.2413	0.9171	1.9868	-0.4804	0.8047	2.1663
0.902	-6.02	8.99	0.9840	0.9629	0.0330	-0.0304	-0.5118	0.9470	2.7407	-0.3170	-0.4064	2.8940
0.799	-0.01	1.03	0.0000	0.0000	0.0664	-0.1520	0.2474	0.0000	-0.1133	-0.1520	0.2474	0.0058
0.800	0.02	2.05	0.9860	0.8565	0.0432	-0.1103	0.0652	0.7681	0.4070	-0.1353	0.1832	0.5299
0.801	-0.04	3.05	0.9860	0.9250	0.0447	-0.1063	0.0425	0.8758	0.8353	-0.1617	0.3108	0.9537
0.802	-0.01	4.97	0.9847	0.9498	0.0429	-0.1202	0.1887	0.9238	1.6598	-0.2735	0.9987	1.7968
0.801	-0.03	6.99	0.9840	0.9657	0.0371	-0.1024	0.1661	0.9485	2.5885	-0.2191	0.8816	2.7290
0.599	5.98	1.02	0.0000	0.0000	0.0607	-0.0979	0.1970	0.0000	-0.1098	-0.0979	0.1970	0.0086
0.600	5.99	2.04	0.9854	0.8864	0.0481	-0.0563	0.0347	0.8338	0.7777	-0.0095	0.2459	0.9327
0.600	6.01	3.04	0.9849	0.9465	0.0456	-0.0429	-0.0193	0.9175	1.5503	0.0325	0.4579	1.6897
0.602	5.99	4.99	0.9850	0.9651	0.0380	-0.0656	0.1955	0.9498	3.0470	-0.0138	1.6565	3.2081
0.601	5.99	7.00	0.9841	0.9729	0.0260	-0.0208	0.0799	0.9628	4.6791	0.2734	1.3477	4.8599
0.600	-0.03	1.01	0.0000	0.0000	0.0611	-0.1507	0.2795	0.0000	-0.1101	-0.1507	0.2795	0.0086
0.602	0.01	1.53	1.0229	0.8544	0.0275	-0.0923	0.0364	0.7655	0.4211	-0.1376	0.2798	0.5501
0.601	-0.02	2.04	0.9858	0.8895	0.0445	-0.1037	0.0736	0.8367	0.7751	-0.1486	0.2837	0.9264
0.602	-0.04	3.05	0.9858	0.9450	0.0456	-0.0978	0.0293	0.9160	1.5463	-0.1957	0.5044	1.6881
0.602	0.00	3.98	0.9842	0.9588	0.0501	-0.0972	0.0396	0.9385	2.2569	-0.2015	0.5482	2.4048
0.602	-0.02	4.98	0.9849	0.9603	0.0418	-0.1130	0.2246	0.9450	3.0138	-0.3864	1.6673	3.1893
0.602	-0.01	5.99	0.9838	0.9660	0.0400	-0.0763	0.1048	0.9538	3.8184	-0.3912	1.8676	4.0033
0.600	-0.05	6.98	0.9842	0.9721	0.0338	-0.0798	0.1575	0.9620	4.6595	-0.2907	1.4392	4.8436
0.600	-6.03	1.00	0.0000	0.0000	0.1150	-0.2052	0.3645	0.0000	-0.1639	-0.2052	0.3645	0.0086
0.600	-5.99	2.03	0.9864	0.8391	0.0808	-0.1675	0.2115	0.7863	0.7278	-0.3026	0.4231	0.9256
0.600	-6.00	3.04	0.9854	0.9141	0.0792	-0.1622	0.1633	0.8852	1.4946	-0.4305	0.6402	1.6884
0.600	-6.01	5.00	0.9856	0.9358	0.0728	-0.1714	0.3219	0.9207	2.9818	-0.7784	1.7991	3.2387
0.600	-6.05	6.97	0.9841	0.9562	0.0628	-0.1240	0.1800	0.9462	4.5865	-0.8303	1.4657	4.8475

Table 4. Concluded

(c) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	0.00	1.50	1.0260	0.9007	0.8981	-4.31	0.1198	-0.0090	0.0533	0.1334
0.000	0.02	2.02	0.9837	0.9394	0.9381	-2.97	0.2167	-0.0112	0.0536	0.2310
0.000	0.02	2.53	0.9843	0.9655	0.9644	-2.79	0.3164	-0.0154	0.0746	0.3281
0.000	0.01	2.99	0.9830	0.9739	0.9722	-3.39	0.4040	-0.0239	0.1219	0.4156
0.000	-0.03	3.47	0.9847	0.9827	0.9826	-0.69	0.5008	-0.0061	0.0149	0.5097
0.000	0.00	3.97	0.9842	0.9792	0.9783	-2.48	0.5941	-0.0257	0.1295	0.6073
0.000	0.01	4.47	0.9844	0.9777	0.9749	-4.33	0.6900	-0.0522	0.2729	0.7078
0.000	0.00	4.99	0.9841	0.9770	0.9733	-4.96	0.7902	-0.0686	0.3681	0.8119
0.000	-0.02	6.02	0.9847	0.9777	0.9747	-4.50	0.9980	-0.0785	0.4468	1.0238
0.000	-0.06	6.98	0.9844	0.9786	0.9778	-2.37	1.1957	-0.0494	0.3267	1.2229

(d) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.601	0.02	1.02	0.0000	0.0000	0.0546	-0.1570	0.2711	0.0000	-0.1027	-0.1570	0.2711	0.0084
0.600	0.01	1.50	1.0285	0.8677	0.0195	-0.0937	-0.0185	0.7760	0.4079	-0.1393	0.2285	0.5256
0.599	0.02	2.01	0.9838	0.8984	0.0362	-0.1098	0.0563	0.8454	0.7690	-0.1545	0.2698	0.9097
0.600	0.00	2.98	0.9836	0.9497	0.0384	-0.1055	0.0284	0.9203	1.5097	-0.2023	0.5036	1.6403
0.600	-0.02	4.02	0.9837	0.9610	0.0470	-0.1204	0.1011	0.9412	2.3005	-0.2266	0.6143	2.4442
0.600	0.00	5.01	0.9853	0.9616	0.0365	-0.1240	0.2092	0.9467	3.0675	-0.4011	1.6799	3.2403
0.599	-0.01	6.03	0.9846	0.9666	0.0362	-0.0942	0.0928	0.9548	3.8949	-0.4108	1.8713	4.0794
0.600	-0.04	7.02	0.9838	0.9736	0.0289	-0.0897	0.1164	0.9637	4.7121	-0.2950	1.3775	4.8895
1.205	0.01	0.98	0.0000	0.0000	0.1820	-0.0876	0.2206	0.0000	-0.2250	-0.0876	0.2206	0.0040
1.199	0.02	1.53	1.0177	-0.2177	0.1554	-0.0652	0.1446	-0.5300	-0.0731	-0.0766	0.2059	0.1380
1.204	0.00	2.02	0.9831	0.2005	0.1681	-0.0992	0.3076	0.0111	0.0025	-0.1103	0.3603	0.2275
1.200	0.00	3.99	0.9874	0.6960	0.1707	-0.1276	0.4876	0.6251	0.3804	-0.1540	0.6159	0.6085
1.200	0.00	6.00	0.9848	0.8277	0.1492	-0.0499	0.0947	0.7851	0.7946	-0.1295	0.5416	1.0122
1.200	-0.03	8.04	0.9854	0.8846	0.1351	-0.0045	-0.1428	0.8545	1.2271	-0.0264	0.0397	1.4360
1.201	-0.01	10.01	0.9845	0.9043	0.1349	0.0802	-0.6340	0.8809	1.6290	0.1149	-0.7058	1.8492
1.200	0.01	12.01	0.9839	0.9133	0.1377	0.1507	-1.0463	0.8943	2.0401	0.2436	-1.3783	2.2811
0.950	0.00	1.06	0.0000	0.0000	0.0884	-0.1580	0.2340	0.0000	-0.1336	-0.1580	0.2340	0.0047
0.949	-0.01	2.01	0.9869	0.7613	0.0638	-0.1342	0.1216	0.6379	0.2335	-0.1522	0.2066	0.3660
0.953	0.00	3.02	0.9866	0.8641	0.0711	-0.1329	0.1389	0.7964	0.5304	-0.1714	0.3281	0.6661
0.949	0.00	5.00	0.9844	0.9273	0.0601	-0.1463	0.2569	0.8924	1.1547	-0.2571	0.8448	1.2939
0.949	-0.02	6.98	0.9844	0.9499	0.0562	-0.1453	0.3203	0.9266	1.7979	-0.2283	0.8318	1.9402
0.948	-0.02	8.98	0.9839	0.9655	0.0363	-0.0418	-0.3003	0.9482	2.4793	-0.0337	-0.2022	2.6146
0.900	0.02	1.05	0.0000	0.0000	0.0658	-0.1635	0.2119	0.0000	-0.1113	-0.1635	0.2119	0.0050
0.900	0.03	1.53	1.0170	0.7740	0.0332	-0.1127	-0.0130	0.5878	0.1438	-0.1328	0.0957	0.2447
0.900	0.01	2.04	0.9870	0.8344	0.0425	-0.1293	0.0674	0.7249	0.3015	-0.1491	0.1610	0.4159
0.902	0.01	3.02	0.9854	0.9075	0.0479	-0.1226	0.0200	0.8462	0.6276	-0.1655	0.2310	0.7418
0.901	0.00	4.01	0.9848	0.9412	0.0412	-0.0902	-0.1712	0.8992	0.9760	-0.1371	0.0566	1.0855
0.901	0.00	5.03	0.9838	0.9441	0.0434	-0.1378	0.1820	0.9126	1.3174	-0.2613	0.8377	1.4436
0.901	-0.01	6.99	0.9844	0.9611	0.0384	-0.1301	0.2110	0.9400	2.0290	-0.2214	0.7764	2.1585
0.899	-0.01	9.01	0.9839	0.9720	0.0215	-0.0040	-0.5181	0.9563	2.7903	0.0070	-0.4151	2.9177
0.800	0.00	1.03	0.0000	0.0000	0.0670	-0.1606	0.2370	0.0000	-0.1135	-0.1606	0.2370	0.0057
0.801	-0.01	1.96	0.9859	0.8435	0.0444	-0.1164	0.0407	0.7487	0.3669	-0.1417	0.1619	0.4901
0.801	0.01	2.97	0.9869	0.9256	0.0406	-0.1048	-0.0143	0.8751	0.8053	-0.1589	0.2521	0.9202
0.801	-0.01	5.04	0.9856	0.9498	0.0413	-0.1268	0.1811	0.9246	1.6980	-0.2835	1.0133	1.8366
0.801	-0.02	6.99	0.9841	0.9652	0.0380	-0.1094	0.1651	0.9482	2.5895	-0.2254	0.8808	2.7309

Table 5. Internal and Aeropropulsive Characteristics for Nozzle 2

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	0.02	1.52	1.0234	0.9244	0.9140	-8.60	0.1255	-0.0190	0.0990	0.1373
0.000	-0.01	2.01	0.9866	0.9385	0.9337	-5.80	0.2148	-0.0218	0.1080	0.2301
0.000	0.02	2.53	0.9866	0.9639	0.9594	-5.54	0.3155	-0.0306	0.1580	0.3289
0.000	-0.01	3.00	0.9858	0.9718	0.9590	-9.28	0.4008	-0.0655	0.3341	0.4179
0.000	-0.01	3.47	0.9873	0.9786	0.9720	-6.64	0.4975	-0.0579	0.3039	0.5119
0.000	-0.05	3.97	0.9871	0.9833	0.9805	-4.28	0.5985	-0.0448	0.2428	0.6104
0.000	-0.05	4.47	0.9864	0.9862	0.9852	-2.53	0.6992	-0.0309	0.1811	0.7097
0.000	-0.04	4.97	0.9860	0.9858	0.9857	-1.12	0.7982	-0.0156	0.1196	0.8098
0.000	-0.02	6.03	0.9870	0.9847	0.9846	0.79	1.0123	0.0139	-0.0092	1.0281
0.000	-0.04	7.04	0.9863	0.9800	0.9794	1.91	1.2132	0.0405	-0.1312	1.2387

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
1.200	0.00	0.91	0.0000	0.0000	0.2582	0.0055	-0.0074	0.0000	-0.3011	0.0055	-0.0074	0.0040
1.200	0.01	1.55	1.0044	-0.5576	0.2080	0.0040	0.0228	-0.8637	-0.1211	-0.0150	-0.1211	0.1402
1.198	0.01	2.05	0.9758	0.0081	0.2195	-0.0262	0.1525	-0.1752	-0.0411	-0.0481	0.2607	0.2344
1.201	0.00	4.03	0.9839	0.6325	0.2153	0.0007	0.0237	0.5625	-0.3452	-0.0426	0.2591	0.6137
1.201	-0.02	6.08	0.9845	0.7840	0.2079	0.0159	-0.0595	0.7421	0.7605	0.0306	-0.0747	1.0249
1.201	-0.01	8.06	0.9850	0.8419	0.1909	0.0186	-0.0710	0.8120	1.1678	0.0848	-0.3223	1.4382
1.198	0.00	9.95	0.9843	0.8705	0.1740	0.0194	-0.0803	0.8471	1.5608	0.1352	-0.5578	1.8425
1.206	0.01	12.08	0.9843	0.8861	0.1558	0.0200	-0.0727	0.8672	1.9727	0.1896	-0.7964	2.2748
0.950	0.00	1.11	0.0000	0.0000	0.1018	-0.0033	-0.2947	0.0000	-0.1467	-0.0033	-0.2947	0.0047
0.954	-0.02	2.01	0.9844	0.6787	0.0927	-0.0963	0.2019	0.5542	0.2001	-0.1307	0.3716	0.3610
0.951	-0.03	3.01	0.9858	0.8245	0.0903	-0.0674	0.0379	0.7568	0.5028	-0.1707	0.5632	0.6643
0.946	-0.03	4.99	0.9844	0.9234	0.0832	-0.1113	0.2060	0.8887	1.1514	-0.1359	0.3928	1.2957
0.950	-0.02	6.99	0.9851	0.9456	0.0683	-0.0773	0.0634	0.9225	1.7909	-0.0160	-0.1345	1.9414
0.950	-0.01	9.00	0.9847	0.9508	0.0489	-0.0656	-0.0051	0.9336	2.4357	0.0787	-0.5838	2.6091
0.901	5.98	1.11	0.0000	0.0000	0.0758	-0.0112	-0.1372	0.0000	-0.1212	-0.0112	-0.1372	0.0049
0.902	6.01	2.02	0.9861	0.7904	0.0603	-0.0283	-0.0027	0.6788	0.2760	-0.0267	0.1873	0.4066
0.900	5.95	3.00	0.9860	0.8881	0.0612	-0.0058	-0.1338	0.8267	0.6108	-0.0467	0.4538	0.7388
0.900	5.98	5.01	0.9847	0.9439	0.0576	-0.0485	0.0717	0.9124	1.3146	0.0741	0.2743	1.4408
0.900	5.98	6.97	0.9854	0.9524	0.0422	-0.0251	-0.0382	0.9314	2.0077	0.2627	-0.2543	2.1557
0.899	5.98	9.02	0.9848	0.9510	0.0211	-0.0140	-0.1048	0.9355	2.7363	0.4435	-0.7569	2.9251
0.903	-0.01	1.11	0.0000	0.0000	0.0548	-0.0356	-0.1887	0.0000	-0.1002	-0.0356	-0.1887	0.0049
0.900	0.02	1.55	1.0028	0.7876	0.0348	-0.0599	-0.0681	0.6041	0.1495	-0.0936	0.1072	0.2474
0.901	-0.01	2.01	0.9865	0.8149	0.0480	-0.0923	-0.0913	0.7027	0.2844	-0.1307	0.2813	0.4047
0.902	0.00	2.98	0.9854	0.8945	0.0476	-0.0557	-0.0876	0.8321	0.6064	-0.1714	0.5020	0.7287
0.901	0.00	4.03	0.9857	0.9333	0.0528	-0.1205	0.2614	0.8918	0.9756	-0.1972	0.6794	1.0940
0.900	-0.03	5.03	0.9846	0.9522	0.0510	-0.1013	0.1318	0.9208	1.3320	-0.1267	0.3295	1.4465
0.900	-0.02	7.02	0.9856	0.9648	0.0334	-0.0730	-0.0045	0.9439	2.0506	-0.0036	-0.2311	2.1724
0.901	-0.01	9.00	0.9847	0.9652	0.0127	-0.0644	-0.0633	0.9495	2.7606	0.0970	-0.7093	2.9074
0.902	-6.03	1.11	0.0000	0.0000	0.0752	-0.0876	-0.1266	0.0000	-0.1206	-0.0876	-0.1266	0.0049
0.899	-5.99	2.01	0.9865	0.7512	0.0679	-0.1309	0.0979	0.6394	0.2597	-0.2088	0.2886	0.4062
0.899	-6.04	2.99	0.9854	0.8495	0.0650	-0.0994	-0.0562	0.7877	0.5788	-0.2891	0.5358	0.7348
0.902	-6.04	5.02	0.9849	0.9322	0.0687	-0.1450	0.1647	0.9006	1.2953	-0.3188	0.3624	1.4382
0.898	-6.02	6.94	0.9853	0.9562	0.0489	-0.1167	0.0347	0.9351	2.0161	-0.2717	-0.1765	2.1561
0.898	-6.01	9.04	0.9848	0.9606	0.0268	-0.1113	-0.0082	0.9451	2.7806	-0.2465	-0.6664	2.9420
0.801	-0.02	1.08	0.0000	0.0000	0.0510	-0.0358	-0.1562	0.0000	-0.0973	-0.0358	-0.1562	0.0056
0.799	-0.01	2.00	0.9858	0.8464	0.0448	-0.0839	0.0803	0.7558	0.3869	-0.1327	0.3218	0.5119
0.802	-0.01	2.96	0.9869	0.9150	0.0389	-0.0420	-0.1239	0.8644	0.7912	-0.1892	0.6246	0.9153
0.801	-0.04	5.02	0.9864	0.9625	0.0425	-0.0866	0.0919	0.9371	1.7120	-0.1195	0.3447	1.8269
0.800	-0.02	6.99	0.9852	0.9703	0.0286	-0.0554	-0.0369	0.9534	2.6094	0.0307	-0.3157	2.7370
0.800	-0.02	6.99	0.9859	0.9695	0.0290	-0.0565	-0.0373	0.9526	2.6132	0.0301	-0.3174	2.7432
0.601	5.98	1.04	0.0000	0.0000	0.0663	0.0033	-0.1289	0.0000	-0.1148	-0.0033	-0.1289	0.0084
0.602	6.00	1.99	0.9859	0.8754	0.0559	-0.0252	0.0393	0.8209	0.7308	-0.0233	0.4633	0.8902
0.601	5.95	3.01	0.9859	0.9400	0.0521	-0.0104	-0.0341	0.9109	1.5168	-0.1011	1.2826	1.6652
0.601	5.97	4.98	0.9862	0.9670	0.0498	-0.0137	0.0063	0.9519	3.0584	0.2555	0.4734	3.2129
0.599	5.98	7.01	0.9856	0.9639	0.0374	-0.0176	-0.1409	0.9540	4.6758	0.6750	-0.6481	4.9013
0.598	-0.03	1.04	0.0000	0.0000	0.0428	-0.0310	-0.1406	0.0000	-0.0912	-0.0310	-0.1406	0.0084
0.603	0.03	1.54	1.0193	0.8703	0.0243	-0.0596	-0.0231	0.7836	0.4368	-0.1345	0.3672	0.5575
0.599	0.01	2.02	0.9874	0.8857	0.0434	-0.0835	0.1100	0.8333	0.7693	-0.1704	0.5411	0.9233
0.599	-0.05	3.02	0.9858	0.9362	0.0407	-0.0648	0.0332	0.9074	1.5211	-0.3250	1.3541	1.6764
0.599	-0.01	4.03	0.9852	0.9630	0.0470	-0.0916	0.1925	0.9434	2.3307	-0.2654	1.1365	2.4704
0.600	-0.03	4.96	0.9869	0.9731	0.0387	-0.0770	-0.0671	0.9580	3.0742	-0.1409	0.5424	3.2089
0.600	-0.02	5.98	0.9858	0.9773	0.0356	-0.0534	-0.0139	0.9653	3.8925	-0.0049	-0.0276	4.0325
0.600	-0.02	7.04	0.9858	0.9757	0.0200	-0.0411	-0.0709	0.9659	4.7368	-0.1170	-0.5896	4.9041
0.600	-6.02	1.04	0.0000	0.0000	0.0659	-0.0744	-0.1225	0.0000	-0.1143	-0.0744	-0.1225	0.0084
0.599	-5.99	2.00	0.9859	0.8485	0.0639	-0.1309	0.1405	0.7954	0.7241	-0.3057	0.5697	0.9103
0.600	-6.03	3.02	0.9858	0.9026	0.0618	-0.1365	0.1660	0.8738	1.4672	-0.5624	1.4828	1.6792
0.601	-6.04	4.98	0.9863	0.9614	0.0547	-0.1268	0.1102	0.9464	3.0473	-0.5201	0.5747	3.2200
0.600	-6.03	6.99	0.9857	0.9718	0.0309	-0.0949	-0.0117	0.9619	4.6778	-0.4414	-0.5074	4.8633

Table 6. Internal and Aeropropulsive Characteristics for Nozzle 3

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	0.05	1.53	1.0256	0.9044	0.9032	-3.02	0.1255	-0.0066	0.0346	0.1389
0.000	0.07	2.01	0.9881	0.9312	0.9304	-2.31	0.2142	-0.0086	0.0311	0.2302
0.000	0.11	2.48	0.9865	0.9626	0.9619	-2.24	0.3074	-0.0120	0.0380	0.3196
0.000	0.13	2.98	0.9858	0.9742	0.9737	-1.85	0.4041	-0.0131	0.0335	0.4150
0.000	0.26	3.46	0.9870	0.9745	0.9720	-4.11	0.4949	-0.0355	0.1626	0.5091
0.000	0.23	3.96	0.9873	0.9805	0.9795	-2.59	0.5957	-0.0270	0.1106	0.6082
0.000	0.14	4.47	0.9865	0.9844	0.9843	-0.70	0.6981	-0.0086	-0.0122	0.7092
0.000	0.11	4.99	0.9864	0.9817	0.9817	-0.07	0.8001	-0.0010	-0.0652	0.8150
0.000	0.43	5.96	0.9873	0.9721	0.9706	-3.10	0.9836	-0.0533	0.2732	1.0134
0.000	0.62	6.97	0.9869	0.9684	0.9659	-4.08	1.1807	-0.0842	0.4678	1.2224

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.601	6.00	1.00	0.0000	0.0000	0.0501	-0.1691	0.3658	0.0000	-0.0983	-0.1691	0.3658	0.0085
0.600	6.01	2.02	0.9867	0.9019	0.0270	-0.0948	0.0331	0.8496	0.7840	-0.0389	0.1561	0.9228
0.599	6.00	3.05	0.9867	0.9549	0.0293	-0.0741	-0.0938	0.9266	1.5774	0.0439	0.0596	1.7025
0.599	6.01	4.99	0.9865	0.9664	0.0325	-0.0855	-0.0009	0.9515	3.0818	0.2435	-0.2592	3.2390
0.599	5.98	7.02	0.9863	0.9642	0.0196	-0.1778	0.7161	0.9544	4.6756	-0.0239	2.6153	4.8991
0.598	-0.01	1.00	0.0000	0.0000	0.0736	-0.1981	0.2675	0.0000	-0.1219	-0.1981	0.2675	0.0086
0.601	0.02	1.54	1.0210	0.8449	0.0339	-0.1507	0.1077	0.7586	0.4249	-0.1769	0.2438	0.5601
0.601	0.02	2.04	0.9911	0.8908	0.0356	-0.1506	0.1021	0.8393	0.7866	-0.1849	0.2242	0.9372
0.601	0.02	3.02	0.9877	0.9480	0.0413	-0.1345	-0.0034	0.9192	1.5385	-0.1879	0.1409	1.6738
0.601	-0.02	3.97	0.9861	0.9622	0.0444	-0.1210	-0.0720	0.9421	2.2708	-0.2291	0.3686	2.4103
0.601	0.00	4.97	0.9869	0.9683	0.0416	-0.1135	-0.1027	0.9532	3.0553	-0.1196	-0.3470	3.2052
0.601	-0.01	5.97	0.9864	0.9583	0.0528	-0.2307	0.6178	0.9463	3.7949	-0.4442	1.7124	4.0104
0.600	-0.02	7.02	0.9864	0.9575	0.0414	-0.2015	0.6152	0.9476	4.6329	-0.5436	2.5128	4.8888
0.601	-6.00	0.98	0.0000	0.0000	0.1450	-0.2739	0.4593	0.0000	-0.1934	-0.2739	0.4593	0.0085
0.600	-6.00	2.02	0.9884	0.8184	0.0945	-0.2478	0.3910	0.7657	0.7022	-0.3711	0.5141	0.9171
0.600	-6.02	3.04	0.9888	0.9108	0.0891	-0.2176	0.2103	0.8824	1.4996	-0.4459	0.3628	1.6995
0.600	-6.02	4.97	0.9876	0.9482	0.0865	-0.2104	0.1978	0.9332	3.0069	-0.5479	-0.0474	3.2222
0.600	-6.03	7.00	0.9868	0.9325	0.1007	-0.2922	0.8632	0.9226	4.5099	-1.1253	2.7509	4.8880
1.201	-0.03	0.83	0.0000	0.0000	0.2113	-0.1689	0.5238	0.0000	-0.2544	-0.1689	0.5238	0.0041
1.199	0.01	1.49	1.0277	-0.2144	0.1462	-0.0900	0.1743	-0.5459	-0.0711	-0.0964	0.2089	0.1302
1.200	0.00	2.08	0.9883	0.2950	0.1538	-0.1173	0.3110	0.1160	0.0280	-0.1261	0.3414	0.2412
1.199	-0.01	4.01	0.9885	0.7222	0.1572	-0.0994	0.2193	0.6518	0.4000	-0.1269	0.3326	0.6138
1.199	0.00	6.01	0.9872	0.8370	0.1358	-0.1262	0.4299	0.7945	0.8087	-0.1808	0.7117	1.0178
1.202	-0.01	8.02	0.9862	0.8808	0.1143	-0.0181	-0.0925	0.8506	1.2149	-0.1337	0.5723	1.4284
1.200	-0.01	9.98	0.9864	0.9073	0.0803	0.1107	-0.7561	0.8839	1.6324	-0.0646	0.2852	1.8468
1.199	-0.02	12.03	0.9860	0.9193	0.0517	0.2755	-1.6444	0.9004	2.0644	0.0364	-0.2060	2.2927
0.949	0.00	1.01	0.0000	0.0000	0.0889	-0.2144	0.3278	0.0000	-0.1341	-0.2144	0.3278	0.0048
0.951	0.00	2.03	0.9916	0.7858	0.0526	-0.1576	0.0958	0.6637	0.2456	-0.1713	0.1447	0.3701
0.953	0.00	3.03	0.9896	0.8816	0.0598	-0.1669	0.1684	0.8141	0.5448	-0.1885	0.2267	0.6692
0.951	-0.01	5.03	0.9871	0.9364	0.0580	-0.1614	0.1186	0.9016	1.1710	-0.1618	0.0064	1.2988
0.953	-0.03	6.99	0.9874	0.9387	0.0513	-0.2018	0.5605	0.9154	1.7704	-0.3366	1.3049	1.9341
0.953	-0.05	9.02	0.9862	0.9508	0.0127	-0.0264	-0.3338	0.9335	2.4324	-0.2604	1.0268	2.6057
0.901	5.97	1.01	0.0000	0.0000	0.0577	-0.1895	0.3904	0.0000	-0.1033	-0.1895	0.3904	0.0050
0.900	6.01	2.03	0.9905	0.8454	0.0341	-0.1082	0.0050	0.7352	0.3041	-0.0832	0.0595	0.4136
0.903	6.00	3.04	0.9891	0.9184	0.0383	-0.1133	0.0218	0.8575	0.6415	-0.0614	0.0879	0.7481
0.900	6.01	5.02	0.9870	0.9493	0.0383	-0.1318	0.1616	0.9178	1.3275	0.0162	0.0385	1.4464
0.897	5.97	6.99	0.9870	0.9566	0.0239	-0.1631	0.5276	0.9357	2.0414	-0.0940	1.3671	2.1816
0.899	5.95	9.03	0.9865	0.9582	0.0037	-0.0430	-0.5166	0.9427	2.7620	0.0742	1.0143	2.9300
0.899	-0.02	1.00	0.0000	0.0000	0.0787	-0.2134	0.2974	0.0000	-0.1243	-0.2134	0.2974	0.0050
0.901	0.02	1.52	1.0219	0.7469	0.0389	-0.1546	0.0709	0.5586	0.1352	-0.1662	0.1119	0.2421
0.900	0.03	2.05	0.9919	0.8295	0.0415	-0.1633	0.1013	0.7210	0.3029	-0.1786	0.1557	0.4202
0.903	0.01	3.01	0.9890	0.9047	0.0493	-0.1727	0.1504	0.8431	0.6237	-0.1962	0.2133	0.7397
0.899	-0.03	4.01	0.9885	0.9357	0.0463	-0.1566	0.0746	0.8940	0.9753	-0.2059	0.2761	1.0910
0.899	-0.01	5.00	0.9862	0.9483	0.0485	-0.1517	0.0387	0.9168	1.3234	-0.1535	-0.0785	1.4435
0.900	-0.02	6.97	0.9868	0.9482	0.0382	-0.1983	0.4944	0.9271	2.0003	-0.3481	1.3221	2.1577
0.902	-0.04	9.05	0.9865	0.9553	-0.0003	-0.0043	-0.4884	0.9397	2.7464	-0.2666	1.0420	2.9226
0.900	-6.03	0.97	0.0000	0.0000	0.1476	-0.2978	0.5280	0.0000	-0.1932	-0.2978	0.5280	0.0050
0.900	-5.99	2.03	0.9919	0.6980	0.0919	-0.2308	0.2466	0.5884	0.2447	-0.2864	0.3012	0.4159
0.900	-6.01	3.02	0.9885	0.8303	0.0995	-0.2435	0.2984	0.7694	0.5759	-0.3438	0.3632	0.7485
0.899	-6.02	5.00	0.9867	0.9113	0.0931	-0.2284	0.2521	0.8797	1.2671	-0.3783	0.1364	1.4404
0.897	-6.03	7.01	0.9867	0.9091	0.0965	-0.2749	0.7039	0.8882	1.9392	-0.6473	1.5479	2.1833
0.898	-6.05	9.06	0.9862	0.9300	0.0317	-0.0765	-0.3444	0.9146	2.6964	-0.6351	1.2006	2.9483
0.800	-0.02	0.99	0.0000	0.0000	0.0789	-0.2036	0.2869	0.0000	-0.1254	-0.2036	0.2869	0.0057
0.800	0.00	2.04	0.9914	0.8483	0.0425	-0.1555	0.1052	0.7604	0.4021	-0.1750	0.1740	0.5288
0.801	0.01	3.05	0.9899	0.9221	0.0467	-0.1506	0.0720	0.8735	0.8356	-0.1817	0.1581	0.9565
0.802	-0.02	4.96	0.9872	0.9557	0.0455	-0.1308	-0.0322	0.9299	1.6719	-0.1352	-0.1658	1.7980
0.802	-0.02	6.98	0.9868	0.9507	0.0414	-0.1937	0.5247	0.9337	2.5424	-0.3827	1.5700	2.7229

Table 7. Internal and Aeropropulsive Characteristics for Nozzle 4

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	0.06	1.48	1.0379	0.9270	0.9263	-2.21	0.1189	-0.0046	0.0230	0.1284
0.000	0.09	2.05	0.9887	0.9553	0.9548	-1.87	0.2274	-0.0074	0.0361	0.2381
0.000	0.12	2.49	0.9857	0.9763	0.9759	-1.71	0.3122	-0.0093	0.0430	0.3200
0.000	0.18	2.98	0.9853	0.9832	0.9824	-2.19	0.4054	-0.0155	0.0804	0.4127
0.000	0.16	3.46	0.9868	0.9864	0.9862	-1.01	0.5006	-0.0089	0.0484	0.5076
0.000	0.27	3.97	0.9876	0.9846	0.9835	-2.68	0.5979	-0.0280	0.1586	0.6080
0.000	0.32	4.47	0.9865	0.9853	0.9843	-2.59	0.6969	-0.0315	0.1972	0.7081
0.000	0.31	4.99	0.9863	0.9840	0.9836	-1.71	0.7996	-0.0238	0.1734	0.8130
0.000	0.21	6.01	0.9876	0.9835	0.9834	0.66	1.0059	0.0117	0.0237	1.0229
0.000	0.03	6.97	0.9864	0.9792	0.9770	3.85	1.1921	0.0801	-0.1947	1.2202

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.600	-0.03	1.02	0.0000	0.0000	0.0531	-0.1341	0.1538	0.0000	-0.1016	-0.1341	0.1538	0.0085
0.599	0.03	1.50	1.0298	0.8865	0.0222	-0.0440	-0.2049	0.7952	0.4226	-0.0626	-0.1109	0.5315
0.602	-0.02	2.03	0.9845	0.9150	0.0398	-0.0593	-0.1548	0.8620	0.7895	-0.0882	-0.0147	0.9160
0.600	-0.03	3.03	0.9852	0.9572	0.0429	-0.0460	-0.2050	0.9282	1.5553	-0.1109	0.1294	1.6757
0.600	0.00	3.97	0.9846	0.9679	0.0444	-0.0454	-0.1906	0.9478	2.2856	-0.1569	0.4411	2.4115
0.601	-0.01	4.97	0.9863	0.9715	0.0387	-0.0398	-0.2204	0.9562	3.0533	-0.1348	0.4632	3.1930
0.602	-0.02	5.99	0.9853	0.9743	0.0464	-0.0150	-0.3742	0.9622	3.8500	0.0266	-0.2163	4.0014
0.599	-0.01	6.98	0.9855	0.9707	0.0348	-0.0578	-0.2891	0.9607	4.6744	0.2634	-1.0730	4.8658
1.199	-0.02	0.88	0.0000	0.0000	0.2211	-0.1055	0.4117	0.0000	-0.2644	-0.1055	0.4117	0.0041
1.199	0.01	1.49	1.0228	-0.3756	0.1693	0.0101	-0.1329	-0.7118	-0.0918	0.0055	-0.1097	0.1290
1.200	0.00	2.02	0.9795	0.1840	0.1774	-0.0130	-0.0212	-0.0066	-0.0015	-0.0201	0.0139	0.2277
1.199	0.02	3.99	0.9867	0.6988	0.1739	0.0103	-0.1329	0.6276	0.3824	-0.0177	0.0269	0.6093
1.199	0.00	5.98	0.9859	0.8165	0.1702	0.0523	-0.3708	0.7734	0.7795	0.0628	-0.3428	1.0079
1.200	0.01	7.98	0.9861	0.8567	0.1607	0.0337	-0.4556	0.8262	1.1740	0.1854	-0.8780	1.4210
1.200	0.00	9.22	0.9871	0.8648	0.1614	0.0438	-0.7182	0.8390	1.4133	0.2831	-1.4217	1.6846
1.200	-0.01	9.20	0.9866	0.8702	0.1527	0.0425	-0.7173	0.8443	1.4169	0.2797	-1.4148	1.6782
0.951	0.00	1.07	0.0000	0.0000	0.0887	-0.1044	0.0931	0.0000	-0.1341	-0.1044	0.0931	0.0048
0.950	0.01	2.00	0.9874	0.7582	0.0707	-0.0617	-0.1001	0.6320	0.2275	-0.0730	-0.0449	0.3599
0.951	-0.02	3.02	0.9881	0.8687	0.0740	-0.0701	-0.0251	0.8005	0.5331	-0.0957	0.1070	0.6659
0.952	0.00	5.04	0.9868	0.9324	0.0655	-0.0612	-0.0420	0.8974	1.1634	-0.0965	0.2220	1.2965
0.952	-0.01	6.98	0.9865	0.9471	0.0572	-0.0868	-0.1201	0.9235	1.7766	0.0397	-0.4289	1.9238
0.951	0.00	9.02	0.9879	0.9438	0.0454	-0.0946	-0.5831	0.9264	2.4216	0.2632	-1.6286	2.6141
0.899	0.00	1.05	0.0000	0.0000	0.0635	-0.1310	-0.1453	0.0000	-0.1094	-0.1310	0.1453	0.0050
0.899	-0.01	1.50	1.0217	0.7700	0.0388	-0.0486	-0.2285	0.5749	0.1351	-0.0570	-0.1867	0.2350
0.903	-0.01	2.01	0.9871	0.8411	0.0462	-0.0615	-0.1637	0.7276	0.2939	-0.0742	-0.1020	0.4039
0.901	-0.01	3.01	0.9874	0.9149	0.0485	-0.0749	-0.0677	0.8530	0.6310	-0.1031	0.0786	0.7398
0.901	0.01	4.03	0.9868	0.9469	0.0406	-0.0399	-0.2533	0.9048	0.9864	-0.0885	0.0273	1.0902
0.902	0.00	4.99	0.9860	0.9546	0.0418	-0.0445	-0.2009	0.9225	1.3170	-0.0863	0.1038	1.4277
0.900	0.01	6.98	0.9862	0.9606	0.0355	-0.0714	-0.3205	0.9393	2.0211	0.0708	-0.6661	2.1517
0.899	0.02	8.99	0.9858	0.9521	0.0324	-0.0642	-0.7465	0.9363	2.7209	0.3330	-1.9043	2.9059
0.802	0.01	1.03	0.0000	0.0000	0.0641	-0.1268	0.1599	0.0000	-0.1108	-0.1268	0.1599	0.0057
0.799	-0.01	2.05	0.9880	0.8670	0.0468	-0.0506	-0.1707	0.7786	0.4118	-0.0672	-0.0904	0.5289
0.799	0.00	3.03	0.9875	0.9366	0.0417	-0.0550	-0.1133	0.8873	0.8411	-0.0912	0.0758	0.9479
0.801	0.01	4.97	0.9861	0.9629	0.0376	-0.0273	-0.2265	0.9370	1.6895	-0.0802	0.1594	1.8031
0.801	-0.01	7.02	0.9865	0.9659	0.0290	-0.0607	-0.3766	0.9489	2.6014	0.1250	-0.8352	2.7415

Table 8. Internal and Aeropropulsive Characteristics for Nozzle 5

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	0.10	1.51	1.0274	0.8906	0.8809	-8.46	0.1198	-0.0178	0.0960	0.1360
0.000	0.11	2.01	0.9838	0.9243	0.9210	-4.90	0.2113	-0.0181	0.0833	0.2295
0.000	0.15	2.49	0.9803	0.9570	0.9545	-4.13	0.3048	-0.0220	0.0932	0.3193
0.000	0.18	2.98	0.9792	0.9715	0.9698	-3.39	0.3991	-0.0236	0.0922	0.4115
0.000	0.20	3.47	0.9803	0.9753	0.9717	-4.96	0.4930	-0.0428	0.1908	0.5074
0.000	0.27	3.98	0.9812	0.9773	0.9758	-3.19	0.5929	-0.0330	0.1324	0.6076
0.000	0.40	4.49	0.9817	0.9743	0.9707	-4.97	0.6880	-0.0598	0.2629	0.7088
0.000	0.56	4.99	0.9841	0.9695	0.9631	-6.61	0.7824	-0.0906	0.4219	0.8124
0.000	0.90	6.01	0.9875	0.9736	0.9588	-10.00	0.9815	-0.1730	0.7612	1.0237
0.000	0.90	6.99	0.9893	0.9722	0.9625	-8.10	1.1842	-0.1685	0.7396	1.2303

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
1.200	-0.02	1.50	1.0039	-0.4329	0.1718	-0.1209	0.4770	-0.7677	-0.0987	-0.1386	0.5726	0.1286
1.202	-0.01	2.02	0.9755	0.0747	0.1932	-0.1740	0.7365	-0.1158	-0.0262	-0.1920	0.8189	0.2261
1.200	-0.03	3.99	0.9843	0.6548	0.1928	-0.2065	0.9234	0.5837	0.3539	-0.2397	1.0551	0.6063
1.200	-0.03	6.01	0.9846	0.8017	0.1621	-0.1110	0.5632	0.7592	0.7698	-0.2836	1.3197	1.0140
1.201	-0.03	8.04	0.9882	0.8676	0.1414	-0.0084	0.0398	0.8376	1.2028	-0.1713	0.7489	1.4361
1.204	-0.04	10.06	0.9897	0.8998	0.1199	0.1157	-0.4985	0.8766	1.6294	-0.0378	0.1616	1.8588
1.201	-0.01	12.05	0.9924	0.9152	0.1006	0.2080	-0.9572	0.8964	2.0636	0.0638	-0.3396	2.3021
0.949	-0.04	1.06	0.0000	0.0000	0.0949	-0.1964	0.4684	0.0000	-0.1401	-0.1964	0.4684	0.0046
0.955	-0.01	1.99	0.9829	0.7043	0.0760	-0.2126	0.7310	0.5761	0.2025	-0.2410	0.8626	0.3515
0.949	-0.04	2.98	0.9831	0.8432	0.0804	-0.2031	0.4974	0.7742	0.5067	-0.2410	0.6435	0.6544
0.950	-0.05	5.01	0.9856	0.9040	0.0745	-0.1984	0.6109	0.8691	1.1250	-0.3448	1.2898	1.2945
0.949	-0.05	7.02	0.9896	0.9265	0.0702	-0.1876	0.7575	0.9035	1.7710	-0.4565	1.9296	1.9602
0.951	-0.05	9.01	0.9926	0.9473	0.0390	-0.0397	-0.0444	0.9302	2.4416	-0.2930	1.0498	2.6250
0.900	-0.02	1.04	0.0000	0.0000	0.0711	-0.1946	0.3494	0.0000	-0.1166	-0.1946	0.3494	0.0049
0.900	-0.03	1.53	1.0037	0.7233	0.0422	-0.1745	0.2883	0.5331	0.1275	-0.2060	0.4571	0.2392
0.899	-0.01	2.00	0.9849	0.7793	0.0563	-0.2275	0.5965	0.6658	0.2672	-0.2595	0.7442	0.4013
0.900	-0.05	3.02	0.9843	0.8823	0.0618	-0.1998	0.3796	0.8210	0.6090	-0.2426	0.5448	0.7418
0.898	-0.02	3.99	0.9843	0.9144	0.0632	-0.2218	0.5187	0.8723	0.9442	-0.2807	0.7538	1.0824
0.900	-0.03	5.01	0.9850	0.9233	0.0559	-0.2021	0.5039	0.8918	1.2852	-0.3647	1.2601	1.4412
0.900	-0.04	7.03	0.9899	0.9399	0.0486	-0.1642	0.5945	0.9191	2.0105	-0.4626	1.8984	2.1874
0.901	-0.04	9.03	0.9942	0.9552	0.0157	0.0026	-0.3155	0.9398	2.7638	-0.2798	0.9048	2.9409
0.800	-0.02	1.03	0.0000	0.0000	0.0715	-0.1860	0.3479	0.0000	-0.1179	-0.1860	0.3479	0.0056
0.801	0.00	2.01	0.9816	0.8132	0.0561	-0.1982	0.3930	0.7222	0.3682	-0.2385	0.5784	0.5098
0.800	-0.03	2.99	0.9879	0.9016	0.0559	-0.1979	0.3742	0.8518	0.7935	-0.2513	0.5799	0.9315
0.801	-0.02	5.01	0.9886	0.9276	0.0566	-0.2050	0.5479	0.9022	1.6452	-0.4090	1.4973	1.8236
0.800	-0.05	7.00	0.9917	0.9435	0.0461	-0.1419	0.5497	0.9267	2.5570	-0.5205	2.2022	2.7592
0.602	-0.01	1.01	0.0000	0.0000	0.0716	-0.1869	0.3494	0.0000	-0.1202	-0.1869	0.3494	0.0083
0.600	0.00	1.50	1.0290	0.7987	0.0436	-0.1742	0.2985	0.7066	0.3724	-0.2447	0.6807	0.5270
0.600	-0.03	1.99	0.9854	0.8510	0.0607	-0.1845	0.3238	0.7970	0.7153	-0.2566	0.6559	0.8974
0.600	-0.01	3.00	0.9878	0.9242	0.0626	-0.2014	0.3545	0.8950	1.4868	-0.2959	0.7204	1.6612
0.600	-0.01	3.99	0.9887	0.9399	0.0696	-0.2078	0.3779	0.9199	2.2389	-0.3392	0.9041	2.4337
0.600	-0.01	4.98	0.9906	0.9370	0.0648	-0.2201	0.6104	0.9220	2.9960	-0.5814	2.2786	3.2493
0.599	-0.05	4.98	0.9929	0.9359	0.0708	-0.1787	0.8140	0.9240	3.7799	-0.8645	3.8166	4.0906
0.598	-0.06	5.98	0.9929	0.9359	0.0708	-0.1787	0.8140	0.9240	4.6386	-0.7944	3.4935	4.9561
0.598	-0.08	7.00	0.9956	0.9457	0.0531	-0.1150	0.5395	0.9359				

Table 9. Internal and Aeropropulsive Characteristics for Nozzle 6

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	-0.09	1.52	1.0193	0.9473	0.9449	-4.10	0.1289	-0.0092	0.0452	0.1364
0.000	-0.06	2.03	0.9841	0.9558	0.9543	-3.27	0.2220	-0.0127	0.0593	0.2326
0.000	-0.02	2.54	0.9830	0.9704	0.9689	-3.19	0.3189	-0.0178	0.0804	0.3291
0.000	0.02	3.00	0.9842	0.9727	0.9716	-2.71	0.4074	-0.0193	0.0908	0.4194
0.000	0.08	3.48	0.9855	0.9733	0.9722	-2.64	0.4976	-0.0229	0.1131	0.5119
0.000	0.12	3.97	0.9855	0.9728	0.9719	-2.47	0.5916	-0.0255	0.1324	0.6087
0.000	0.10	4.46	0.9855	0.9713	0.9595	-3.49	0.6867	-0.0419	0.2242	0.7083
0.000	0.10	4.97	0.9861	0.9681	0.9660	-3.74	0.7845	-0.0513	0.2904	0.8121
0.000	0.06	6.04	0.9880	0.9643	0.9612	-4.59	0.9926	-0.0796	0.4749	1.0326
0.000	-0.08	6.97	0.9880	0.9650	0.9645	-1.91	1.1838	-0.0396	0.3005	1.2275

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.599	0.01	1.01	0.0000	0.0000	0.0637	-0.1691	0.3035	0.0000	-0.1117	-0.1691	0.3035	0.0084
0.598	-0.01	1.53	1.0175	0.8815	0.0347	-0.0958	-0.0105	0.7941	0.4383	-0.1329	0.1710	0.5519
0.599	-0.01	1.96	0.9842	0.9080	0.0390	-0.1032	0.0032	0.8532	0.7506	-0.1522	0.2323	0.8798
0.600	-0.01	2.98	0.9852	0.9439	0.0437	-0.0954	-0.0624	0.9147	1.5090	-0.1718	0.2942	1.6498
0.600	-0.02	3.97	0.9846	0.9501	0.0549	-0.1127	-0.0470	0.9301	2.2455	-0.2145	0.5727	2.4142
0.599	0.00	4.99	0.9863	0.9471	0.0604	-0.1572	0.3489	0.9322	3.0236	-0.3631	1.5142	3.2436
0.599	-0.02	6.04	0.9868	0.9484	0.0574	-0.0874	0.0542	0.9366	3.8446	-0.4054	1.9433	4.1049
0.599	-0.05	7.03	0.9870	0.9550	0.0516	-0.0895	0.0705	0.9452	4.6658	-0.2416	1.2268	4.9360
1.200	-0.03	0.85	0.0000	0.0000	0.2381	-0.1601	0.5718	0.0000	-0.2812	-0.1601	0.5718	0.0040
1.200	0.01	1.52	1.0138	-0.3683	0.1774	-0.0706	0.1732	-0.6887	-0.0927	-0.0798	0.2181	0.1346
1.198	-0.01	1.97	0.9805	0.0953	0.1891	-0.0970	0.2809	-0.1013	-0.0223	-0.1093	0.3383	0.2197
1.201	-0.02	4.01	0.9864	0.6744	0.1815	-0.1221	0.4721	0.6038	0.3696	-0.1478	0.6051	0.6120
1.201	-0.02	6.05	0.9859	0.8107	0.1560	0.0040	-0.1431	0.7684	0.7859	-0.0746	0.3248	1.0227
1.200	0.01	7.98	0.9871	0.8575	0.1552	0.0395	-0.3250	0.8272	1.1811	0.0432	-0.2132	1.4278
1.203	0.00	10.02	0.9863	0.8754	0.1655	0.1090	-0.7107	0.8521	1.5769	0.1989	-0.9761	1.8507
1.202	0.03	11.66	0.9901	0.8723	0.1893	0.1716	-0.9539	0.8528	1.8875	0.3321	-1.5227	2.2133
0.951	0.00	1.05	0.0000	0.0000	0.1032	-0.1740	0.3169	0.0000	-0.1483	-0.1740	0.3169	0.0047
0.952	0.00	2.02	0.9882	0.7410	0.0767	-0.1229	0.1076	0.6184	0.2276	-0.1429	0.2011	0.3680
0.953	0.00	3.01	0.9878	0.8436	0.0826	-0.1344	0.1762	0.7756	0.5152	-0.1648	0.3195	0.6642
0.948	0.01	4.99	0.9859	0.9055	0.0785	-0.1516	0.3235	0.8706	1.1277	-0.2336	0.7889	1.2954
0.952	-0.01	7.00	0.9868	0.9268	0.0753	-0.1038	0.1556	0.9036	1.7563	-0.1647	0.6212	1.9436
0.950	-0.01	9.06	0.9870	0.9421	0.0623	-0.0448	-0.2239	0.9250	2.4434	0.0336	-0.3663	2.6416
0.903	0.00	1.03	0.0000	0.0000	0.0768	-0.1912	0.3217	0.0000	-0.1223	-0.1912	0.3217	0.0050
0.901	0.02	1.50	1.0139	0.7628	0.0444	-0.1089	-0.0258	0.5659	0.1309	-0.1248	0.0528	0.2314
0.903	0.00	2.03	0.9905	0.8347	0.0463	-0.1243	0.0459	0.7238	0.2974	-0.1466	0.1499	0.4109
0.901	-0.01	3.03	0.9868	0.8973	0.0536	-0.1238	0.0601	0.8364	0.6253	-0.1582	0.2216	0.7476
0.901	0.01	4.00	0.9869	0.9226	0.0521	-0.1234	0.0689	0.8806	0.9568	-0.1685	0.3049	1.0864
0.898	0.00	4.96	0.9854	0.9292	0.0538	-0.1337	0.2093	0.8974	1.2852	-0.2238	0.7194	1.4322
0.901	-0.05	6.98	0.9865	0.9445	0.0463	-0.0860	0.0146	0.9234	1.9951	-0.1570	0.5414	2.1606
0.899	0.01	9.04	0.9867	0.9521	0.0406	-0.0146	-0.4265	0.9366	2.7541	0.0723	-0.5778	2.9405
0.801	0.02	1.01	0.0000	0.0000	0.0753	-0.1780	0.3162	0.0000	-0.1218	-0.1780	0.3162	0.0057
0.799	-0.01	2.02	0.9871	0.8572	0.0487	-0.1110	0.0271	0.7680	0.4001	-0.1394	0.1597	0.5210
0.800	-0.02	3.03	0.9869	0.9175	0.0487	-0.0991	-0.0271	0.8685	0.8229	-0.1428	0.1775	0.9475
0.800	0.00	5.01	0.9869	0.9347	0.0553	-0.1243	-0.2263	0.9093	1.6623	-0.2407	0.8871	1.8280
0.800	-0.04	7.03	0.9867	0.9478	0.0495	-0.0730	0.0187	0.9310	2.5724	-0.1585	0.6678	2.7631

Table 10. Internal and Aeropulsive Characteristics for Nozzle 7

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	0.07	1.45	1.0548	0.8988	0.8940	-5.94	0.1100	-0.0115	0.0643	0.1230
0.000	0.08	2.02	0.9873	0.9339	0.9325	-3.20	0.2155	-0.0120	0.0556	0.2311
0.000	0.11	2.49	0.9862	0.9553	0.9542	-2.82	0.3037	-0.0150	0.0672	0.3183
0.000	0.17	2.97	0.9857	0.9695	0.9680	-3.18	0.3965	-0.0221	0.1023	0.4096
0.000	0.12	3.46	0.9861	0.9844	0.9843	-0.34	0.4968	-0.0030	-0.0116	0.5047
0.000	0.28	3.97	0.9867	0.9798	0.9784	-3.10	0.5916	-0.0321	0.1437	0.6047
0.000	0.42	4.48	0.9859	0.9806	0.9768	-5.01	0.6893	-0.0604	0.2875	0.7057
0.000	0.50	5.00	0.9862	0.9802	0.9761	-5.25	0.7914	-0.0727	0.3590	0.8108
0.000	0.53	6.04	0.9868	0.9815	0.9791	-4.03	1.0024	-0.0706	0.3617	1.0238
0.000	0.47	6.99	0.9856	0.9838	0.9830	-2.36	1.1976	-0.0494	0.2653	1.2183

(b) Aeropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
1.200	-0.03	0.93	0.0000	0.0000	0.2175	-0.1053	0.4077	0.0000	-0.2609	-0.1053	0.4077	0.0040
1.201	0.03	1.52	1.0056	-0.4008	0.1751	-0.0674	0.2471	-0.7288	-0.0965	-0.0788	0.3098	0.1324
1.201	0.00	2.03	0.9776	0.0811	0.1968	-0.1158	0.4693	-0.1090	-0.0249	-0.1277	0.5242	0.2286
1.201	-0.02	4.04	0.9873	0.6634	0.1929	-0.1494	0.6531	0.5925	0.3634	-0.1822	0.8105	0.6133
1.200	-0.04	5.99	0.9855	0.8089	0.1721	-0.0719	0.2623	0.7656	0.7691	-0.1427	0.6210	1.0046
1.202	-0.02	7.97	0.9842	0.8726	0.1576	-0.0299	0.0573	0.8417	1.1828	-0.0575	0.2208	1.4053
1.210	0.00	10.01	0.9855	0.9021	0.1422	0.0591	-0.4088	0.8781	1.5890	0.0766	-0.4490	1.8097
1.200	-0.02	10.00	0.9858	0.9011	0.1459	0.0626	-0.4189	0.8774	1.6137	0.0798	-0.4595	1.8392
1.201	0.00	12.04	0.9849	0.9120	0.1469	0.1361	-0.8103	0.8928	2.0267	0.1992	-1.0564	2.2701
1.200	0.04	12.00	0.9852	0.9065	0.1585	0.1354	-0.7994	0.8872	2.0098	0.1990	-1.0413	2.2653
0.951	0.02	1.07	0.0000	0.0000	0.0944	-0.1404	0.2821	0.0000	-0.1400	-0.1404	0.2821	0.0047
0.953	-0.02	2.01	0.9920	0.7159	0.0765	-0.1337	0.3051	0.5900	0.2132	-0.1527	0.3927	0.3614
0.949	-0.02	3.01	0.9893	0.8409	0.0831	-0.1517	0.3049	0.7724	0.5139	-0.1873	0.4662	0.6654
0.953	0.00	4.99	0.9856	0.9143	0.0794	-0.1464	0.4109	0.8785	1.1176	-0.2600	0.9723	1.2721
0.951	-0.01	6.98	0.9862	0.9468	0.0684	-0.1411	0.3715	0.9232	1.7755	-0.2201	0.7929	1.9233
0.949	-0.02	9.00	0.9858	0.9675	0.0382	-0.0497	-0.1617	0.9500	2.4706	-0.0576	-0.0647	2.6007
0.902	-0.02	1.06	0.0000	0.0000	0.0682	-0.1449	0.1787	0.0000	-0.1142	-0.1449	0.1787	0.0050
0.900	0.05	1.50	1.0186	0.7230	0.0438	-0.1191	0.0922	0.5234	0.1205	-0.1393	0.2042	0.2302
0.900	0.04	2.01	0.9867	0.7880	0.0581	-0.1400	0.1799	0.6738	0.2713	-0.1609	0.2783	0.4027
0.899	-0.02	2.96	0.9875	0.8775	0.0642	-0.1487	0.2121	0.8139	0.5879	-0.1875	0.3877	0.7224
0.901	0.01	3.99	0.9878	0.9313	0.0493	-0.0891	-0.1068	0.8885	0.9536	-0.1460	0.1501	1.0732
0.899	-0.01	4.99	0.9872	0.9356	0.0567	-0.1495	0.2978	0.9035	1.2931	-0.2777	0.9289	1.4312
0.899	-0.05	7.03	0.9867	0.9619	0.0436	-0.1296	0.2114	0.9407	2.0429	-0.2171	0.6725	2.1717
0.898	-0.02	9.00	0.9859	0.9767	0.0154	-0.0192	-0.3853	0.9609	2.7943	-0.0279	-0.2771	2.9080
0.800	-0.03	1.03	0.0000	0.0000	0.0670	-0.1371	0.1822	0.0000	-0.1139	-0.1371	0.1822	0.0057
0.801	0.01	2.00	0.9887	0.8164	0.0574	-0.1266	0.1564	0.7237	0.3657	-0.1531	0.2811	0.5054
0.800	0.00	2.98	0.9881	0.8993	0.0616	-0.1196	0.1209	0.8484	0.7818	-0.1687	0.3446	0.9215
0.801	-0.02	4.98	0.9866	0.9436	0.0577	-0.1365	0.2840	0.9176	1.6479	-0.2971	1.0730	1.7960
0.800	-0.04	7.00	0.9869	0.9651	0.0452	-0.1082	0.1638	0.9479	2.5851	-0.2202	0.7550	2.7271
0.602	-0.02	1.02	0.0000	0.0000	0.0659	-0.1319	0.1961	0.0000	-0.1150	-0.1319	0.1961	0.0084
0.601	0.01	1.48	1.0413	0.8014	0.0489	-0.1149	0.1385	0.7048	0.3574	-0.1604	0.3908	0.5072
0.601	0.01	2.04	0.9905	0.8574	0.0672	-0.1203	0.1621	0.8045	0.7464	-0.1678	0.3816	0.9277
0.601	0.00	3.04	0.9875	0.9286	0.0660	-0.1171	0.1479	0.8994	1.5080	-0.2066	0.5549	1.6767
0.601	-0.01	3.96	0.9867	0.9502	0.0671	-0.1048	0.1035	0.9297	2.2212	-0.2324	0.6763	2.3891
0.600	-0.02	4.96	0.9871	0.9559	0.0623	-0.1270	0.3075	0.9405	2.9984	-0.4107	1.7011	3.1881
0.601	-0.02	6.01	0.9866	0.9654	0.0552	-0.0923	0.1744	0.9533	3.8372	-0.3757	1.6191	4.0253
0.600	-0.05	7.02	0.9861	0.9737	0.0427	-0.0868	0.1716	0.9636	4.6748	-0.2845	1.2118	4.8514



Table 11. Internal and Aeropropulsive Characteristics for Nozzle 8

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	0.07	1.51	1.0286	0.8707	0.8700	-2.30	0.1184	-0.0048	0.0435	0.1361
0.000	0.11	2.01	0.9875	0.8719	0.8705	-3.25	0.2005	-0.0114	0.0770	0.2303
0.000	0.18	2.49	0.9858	0.9097	0.9077	-3.79	0.2910	-0.0193	0.1204	0.3206
0.000	0.23	2.98	0.9853	0.9330	0.9312	-3.52	0.3854	-0.0237	0.1458	0.4138
0.000	0.39	3.45	0.9865	0.9444	0.9384	-6.47	0.4751	-0.0539	0.3081	0.5064
0.000	0.37	3.97	0.9865	0.9570	0.9541	-4.49	0.5795	-0.0455	0.2727	0.6074
0.000	0.44	4.47	0.9856	0.9610	0.9577	-4.71	0.6767	-0.0557	0.3337	0.7066
0.000	0.57	4.98	0.9856	0.9613	0.9560	-6.04	0.7750	-0.0820	0.4744	0.8106
0.000	0.75	5.96	0.9858	0.9677	0.9600	-7.26	0.9707	-0.1236	0.6553	1.0112
0.000	0.66	6.97	0.9848	0.9708	0.9678	-4.52	1.1791	-0.0932	0.5279	1.2184

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.598	0.00	1.02	0.0000	0.0000	0.0544	-0.1309	0.1506	0.0000	-0.1027	-0.1309	0.1506	0.0086
0.598	0.00	1.50	1.0256	0.8176	0.0308	-0.1325	0.1306	0.7266	0.3871	-0.1514	0.2994	0.5328
0.599	-0.01	2.01	0.9844	0.8292	0.0403	-0.1349	0.0975	0.7758	0.7054	-0.1797	0.4057	0.9093
0.597	-0.03	3.02	0.9852	0.9021	0.0520	-0.1476	0.1774	0.8733	1.4721	-0.2466	0.7807	1.6857
0.597	-0.02	3.99	0.9844	0.9314	0.0606	-0.1642	0.2548	0.9115	2.2294	-0.3490	1.3582	2.4459
0.599	-0.02	4.97	0.9856	0.9386	0.0565	-0.1926	0.4718	0.9235	2.9729	-0.5187	2.3530	3.2190
0.599	-0.02	5.98	0.9844	0.9482	0.0531	-0.1289	0.4238	0.9361	3.7698	-0.6243	3.0448	4.0269
0.599	-0.04	6.99	0.9846	0.9596	0.0418	-0.0943	0.2515	0.9496	4.6266	-0.4665	2.3441	4.8719
0.797	0.01	1.03	0.0000	0.0000	0.0655	-0.1316	0.1359	0.0000	-0.1119	-0.1316	0.1359	0.0057
0.798	0.00	1.98	0.9854	0.7886	0.0419	-0.1289	0.0921	0.6956	0.3473	-0.1532	0.2608	0.4993
0.798	-0.01	2.98	0.9847	0.8817	0.0467	-0.1465	0.1625	0.8317	0.7727	-0.1999	0.4903	0.9291
0.799	-0.01	5.02	0.9850	0.9311	0.0466	-0.1695	0.4001	0.9057	1.6555	-0.3561	1.4769	1.8278
0.799	-0.06	6.97	0.9846	0.9541	0.0380	-0.1053	0.2473	0.9371	2.5559	-0.3165	1.4286	2.7274
1.200	-0.03	0.92	0.0000	0.0000	0.2137	-0.0982	0.3499	0.0000	-0.2571	-0.0982	0.3499	0.0040
1.201	0.02	1.51	0.9998	-0.3263	0.1598	-0.0297	0.0465	-0.6579	-0.0860	-0.0345	0.0890	0.1308
1.199	-0.01	1.98	0.9789	0.0764	0.1764	-0.0998	0.3636	-0.1209	-0.0266	-0.1106	0.4384	0.2200
1.199	-0.02	3.92	0.9860	0.6570	0.1765	-0.1292	0.5338	0.5840	0.3474	-0.1737	0.7992	0.5948
1.200	-0.01	6.06	0.9849	0.8151	0.1499	-0.0278	0.1468	0.7726	0.7897	-0.1546	0.7844	1.0221
1.200	-0.02	7.98	0.9850	0.8730	0.1391	-0.0309	-0.1990	0.8424	1.1956	-0.0316	0.1973	1.4193
1.200	0.00	9.92	0.9849	0.9020	0.1284	0.1015	-0.5902	0.8783	1.6075	0.0977	-0.4386	1.8303
1.199	0.01	11.96	0.9847	0.9174	0.1198	0.1520	-0.9087	0.8983	2.0397	0.2099	-1.0136	2.2707
0.950	0.00	1.06	0.0000	0.0000	0.0855	-0.1318	0.2218	0.0000	-0.1309	-0.1318	0.2218	0.0048
0.949	0.00	2.00	0.9874	0.7185	0.0552	-0.1308	0.1956	0.5932	0.2149	-0.1485	0.3180	0.3623
0.951	-0.03	3.03	0.9862	0.8305	0.0680	-0.1462	0.2702	0.7627	0.5102	-0.1856	0.5101	0.6689
0.950	-0.02	5.06	0.9854	0.9068	0.0645	-0.1565	0.4358	0.8721	1.1400	-0.2911	1.2109	1.3072
0.950	-0.04	6.98	0.9852	0.9376	0.0581	-0.1299	0.4475	0.9141	1.7672	-0.2778	1.2788	1.9333
0.949	-0.02	8.94	0.9845	0.9577	0.0385	-0.0406	-0.1046	0.9402	2.4387	-0.0947	0.3357	2.5938
0.902	-0.01	1.05	0.0000	0.0000	0.0672	-0.1340	0.1305	0.0000	-0.1130	-0.1340	0.1305	0.0050
0.900	-0.01	1.54	1.0124	0.7205	0.0388	-0.1250	0.1017	0.5333	0.1305	-0.1342	0.1801	0.2448
0.902	0.01	2.03	0.9868	0.7722	0.0408	-0.1336	0.1217	0.6609	0.2719	-0.1539	0.2611	0.4114
0.901	-0.03	3.00	0.9864	0.8643	0.0492	-0.1489	0.1834	0.8021	0.5903	-0.1918	0.4447	0.7360
0.902	-0.01	4.01	0.9858	0.9062	0.0527	-0.1645	0.3120	0.8638	0.9333	-0.2462	0.8001	1.0805
0.902	-0.01	5.03	0.9848	0.9226	0.0493	-0.1612	0.3674	0.8908	1.2820	-0.3086	1.2178	1.4392
0.899	-0.04	7.00	0.9857	0.9484	0.0407	-0.1141	0.2855	0.9273	2.0129	-0.2786	1.2112	2.1707
0.897	-0.01	8.99	0.9845	0.9650	0.0221	-0.0089	-0.3089	0.9493	2.7706	-0.0664	0.1729	2.9184

Table 12. Internal and Aeropropulsive Characteristics for Nozzle 9

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	0.01	1.53	1.0076	0.9656	0.9644	-2.94	0.1291	-0.0066	0.0347	0.1338
0.000	-0.01	2.02	0.9734	0.9740	0.9730	-2.53	0.2165	-0.0096	0.0426	0.2225
0.000	0.02	2.53	0.9745	0.9856	0.9849	-2.25	0.3091	-0.0121	0.0535	0.3138
0.000	0.00	3.01	0.9737	0.9867	0.9862	-1.75	0.3968	-0.0121	0.0484	0.4024
0.000	0.01	3.47	0.9756	0.9835	0.9822	-2.92	0.4809	-0.0245	0.1184	0.4897
0.000	0.01	3.97	0.9755	0.9802	0.9761	-5.25	0.5710	-0.0525	0.2633	0.5850
0.000	0.00	4.47	0.9756	0.9801	0.9749	-5.88	0.6626	-0.0682	0.3559	0.6797
0.000	0.00	4.97	0.9759	0.9784	0.9745	-5.12	0.7573	-0.0678	0.3661	0.7771
0.000	-0.04	6.04	0.9779	0.9777	0.9768	-2.36	0.9665	-0.0398	0.2438	0.9894
0.000	-0.02	6.96	0.9781	0.9780	0.9780	-0.03	1.1478	-0.0006	0.0696	1.1736

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.600	0.01	1.01	0.0000	0.0000	0.0559	-0.1773	0.3307	0.0000	-0.1038	-0.1773	0.3307	0.0085
0.598	0.02	1.52	1.0010	0.9112	0.0325	-0.1051	-0.0117	0.8188	0.4262	-0.1310	0.1260	0.5206
0.599	0.02	2.02	0.9717	0.9308	0.0386	-0.1105	0.0268	0.8760	0.7711	-0.1484	0.1958	0.8802
0.562	0.00	3.02	0.9733	0.9602	0.0482	-0.1287	0.0428	0.9334	1.7056	-0.1853	0.2726	1.8273
0.599	0.01	4.04	0.9729	0.9555	0.0533	-0.1427	0.2049	0.9351	2.2161	-0.3545	1.2790	2.3699
0.599	-0.01	4.96	0.9748	0.9602	0.0466	-0.1116	0.0905	0.9445	2.9108	-0.3816	1.5438	3.0817
0.599	-0.02	5.98	0.9749	0.9677	0.0489	-0.0938	0.0143	0.9552	3.7035	-0.2624	1.0110	3.8772
0.600	-0.01	7.03	0.9756	0.9726	0.0359	-0.0680	-0.1421	0.9624	4.5321	-0.0587	0.0795	4.7093
1.201	-0.02	0.88	0.0000	0.0000	0.2341	-0.1782	0.6837	0.0000	-0.2771	-0.1782	0.6837	0.0040
1.200	-0.02	1.51	0.9955	-0.4843	0.1837	-0.0793	0.2273	-0.8284	-0.1037	-0.0857	0.2613	0.1252
1.199	0.00	2.00	0.9692	0.0928	0.1912	-0.0977	0.3061	-0.1066	-0.0231	-0.1071	0.3480	0.2163
1.200	0.02	3.95	0.9729	0.6605	0.1830	-0.0909	0.2843	0.5855	0.3366	-0.1418	0.5407	0.5749
1.199	0.02	5.98	0.9741	0.8051	0.1704	-0.0285	-0.0081	0.7605	0.7363	-0.0700	0.2407	0.9682
1.201	0.00	8.04	0.9735	0.8544	0.1740	-0.0002	-0.1704	0.8229	1.1293	0.0450	-0.3049	1.3724
1.200	0.00	9.98	0.9749	0.8715	0.1834	0.0556	-0.4803	0.8471	1.5005	0.1829	-0.9792	1.7713
1.206	0.05	11.04	0.9752	0.8840	0.1729	0.0813	-0.6770	0.8621	1.6992	0.2533	-1.3681	1.9711
0.953	-0.01	1.07	0.0000	0.0000	0.0914	-0.1764	0.3235	0.0000	-0.1365	-0.1764	0.3235	0.0047
0.951	0.01	2.00	0.9747	0.7794	0.0661	-0.1291	0.0980	0.6483	0.2233	-0.1439	0.1645	0.3444
0.950	0.03	2.97	0.9754	0.8678	0.0734	-0.1394	0.1520	0.7959	0.4995	-0.1560	0.2167	0.6277
0.950	-0.01	5.01	0.9740	0.9185	0.0719	-0.1410	0.2378	0.8821	1.0943	-0.2469	0.8101	1.2406
0.950	-0.02	7.00	0.9755	0.9438	0.0683	-0.1302	0.1773	0.9195	1.7136	-0.1290	0.2754	1.8636
0.951	0.01	9.01	0.9753	0.9505	0.0668	-0.0888	-0.1525	0.9325	2.3361	0.0487	-0.6565	2.5052
0.903	0.01	1.04	0.0000	0.0000	0.0684	-0.1938	0.3407	0.0000	-0.1140	-0.1938	0.3407	0.0050
0.899	0.01	1.50	0.9700	0.7869	0.0482	-0.1132	-0.0065	0.5755	0.1241	-0.1245	0.0539	0.2156
0.900	0.02	2.01	0.9770	0.8546	0.0446	-0.1226	0.0440	0.7375	0.2870	-0.1392	0.1186	0.3892
0.900	-0.01	3.00	0.9745	0.9149	0.0500	-0.1244	0.0455	0.8505	0.6023	-0.1454	0.1281	0.7082
0.900	-0.02	4.00	0.9737	0.9353	0.0438	-0.1113	-0.0009	0.8913	0.9253	-0.2058	0.4728	1.0381
0.901	0.00	5.02	0.9737	0.9416	0.0488	-0.1197	0.1026	0.9086	1.2565	-0.2369	0.7371	1.3829
0.901	-0.03	6.98	0.9753	0.9586	0.0455	-0.0981	-0.0134	0.9366	1.9361	-0.0983	0.0999	2.0673
0.902	0.01	9.00	0.9759	0.9596	0.0473	-0.0590	-0.3218	0.9433	2.6308	0.0938	-0.8810	2.7890
0.801	0.01	1.03	0.0000	0.0000	0.0667	-0.1821	0.3405	0.0000	-0.1132	-0.1821	0.3405	0.0057
0.800	0.01	1.99	0.9755	0.8774	0.0448	-0.1121	0.0275	0.7810	0.3763	-0.1329	0.1209	0.4819
0.801	-0.01	2.99	0.9760	0.9303	0.0479	-0.1157	0.0523	0.8783	0.7845	-0.1414	0.1533	0.8933
0.801	0.00	5.01	0.9742	0.9500	0.0460	-0.1025	0.0701	0.9234	1.6142	-0.2512	0.8749	1.7481
0.803	-0.02	6.98	0.9759	0.9642	0.0410	-0.0737	-0.0864	0.9464	2.4689	-0.0732	0.0567	2.6086

Table 13. Internal and Aeropropulsive Characteristics for Nozzle 10

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	0.08	1.50	1.0334	0.9059	0.9029	-4.65	0.1197	-0.0097	0.0501	0.1326
0.000	0.11	2.01	0.9880	0.9330	0.9319	-2.78	0.2143	-0.0104	0.0475	0.2300
0.000	0.15	2.51	0.9875	0.9619	0.9610	-2.46	0.3116	-0.0134	0.0601	0.3242
0.000	0.21	3.02	0.9869	0.9729	0.9712	-3.36	0.4107	-0.0241	0.1039	0.4229
0.000	0.14	3.50	0.9878	0.9805	0.9805	-0.41	0.5074	-0.0036	0.0051	0.5175
0.000	0.25	3.99	0.9880	0.9784	0.9773	-2.69	0.6000	-0.0282	0.1204	0.6140
0.000	0.38	4.49	0.9870	0.9773	0.9746	-4.26	0.6945	-0.0518	0.2443	0.7126
0.000	0.46	4.99	0.9867	0.9766	0.9732	-4.78	0.7931	-0.0663	0.3290	0.8149
0.000	0.57	6.03	0.9877	0.9769	0.9738	-4.53	1.0014	-0.0793	0.4154	1.0282
0.000	0.47	7.02	0.9859	0.9804	0.9797	-2.21	1.2084	-0.0466	0.2899	1.2335

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
1.199	-0.01	0.78	0.0000	0.0000	0.2939	-0.1287	0.4296	0.0000	-0.3372	-0.1287	0.4296	0.0040
1.201	-0.01	1.51	1.0111	-0.6501	0.2070	-0.0462	0.1309	-0.9787	-0.1290	-0.0558	0.1804	0.1318
1.199	0.00	1.99	0.9754	-0.0920	0.2298	-0.0889	0.2825	-0.2874	-0.0638	-0.0992	0.3298	0.2220
1.199	-0.03	3.99	0.9862	0.6063	0.2270	-0.1072	0.3998	0.5351	0.3259	-0.1355	0.5195	0.6091
1.200	-0.01	5.99	0.9844	0.7791	0.1993	-0.0416	0.1226	0.7360	0.7421	-0.1199	0.5312	1.0082
1.200	-0.02	8.00	0.9860	0.8494	0.1875	-0.0432	-0.2724	0.8189	1.1694	0.0283	-0.1065	1.4280
1.199	0.00	10.00	0.9851	0.8784	0.1880	-0.1384	-0.7286	0.8549	1.5826	0.1890	-0.8130	1.8512
1.200	0.01	12.00	0.9855	0.8951	0.1839	-0.2049	-1.0636	0.8760	1.9952	0.3209	-1.3972	2.2776
0.951	-0.01	1.00	0.0000	0.0000	0.1549	0.0355	-0.4024	0.0000	-0.2003	0.0355	-0.4024	0.0047
0.952	-0.02	1.97	0.9848	0.5792	0.1245	-0.0736	-0.0631	0.4501	0.1581	-0.0901	0.1382	0.3514
0.950	0.01	3.01	0.9876	0.7740	0.1308	-0.0906	0.1129	0.7058	0.4701	-0.1286	0.2770	0.6661
0.952	-0.01	4.99	0.9858	0.8722	0.1309	-0.1259	0.3231	0.8369	1.0752	-0.2308	0.8427	1.2848
0.951	-0.02	7.01	0.9864	0.9184	0.1181	-0.0967	0.1938	0.8951	1.7421	-0.1719	0.6545	1.9463
0.951	-0.04	9.00	0.9856	0.9385	0.1101	-0.0116	-0.3590	0.9211	2.4018	0.0389	-0.2944	2.6075
0.899	5.97	0.99	0.0000	0.0000	0.1246	-0.0230	-0.1043	0.0000	-0.1705	-0.0230	-0.1043	0.0050
0.901	5.98	1.99	0.9878	0.7277	0.0808	-0.0662	0.0579	0.6124	0.2434	-0.0457	0.1417	0.3974
0.899	6.00	2.97	0.9870	0.8574	0.0831	-0.0715	0.0500	0.7947	0.5812	-0.0393	0.2322	0.7313
0.901	5.99	5.00	0.9864	0.9265	0.0721	-0.0974	0.2068	0.8946	1.2850	-0.0679	0.7880	1.4363
0.901	5.97	7.01	0.9865	0.9458	0.0691	-0.0903	0.2323	0.9247	2.0054	0.0481	0.7459	2.1687
0.903	5.99	9.02	0.9858	0.9476	0.0764	-0.0349	-0.4009	0.9318	2.7044	0.3649	-0.3335	2.9022
0.903	-0.02	1.02	0.0000	0.0000	0.1039	-0.0603	-0.1003	0.0000	-0.1497	-0.0603	-0.1063	0.0050
0.897	-0.01	1.50	1.0212	0.6405	0.0641	-0.0669	-0.0731	0.4455	0.1048	-0.0842	0.0159	0.2352
0.900	0.00	2.00	0.9881	0.7467	0.0744	-0.0970	0.0273	0.6329	0.2549	-0.1153	0.1112	0.4028
0.902	-0.03	3.01	0.9882	0.8602	0.0810	-0.0950	0.0143	0.7982	0.5903	-0.1377	0.0954	0.7395
0.901	-0.03	3.99	0.9864	0.9090	0.0753	-0.0568	-0.1602	0.8665	0.9348	-0.1070	0.1517	1.0788
0.901	-0.04	7.01	0.9867	0.9465	0.0697	-0.1134	0.1902	0.9254	2.0039	-0.1976	0.7037	2.1656
0.899	0.00	9.01	0.9861	0.9611	0.0558	0.0104	-0.4241	0.9454	2.7631	0.0434	-0.3539	2.9226
0.902	-6.00	1.02	0.0000	0.0000	0.1454	-0.2091	-0.3111	0.0000	-0.1912	-0.2091	0.3111	0.0050
0.899	-6.00	1.98	0.9868	0.6819	0.0951	-0.1304	-0.0345	0.5661	0.2242	-0.1872	0.0498	0.3960
0.895	-6.00	2.97	0.9864	0.8207	0.1020	-0.1357	-0.0101	0.7584	0.5581	-0.2527	0.1736	0.7359
0.901	-6.01	5.00	0.9865	0.8923	0.0963	-0.1445	0.0789	0.8603	1.2333	-0.4067	0.6582	1.4335
0.902	-6.02	7.01	0.9865	0.9258	0.0945	-0.1485	0.1581	0.9045	1.9528	-0.4525	0.6713	2.1589
0.902	-6.00	8.99	0.9857	0.9521	0.0703	-0.0231	-0.4451	0.9363	2.7099	-0.2883	-0.3712	2.8944
0.800	-0.03	1.03	0.0000	0.0000	0.0735	-0.1519	0.1898	0.0000	-0.1202	-0.1519	0.1898	0.0057
0.800	0.01	1.97	0.9863	0.8406	0.0455	-0.0914	-0.0269	0.7466	0.3713	-0.1144	0.0794	0.4972
0.801	-0.01	2.99	0.9877	0.9223	0.0444	-0.0836	-0.0799	0.8721	0.8117	-0.1372	0.1505	0.9308
0.801	0.00	5.01	0.9876	0.9496	0.0413	-0.1005	0.0453	0.9240	1.6871	-0.2488	0.7818	1.8258
0.801	-0.02	7.01	0.9863	0.9639	0.0419	-0.1069	0.1527	0.9469	2.5962	-0.2126	0.8016	2.7418
0.602	5.99	1.02	0.0000	0.0000	0.0593	-0.1225	0.2415	0.0000	-0.1083	-0.1225	0.2415	0.0084
0.601	6.00	1.99	0.9862	0.8843	0.0430	-0.0494	-0.0517	0.8296	0.7411	-0.0031	0.1367	0.8934
0.600	6.00	2.99	0.9875	0.9453	0.0423	-0.0404	-0.0800	0.9158	1.5173	0.0329	0.3302	1.6569
0.601	5.99	4.99	0.9878	0.9659	0.0305	-0.0646	0.0647	0.9507	3.0682	0.0022	1.3652	3.2271
0.600	5.96	7.01	0.9859	0.9719	0.0313	-0.0573	0.1181	0.9618	4.6906	0.2521	1.2780	4.8767
0.601	-0.03	1.01	0.0000	0.0000	0.0703	-0.1401	0.1791	0.0000	-0.1191	-0.1401	0.1791	0.0084
0.600	0.01	1.51	1.0314	0.8526	0.0270	-0.0748	-0.0620	0.7611	0.4064	-0.1132	0.1364	0.5339
0.600	0.02	1.99	0.9881	0.8866	0.0399	-0.0837	-0.0386	0.8321	0.7452	-0.1245	0.1500	0.8957
0.599	0.01	2.99	0.9876	0.9450	0.0414	-0.0819	-0.0746	0.9156	1.5186	-0.1771	0.3368	1.6586
0.601	-0.02	4.01	0.9870	0.9608	0.0426	-0.0571	-0.1838	0.9408	2.2980	-0.1699	0.2940	2.4426
0.599	-0.02	4.99	0.9884	0.9608	0.0350	-0.0994	0.0634	0.9457	3.0654	-0.3634	1.3673	3.2412
0.600	-0.03	5.99	0.9869	0.9655	0.0355	-0.0699	-0.0064	0.9534	3.8530	-0.3843	1.6274	4.0412
0.601	-0.05	7.00	0.9863	0.9716	0.0366	-0.0919	0.1261	0.9615	4.6770	-0.2835	1.2863	4.8641
0.601	-6.01	1.00	0.0000	0.0000	0.1210	-0.1873	0.2114	0.0000	-0.1698	-0.1873	0.2114	0.0084
0.600	-6.00	1.98	0.9879	0.8375	0.0745	-0.1339	-0.0113	0.7828	0.6982	-0.2616	0.1778	0.8919
0.599	-6.02	2.99	0.9877	0.9152	0.0720	-0.1309	-0.0106	0.8858	1.4705	-0.3946	0.4009	1.6601
0.600	-6.00	5.02	0.9881	0.9387	0.0622	-0.1361	0.0647	0.9237	3.0087	-0.7298	1.3779	3.2570
0.601	-6.03	7.00	0.9864	0.9565	0.0638	-0.1181	0.0779	0.9465	4.6091	-0.8052	1.2381	4.8696

Table 14. Internal and Aeropropulsive Characteristics for Nozzle 11

## (a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	-0.01	1.50	1.0267	0.9141	0.9107	-4.90	0.1209	-0.0104	0.0603	0.1328
0.000	0.02	1.98	0.9829	0.9378	0.9363	-3.17	0.2079	-0.0115	0.0602	0.2220
0.000	0.02	2.46	0.9834	0.9682	0.9673	-2.52	0.3034	-0.0134	0.0655	0.3137
0.000	0.02	2.99	0.9842	0.9772	0.9754	-3.44	0.4049	-0.0243	0.1329	0.4151
0.000	-0.02	3.48	0.9850	0.9872	0.9871	-0.74	0.5043	-0.0065	0.0176	0.5109
0.000	0.01	3.96	0.9851	0.9830	0.9820	-2.51	0.5947	-0.0261	0.1418	0.6056
0.000	0.00	4.48	0.9852	0.9811	0.9784	-4.29	0.6934	-0.0520	0.3045	0.7087
0.000	-0.01	4.98	0.9847	0.9804	0.9767	-4.95	0.7905	-0.0684	0.4047	0.8094
0.000	-0.01	5.98	0.9858	0.9796	0.9765	-4.54	0.9902	-0.0787	0.4866	1.0140
0.000	-0.04	6.98	0.9847	0.9810	0.9802	-2.36	1.1961	-0.0493	0.3578	1.2203

## (b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
1.200	0.00	0.94	0.0000	0.0000	0.1731	-0.0940	0.3468	0.0000	-0.2161	-0.0940	0.3468	0.0040
1.200	0.03	1.50	1.0034	-0.1111	0.1338	-0.0456	0.1228	-0.4472	-0.0574	-0.0559	0.1826	0.1283
1.199	0.00	2.04	0.9720	0.2917	0.1516	-0.0893	0.3643	0.1045	0.0241	-0.1009	0.4241	0.2305
1.200	-0.02	4.01	0.9811	0.7342	0.1528	-0.1318	0.6226	0.6631	0.4025	-0.1580	0.7637	0.6069
1.201	-0.04	6.06	0.9812	0.8537	0.1298	-0.0379	0.1065	0.8112	0.8244	-0.1142	0.5779	1.0163
1.201	-0.02	7.99	0.9821	0.8999	0.1175	0.0128	-0.2451	0.8694	1.2313	-0.0071	-0.0204	1.4162
1.201	0.01	10.01	0.9821	0.9176	0.1142	0.0928	-0.8034	0.8942	1.6460	0.1324	-0.8364	1.8407
1.200	0.01	10.17	0.9824	0.9178	0.1151	0.0939	-0.8483	0.8947	1.6794	0.1383	-0.9016	1.8770
1.201	-6.04	0.86	0.0000	0.0000	0.2450	-0.2150	0.8951	0.0000	-0.2882	-0.2150	0.8951	0.0040
0.943	-0.01	1.06	0.0000	0.0000	0.0733	-0.1492	0.1855	0.0000	-0.1185	-0.1492	0.1855	0.0047
0.948	-0.02	2.03	0.9824	0.7925	0.0538	-0.1360	0.1929	0.6696	0.2464	-0.1547	0.2887	0.3680
0.948	0.02	3.02	0.9822	0.8865	0.0610	-0.1315	0.1582	0.8188	0.5472	-0.1700	0.3699	0.6682
0.947	-0.02	4.98	0.9820	0.9327	0.0601	-0.1502	0.3330	0.8975	1.1548	-0.2596	0.9781	1.2866
0.944	-0.04	6.93	0.9827	0.9538	0.0548	-0.1443	0.2959	0.9304	1.7999	-0.2273	0.8796	1.9345
0.948	0.01	8.98	0.9829	0.9701	0.0283	-0.0316	-0.5096	0.9527	2.4802	-0.0165	-0.3507	2.6033
0.897	6.01	1.04	0.0000	0.0000	0.0672	-0.1037	0.1578	0.0000	-0.1128	-0.1037	0.1578	0.0050
0.897	6.00	2.02	0.9844	0.8108	0.0518	-0.0825	0.0732	0.6998	0.2876	-0.0628	0.1800	0.4110
0.899	6.00	3.03	0.9848	0.8984	0.0579	-0.0751	0.0086	0.8373	0.6249	-0.0419	0.2442	0.7463
0.908	5.99	5.05	0.9828	0.9459	0.0508	-0.1033	0.2665	0.9139	1.3005	-0.0771	0.9772	1.4231
0.897	5.97	6.98	0.9837	0.9587	0.0462	-0.0664	0.0999	0.9377	2.0301	0.0679	0.7327	2.1651
0.900	6.03	8.98	0.9825	0.9604	0.0431	0.0587	-0.8436	0.9446	2.7330	0.3736	-0.6687	2.8931
0.898	-0.03	1.05	0.0000	0.0000	0.0676	-0.1509	0.1928	0.0000	-0.1132	-0.1509	0.1928	0.0050
0.900	-0.01	1.51	1.0098	0.7296	0.0455	-0.1193	0.0679	0.5356	0.1259	-0.1377	0.1742	0.2350
0.900	-0.02	2.06	0.9835	0.8112	0.0534	-0.1389	0.1737	0.7023	0.2940	-0.1597	0.2799	0.4186
0.902	-0.03	3.06	0.9830	0.8962	0.0611	-0.1313	0.1234	0.8356	0.6279	-0.1746	0.3581	0.7514
0.901	0.02	4.03	0.9829	0.9336	0.0550	-0.1133	0.0040	0.8917	0.9700	-0.1591	0.2548	1.0878
0.900	-0.01	4.98	0.9817	0.9360	0.0622	-0.1522	0.3168	0.9039	1.2856	-0.2729	1.0302	1.4223
0.900	-0.04	6.98	0.9829	0.9576	0.0522	-0.1334	0.2241	0.9364	2.0104	-0.2217	0.8531	2.1470
0.900	0.00	9.02	0.9820	0.9708	0.0318	-0.0098	-0.6868	0.9551	2.7696	0.0090	-0.5199	2.8999
0.899	-6.03	1.02	0.0000	0.0000	0.1258	-0.2374	0.4638	0.0000	-0.1714	-0.2374	0.4638	0.0050
0.898	-6.00	2.03	0.9819	0.6896	0.0982	-0.2182	0.3875	0.5784	0.2373	-0.2790	0.4941	0.4103
0.900	-6.00	3.03	0.9827	0.8277	0.1032	-0.2162	0.3602	0.7665	0.5717	-0.3352	0.5954	0.7458
0.901	-6.01	5.05	0.9823	0.8945	0.1010	-0.2302	0.5317	0.8630	1.2472	-0.4993	1.2538	1.4452
0.900	-6.04	6.98	0.9824	0.9312	0.0894	-0.2034	0.3747	0.9099	1.9537	-0.5114	1.0033	2.1471
0.901	-6.00	9.04	0.9824	0.9597	0.0492	-0.0629	-0.5977	0.9439	2.7377	-0.3412	-0.4352	2.9003
0.800	-0.02	1.03	0.0000	0.0000	0.0719	-0.1488	0.2240	0.0000	-0.1184	-0.1488	0.2240	0.0057
0.801	0.02	2.04	0.9834	0.8316	0.0557	-0.1330	0.1734	0.7425	0.3876	-0.1588	0.3074	0.5220
0.799	-0.01	3.01	0.9828	0.9111	0.0617	-0.1252	0.1304	0.8614	0.8064	-0.1798	0.4284	0.9362
0.800	-0.01	5.01	0.9827	0.9430	0.0643	-0.1427	0.3219	0.9174	1.6669	-0.2966	1.2310	1.8169
0.799	-0.04	6.99	0.9827	0.9618	0.0557	-0.1105	0.1749	0.9448	2.5778	-0.2220	0.9704	2.7285
0.601	5.99	1.01	0.0000	0.0000	0.0781	-0.0989	0.2250	0.0000	-0.1268	-0.0989	0.2250	0.0084
0.601	6.00	2.04	0.9833	0.8697	0.0635	-0.0680	0.1041	0.8172	0.7560	-0.0231	0.3423	0.9251
0.600	6.01	3.05	0.9825	0.9370	0.0701	-0.0560	0.0239	0.9082	1.5317	0.0205	0.5526	1.6865
0.602	5.99	4.98	0.9836	0.9587	0.0718	-0.0852	0.2889	0.9435	3.0097	-0.0282	1.8854	3.1900
0.598	5.95	7.01	0.9830	0.9688	0.0583	-0.0256	0.0245	0.9589	4.6824	0.2795	1.4346	4.8833
0.598	-0.02	1.01	0.0000	0.0000	0.0722	-0.1479	0.2687	0.0000	-0.1207	-0.1479	0.2687	0.0084
0.599	0.02	1.53	1.0200	0.8199	0.0504	-0.1223	0.1768	0.7319	0.4037	-0.1639	0.4171	0.5515
0.599	0.01	2.03	0.9842	0.8716	0.0610	-0.1273	0.1971	0.8194	0.7610	-0.1735	0.4369	0.9288
0.600	0.00	3.04	0.9840	0.9342	0.0707	-0.1201	0.1308	0.9054	1.5238	-0.2168	0.6597	1.6831
0.601	-0.02	3.97	0.9840	0.9494	0.0803	-0.1286	0.1956	0.9292	2.2289	-0.2329	0.7568	2.3987
0.601	-0.02	4.97	0.9843	0.9533	0.0760	-0.1414	0.3644	0.9381	2.9890	-0.4104	1.9499	3.1861
0.601	-0.02	5.98	0.9838	0.9601	0.0736	-0.1020	0.2193	0.9480	3.7993	-0.4148	2.1461	4.0076
0.601	-0.05	7.01	0.9832	0.9690	0.0613	-0.0916	0.1437	0.9590	4.6365	-0.2875	1.5412	4.8348
0.600	-6.03	1.00	0.0000	0.0000	0.1394	-0.2467	0.5775	0.0000	-0.1878	-0.2467	0.5775	0.0084
0.600	-5.99	2.03	0.9844	0.8118	0.1064	-0.2168	0.4457	0.7594	0.7025	-0.3531	0.6842	0.9251
0.601	-5.99	3.06	0.9848	0.9011	0.1076	-0.2031	0.3561	0.8725	1.4790	-0.4717	0.8838	1.6951
0.600	-6.02	4.98	0.9847	0.9260	0.1168	-0.2248	0.5918	0.9109	2.9172	-0.8213	2.1896	3.2025
0.600	-6.05	7.00	0.9837	0.9517	0.0968	-0.1712	0.2787	0.9417	4.5696	-0.8651	1.6838	4.8526

Table 15. Internal and Aeropropulsive Characteristics for Nozzle 12

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	0.09	1.52	1.0193	0.9082	0.9051	-4.73	0.1223	-0.0101	0.0827	0.1351
0.000	0.12	2.03	0.9805	0.9328	0.9317	-2.67	0.2164	-0.0101	0.0936	0.2323
0.000	0.00	2.51	0.9796	0.9624	0.9616	-2.37	0.3101	-0.0129	0.1203	0.3225
0.000	0.01	2.98	0.9784	0.9714	0.9699	-3.16	0.3976	-0.0219	0.1868	0.4100
0.000	-0.03	3.46	0.9794	0.9796	0.9795	-0.82	0.4927	-0.0070	0.1156	0.5030
0.000	0.01	3.97	0.9792	0.9788	0.9781	-2.15	0.5904	-0.0222	0.2183	0.6036
0.000	0.00	4.48	0.9794	0.9772	0.9748	-4.05	0.6862	-0.0486	0.3790	0.7039
0.000	0.00	4.98	0.9789	0.9761	0.9729	-4.63	0.7833	-0.0634	0.4879	0.8051
0.000	-0.03	5.97	0.9792	0.9769	0.9738	-4.61	0.9788	-0.0789	0.5930	1.0051
0.000	-0.06	7.01	0.9789	0.9779	0.9768	-2.71	1.1922	-0.0565	0.5365	1.2206

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
1.200	0.03	0.92	0.0000	0.0000	0.2168	0.1677	-0.8208	0.0000	-0.2604	0.1677	-0.8208	0.0041
1.201	0.00	1.51	0.9973	-0.4381	0.1760	0.1695	-0.7809	-0.7767	-0.1001	0.1595	-0.6992	0.1289
1.199	0.05	2.01	0.9691	0.1281	0.1819	0.0805	-0.3215	-0.0672	-0.0150	0.0707	-0.2290	0.2236
1.198	-0.01	3.96	0.9762	0.6950	0.1697	0.0497	-0.0922	0.6218	0.3714	0.0284	0.1247	0.5972
1.199	-0.01	6.01	0.9778	0.8298	0.1467	0.1655	-0.6705	0.7864	0.7927	0.0879	-0.0833	1.0080
1.199	0.03	8.03	0.9775	0.8758	0.1455	0.2400	-1.1160	0.8450	1.1997	0.2060	-0.6374	1.4199
1.198	0.05	9.93	0.9769	0.8880	0.1599	0.3369	-1.6303	0.8640	1.5724	0.3442	-1.2530	1.8200
1.200	-0.01	12.00	0.9768	0.8887	0.1857	0.4389	-2.1120	0.8693	1.9599	0.4884	-1.8469	2.2545
0.951	0.01	1.06	0.0000	0.0000	0.0896	0.0681	-0.6519	0.0000	-0.1352	0.0681	-0.6519	0.0048
0.952	0.00	2.06	0.9787	0.7925	0.0528	-0.0068	-0.2169	0.6702	0.2501	-0.0227	-0.0684	0.3732
0.951	0.02	3.05	0.9787	0.8883	0.0562	-0.0227	-0.2540	0.8203	0.5502	-0.0357	0.0450	0.6708
0.949	0.00	5.07	0.9777	0.9349	0.0514	-0.0230	-0.0254	0.8998	1.1718	-0.1257	0.7626	1.3023
0.950	-0.04	6.93	0.9778	0.9560	0.0412	0.0257	-0.1896	0.9320	1.7740	-0.0678	0.6666	1.9034
0.952	-0.02	9.04	0.9773	0.9656	0.0300	0.1667	-1.0222	0.9480	2.4544	0.1449	-0.3482	2.5891
0.902	5.99	1.02	0.0000	0.0000	0.1232	0.0897	-0.6286	0.0000	-0.1692	0.0897	-0.6286	0.0051
0.900	6.03	2.09	0.9794	0.7623	0.0734	0.0492	-0.3781	0.6549	0.2809	0.0736	-0.2108	0.4290
0.902	6.03	3.10	0.9826	0.8727	0.0734	0.0550	-0.4136	0.8125	0.6217	0.0962	-0.0787	0.7651
0.901	6.02	5.05	0.9767	0.9311	0.0678	0.0240	-0.0858	0.8990	1.2916	0.0582	0.7849	1.4367
0.902	5.94	6.94	0.9782	0.9464	0.0649	0.1176	-0.4920	0.9247	1.9550	0.2302	0.4558	2.1142
0.901	5.99	8.98	0.9777	0.9471	0.0728	0.2754	-1.4461	0.9310	2.6717	0.5427	0.6880	2.6696
0.904	-0.01	1.04	0.0000	0.0000	0.0750	0.0599	-0.6593	0.0000	-0.1210	0.0599	-0.6593	0.0051
0.901	0.01	1.50	1.0025	0.7347	0.0432	0.0257	-0.4533	0.5343	0.1228	0.0080	-0.3081	0.2298
0.897	0.00	2.02	0.9795	0.8176	0.0468	-0.0124	-0.2638	0.7049	0.2881	-0.0304	-0.0980	0.4087
0.902	0.02	2.97	0.9801	0.9023	0.0483	-0.0085	-0.2980	0.8382	0.6025	-0.0451	0.0297	0.7188
0.900	0.03	4.03	0.9788	0.9384	0.0414	-0.0114	-0.2565	0.8960	0.9729	-0.0484	0.1319	1.0859
0.896	0.02	4.97	0.9779	0.9414	0.0474	-0.0334	-0.0387	0.9091	1.2967	-0.1434	0.8230	1.4263
0.901	-0.05	7.00	0.9781	0.9626	0.0320	0.0368	-0.2944	0.9411	2.0147	0.0652	0.6516	2.1409
0.900	-0.02	9.02	0.9775	0.9709	0.0174	0.1895	-1.1972	0.9550	2.7598	0.1647	-0.4417	2.8899
0.901	-6.00	1.04	0.0000	0.0000	0.0788	0.0151	-0.5809	0.0000	-0.1248	0.0151	-0.5809	0.0051
0.900	-5.99	2.03	0.9780	0.7983	0.0513	-0.0541	-0.2365	0.6853	0.2794	-0.1115	-0.0715	0.4076
0.900	-5.98	3.02	0.9787	0.8890	0.0534	-0.0491	-0.2762	0.8267	0.6111	-0.1607	0.0557	0.7392
0.900	-5.99	5.03	0.9776	0.9249	0.0518	-0.0823	-0.0097	0.8928	1.2792	-0.3403	0.8585	1.4328
0.898	-6.04	6.97	0.9785	0.9497	0.0364	-0.0164	-0.2240	0.9282	1.9901	-0.3380	0.7310	2.1440
0.901	-6.03	9.05	0.9777	0.9705	-0.0002	0.1414	-1.1440	0.9546	2.7610	-0.1781	-0.3933	2.8923
0.800	-0.02	1.03	0.0000	0.0000	0.0778	0.0606	-0.6094	0.0000	-0.1248	0.0606	-0.6094	0.0058
0.800	-0.01	2.00	0.9798	0.8432	0.0442	-0.0047	-0.2656	0.7499	0.3778	-0.0274	-0.0583	0.5038
0.800	0.01	3.02	0.9799	0.9184	0.0486	-0.0019	-0.2945	0.8681	0.8102	-0.0486	0.1249	0.9332
0.801	0.01	4.99	0.9773	0.9497	0.0457	-0.0308	-0.0389	0.9235	1.6558	-0.1704	1.0504	1.7929
0.798	-0.05	6.96	0.9781	0.9652	0.0332	0.0521	-0.2916	0.9479	2.5701	-0.0797	0.9189	2.7113
0.602	5.98	1.00	0.0000	0.0000	0.1151	0.0825	-0.4963	0.0000	-0.1642	0.0825	-0.4963	0.0086
0.600	6.02	2.02	0.9793	0.8542	0.0701	0.0583	-0.3646	0.8001	0.7261	0.1072	0.0054	0.9076
0.601	6.01	3.02	0.9792	0.9297	0.0686	0.0645	-0.3979	0.9001	1.4920	0.1503	0.3472	1.6576
0.601	5.98	4.99	0.9790	0.9572	0.0606	0.0245	-0.0768	0.9419	3.0061	0.1010	1.8595	3.1917
0.601	5.94	6.98	0.9779	0.9647	0.0610	0.1501	-0.4455	0.9545	4.5823	0.4107	1.6859	4.8010
0.600	-0.02	1.01	0.0000	0.0000	0.0713	0.0544	-0.5454	0.0000	-0.1204	0.0544	-0.5454	0.0086
0.601	0.02	1.54	1.0105	0.8425	0.0370	0.0022	-0.2735	0.7534	0.4152	-0.0377	0.0559	0.5510
0.600	0.02	2.07	0.9830	0.8889	0.0393	-0.0154	-0.2058	0.8373	0.7960	-0.0550	0.1683	0.9507
0.600	-0.01	3.02	0.9787	0.9442	0.0456	-0.0100	-0.2563	0.9146	1.5187	-0.0937	0.4911	1.6605
0.600	0.02	4.04	0.9778	0.9570	0.0506	-0.0562	0.0323	0.9369	2.2956	-0.1401	0.9083	2.4501
0.600	0.00	4.98	0.9788	0.9606	0.0419	-0.0399	0.0160	0.9451	3.0157	-0.2876	1.9473	3.1904
0.600	0.00	5.97	0.9788	0.9652	0.0359	0.0127	-0.0595	0.9529	3.7977	-0.2997	2.2925	3.9856
0.600	-0.06	7.00	0.9781	0.9713	0.0299	0.0702	-0.2641	0.9611	4.6459	-0.1606	1.8692	4.8339
0.600	-6.01	1.01	0.0000	0.0000	0.0753	-0.0025	-0.4508	0.0000	-0.1244	-0.0025	-0.4508	0.0086
0.600	-5.99	1.99	0.9787	0.8664	0.0497	-0.0662	-0.1707	0.8114	0.7238	-0.0928	0.1979	0.8921
0.600	-5.98	3.01	0.9783	0.9308	0.0508	-0.0627	-0.2008	0.9012	1.4923	-0.3134	0.5453	1.6560
0.601	-6.01	4.99	0.9793	0.9426	0.0545	-0.0976	0.0621	0.9273	2.9597	-0.6696	1.9970	3.1919
0.600	-6.04	7.00	0.9778	0.9612	0.0305	0.0046	-0.2125	0.9510	4.5840	-0.7157	1.9185	4.8202

Table 16. Internal and Aeropropulsive Characteristics for Nozzle 13

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTA P	CFJ	CFN	CMJ	CFI
0.000	0.06	1.49	1.0309	0.8560	0.8550	-2.72	0.1127	-0.0054	0.0435	0.1318
0.000	0.09	2.01	0.9874	0.9019	0.9015	-1.82	0.2077	-0.0066	0.0575	0.2304
0.000	0.14	2.49	0.9856	0.9371	0.9366	-2.02	0.3007	-0.0106	0.0855	0.3210
0.000	0.20	2.96	0.9850	0.9543	0.9534	-2.61	0.3918	-0.0178	0.1323	0.4109
0.000	0.25	3.46	0.9863	0.9670	0.9661	-2.46	0.4917	-0.0211	0.1644	0.5090
0.000	0.13	3.97	0.9864	0.9814	0.9813	0.65	0.5975	0.0068	0.0165	0.6089
0.000	0.12	4.46	0.9851	0.9860	0.9858	1.22	0.6971	0.0149	-0.0227	0.7072
0.000	0.31	4.99	0.9854	0.9809	0.9807	-1.22	0.7986	-0.0169	0.1764	0.8143
0.000	0.56	5.98	0.9852	0.9791	0.9774	-3.37	0.9922	-0.0583	0.4340	1.0152
0.000	0.73	6.99	0.9841	0.9777	0.9751	-4.18	1.1934	-0.0872	0.5955	1.2239

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.597	5.99	1.01	0.0000	0.0000	0.0869	0.0214	-0.2604	0.0000	-0.1353	0.0214	-0.2604	0.0085
0.600	6.01	2.03	0.9837	0.8159	0.0808	0.0479	-0.4050	0.7634	0.7046	0.1093	-0.1751	0.9230
0.600	6.02	3.04	0.9835	0.9152	0.0710	0.0306	-0.2872	0.8865	1.4962	0.1371	0.2043	1.6877
0.599	6.00	4.96	0.9846	0.9587	0.0636	-0.0212	0.0016	0.9436	3.0354	0.2445	0.6861	3.2168
0.599	5.98	7.04	0.9843	0.9668	0.0497	0.0731	-0.1390	0.9569	4.7024	0.2206	2.2642	4.9142
0.598	-0.03	1.01	0.0000	0.0000	0.0709	-0.0337	-0.1864	0.0000	-0.1194	-0.0337	-0.1864	0.0085
0.598	0.00	1.53	1.0178	0.7940	0.0379	-0.0143	-0.2186	0.7067	0.3930	-0.0362	-0.0407	0.5562
0.599	0.02	2.05	0.9873	0.8453	0.0553	-0.0201	-0.2557	0.7943	0.7547	-0.0465	-0.0219	0.9502
0.598	0.01	3.04	0.9844	0.9262	0.0536	-0.0391	-0.1494	0.8976	1.5225	-0.1026	0.3444	1.6962
0.598	-0.02	3.98	0.9835	0.9564	0.0682	-0.0022	-0.3499	0.9364	2.2785	0.0251	-0.2898	2.4332
0.598	0.01	4.97	0.9852	0.9648	0.0529	-0.0618	-0.0154	0.9498	3.0684	-0.1266	0.6736	3.2307
0.598	-0.02	5.98	0.9845	0.9658	0.0495	-0.0804	0.1737	0.9538	3.8657	-0.3148	1.9077	4.0529
0.598	-0.04	6.99	0.9838	0.9683	0.0342	-0.0026	0.0184	0.9584	4.6866	-0.3542	2.3990	4.8899
0.598	-6.02	1.00	0.0000	0.0000	0.0994	-0.1022	-0.0166	0.0000	-0.1480	-0.1022	-0.0166	0.0085
0.601	-5.98	2.02	0.9845	0.8134	0.0761	-0.0724	-0.1768	0.7604	0.6967	-0.1848	0.0518	0.9163
0.601	-5.98	3.05	0.9849	0.9034	0.0767	-0.0976	-0.0241	0.8747	1.4807	-0.3285	0.4607	1.6928
0.600	-5.99	4.99	0.9855	0.9508	0.0725	-0.1240	0.1317	0.9357	3.0168	-0.5205	0.8290	3.2239
0.601	-6.03	6.99	0.9846	0.9515	0.0492	-0.0531	0.0611	0.9415	4.5610	-0.8923	2.4170	4.8443
1.199	0.00	0.88	0.0000	0.0000	0.2171	0.0350	-0.2353	0.0000	-0.2604	0.0350	-0.2353	0.0040
1.202	0.03	1.49	1.0176	-0.4423	0.1683	0.1017	-0.5192	-0.7790	-0.1002	0.0964	-0.4762	0.1286
1.200	0.01	2.02	0.9768	0.1320	0.1770	0.0396	-0.2200	-0.0587	-0.0133	0.0331	-0.1628	0.2271
1.200	-0.01	4.01	0.9840	0.7007	0.1735	-0.0041	0.0418	0.6298	0.3850	0.0035	0.0533	0.6114
1.200	0.00	6.04	0.9839	0.8329	0.1483	0.0804	-0.3413	0.7904	0.8055	0.0198	0.1065	1.0191
1.200	0.00	8.02	0.9853	0.8789	0.1299	0.2099	-0.9224	0.8486	1.2143	0.0941	-0.1682	1.4309
1.199	0.00	9.99	0.9848	0.8986	0.1169	0.3742	-1.7036	0.8751	1.6184	0.2022	-0.6358	1.8493
1.199	-0.01	12.00	0.9842	0.9050	0.1126	0.5806	-2.6931	0.8859	2.0215	0.3513	-1.3052	2.2818
0.949	0.00	1.05	0.0000	0.0000	0.0949	-0.0191	-0.3248	0.0000	-0.1402	-0.0191	-0.3248	0.0047
0.954	0.00	2.03	0.9854	0.7168	0.0690	-0.0222	-0.2168	0.5936	0.2183	-0.0326	-0.1256	0.3678
0.952	0.00	3.01	0.9859	0.8454	0.0727	-0.0286	-0.2170	0.7771	0.5152	-0.0548	-0.0169	0.6630
0.950	0.03	5.03	0.9847	0.9327	0.0632	-0.0226	-0.2546	0.8978	1.1645	-0.0498	0.0324	1.2971
0.950	-0.01	6.97	0.9849	0.9473	0.0521	-0.0159	-0.0506	0.9239	1.7833	-0.1532	0.8858	1.9302
0.949	-0.03	8.98	0.9843	0.9617	0.0127	0.2037	-1.0268	0.9443	2.4660	-0.0267	0.4242	2.6114
0.898	6.00	1.03	0.0000	0.0000	1.0001	0.0164	-0.3698	0.0000	-0.1458	0.0164	-0.3698	0.0050
0.898	6.01	2.00	0.9867	0.7113	0.0763	0.0375	-0.4697	0.5985	0.2427	0.0641	-0.3682	0.4055
0.900	6.00	3.01	0.9856	0.8614	0.0691	0.0193	-0.3462	0.7999	0.5942	0.0646	-0.1236	0.7429
0.899	6.01	5.01	0.9846	0.9387	0.0573	-0.0398	0.0317	0.9071	1.3099	0.0782	0.3477	1.4442
0.900	5.98	6.98	0.9852	0.9519	0.0523	0.0663	-0.2767	0.9307	2.0071	0.1327	0.7706	2.1566
0.901	5.95	9.05	0.9849	0.9549	0.0434	0.3356	-1.4941	0.9392	2.7457	0.3726	0.1339	2.9234
0.901	-0.01	1.03	0.0000	0.0000	0.0774	-0.0298	-0.3042	0.0000	-0.1231	-0.0298	-0.3042	0.0050
0.900	0.03	1.53	1.0159	0.6918	0.0422	-0.0049	-0.3809	0.5053	0.1240	-0.0145	-0.3023	0.2453
0.901	0.01	2.06	0.9871	0.7818	0.0513	-0.0255	-0.3109	0.6730	0.2829	-0.0372	-0.2076	0.4203
0.901	-0.01	3.02	0.9856	0.8858	0.0522	-0.0335	-0.2668	0.8244	0.6131	-0.0622	-0.0467	0.7437
0.902	-0.01	4.05	0.9861	0.9306	0.0574	-0.0556	-0.1226	0.8890	0.9766	-0.0403	-0.1103	1.0986
0.899	-0.01	4.98	0.9845	0.9501	0.0455	-0.0501	-0.1520	0.9182	1.3168	-0.0796	0.1566	1.4341
0.898	-0.01	6.99	0.9851	0.9599	0.0308	-0.0094	-0.1131	0.9388	2.0364	-0.1643	0.9415	2.1692
0.900	-0.01	9.03	0.9842	0.9684	-0.0056	-0.2503	-1.2555	0.9527	2.7826	-0.0072	0.3707	2.9206
0.898	-6.01	1.01	0.0000	0.0000	0.0985	-0.0799	-0.1775	0.0000	-0.1442	-0.0799	-0.1775	0.0050
0.897	-6.00	2.02	0.9874	0.7369	0.0642	-0.0583	-0.2957	0.6253	0.2565	-0.1086	-0.1935	0.4103
0.896	-6.00	3.02	0.9863	0.8561	0.0677	-0.0864	-0.1397	0.7952	0.5983	-0.1904	0.0834	0.7524
0.903	-6.00	5.05	0.9852	0.9258	0.0685	-0.1429	0.1881	0.8942	1.2933	-0.3228	0.5125	1.4463
0.902	-6.03	6.99	0.9854	0.9413	0.0423	-0.0516	-0.0960	0.9200	1.9798	-0.4241	0.9502	2.1519
0.900	-6.03	9.04	0.9846	0.9586	-0.0209	0.2072	-1.2478	0.9430	2.7566	-0.3451	0.3799	2.9233
0.800	0.02	1.02	0.0000	0.0000	0.0763	-0.0276	-0.3051	0.0000	-0.1230	-0.0276	-0.2471	0.0057
0.802	-0.02	2.07	0.9885	0.8074	0.0511	-0.0145	-0.3051	0.7202	0.3851	-0.0296	-0.1743	0.5347
0.802	-0.01	3.01	0.9866	0.9000	0.0509	-0.0332	-0.1997	0.8501	0.7951	-0.0703	0.0819	0.9352
0.802	0.01	5.00	0.9854	0.9552	0.0464	-0.0598	-0.0238	0.9295	1.6848	-0.0976	0.3716	1.8126
0.800	0.00	6.97	0.9849	0.9617	0.0344	0.0006	-0.0835	0.9446	2.5761	-0.1934	1.2407	2.7272

Table 17. Internal and Aeropropulsive Characteristics for Nozzle 14

## (a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTA P	CFJ	CFN	CMJ	CFI
0.000	0.04	1.54	1.0200	0.8692	0.8670	-4.05	0.1217	-0.0086	0.0335	0.1404
0.000	0.07	1.96	0.9856	0.9072	0.9045	-4.45	0.1991	-0.0155	0.0599	0.2202
0.000	0.13	2.49	0.9853	0.9453	0.9407	-5.68	0.3017	-0.0300	0.1154	0.3208
0.000	0.18	2.97	0.9843	0.9633	0.9588	-5.52	0.3959	-0.0383	0.1499	0.4129
0.000	0.33	3.46	0.9859	0.9760	0.9647	-8.73	0.4909	-0.0754	0.2894	0.5089
0.000	0.39	3.96	0.9857	0.9833	0.9740	-7.90	0.5937	-0.0824	0.3135	0.6095
0.000	0.35	4.48	0.9852	0.9863	0.9826	-4.99	0.6993	-0.0610	0.2389	0.7117
0.000	0.28	5.00	0.9855	0.9883	0.9872	-2.74	0.8068	-0.0387	0.1421	0.8173
0.000	0.14	5.98	0.9853	0.9907	0.9907	0.05	1.0091	0.0008	-0.0462	1.0186
0.000	0.00	6.97	0.9850	0.9887	0.9882	1.95	1.2104	0.0411	-0.2360	1.2249

## (b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.597	5.97	1.04	0.0000	0.0000	0.0503	-0.1352	0.3392	0.0000	-0.0986	-0.1352	0.3392	0.0085
0.599	6.01	2.04	0.9852	0.8547	0.0532	-0.1305	0.3164	0.8032	0.7526	-0.1080	0.5750	0.9370
0.500	6.01	3.03	0.9841	0.9312	0.0575	-0.1106	0.2563	0.9026	1.5214	-0.1025	0.8896	1.6855
0.500	5.98	4.98	0.9849	0.9701	0.0582	-0.1550	0.4586	0.9552	3.0873	0.0222	1.0336	3.2321
0.500	6.00	7.02	0.9841	0.9712	0.0450	-0.0957	0.2382	0.9613	4.7158	0.5829	-0.7416	4.9054
0.502	-0.03	1.04	0.0000	0.0000	0.0615	-0.1448	0.2174	0.0000	-0.1097	-0.1448	0.2174	0.0084
0.599	0.01	1.53	1.0217	0.7872	0.0437	-0.1201	0.1481	0.6998	0.3866	-0.1537	0.2794	0.5525
0.500	0.00	2.03	0.9843	0.8487	0.0568	-0.1507	0.2485	0.7968	0.7416	-0.2172	0.5054	0.9307
0.500	-0.01	3.05	0.9845	0.9243	0.0621	-0.1317	0.1939	0.8959	1.5256	-0.2982	0.8413	1.7027
0.500	0.01	3.97	0.9844	0.9428	0.0789	-0.1911	0.4627	0.9229	2.2373	-0.5197	1.7135	2.4242
0.500	-0.01	4.97	0.9850	0.9660	0.0717	-0.1620	0.3763	0.9510	3.0633	-0.3201	0.9551	3.2211
0.500	-0.02	5.99	0.9844	0.9774	0.0535	-0.1371	0.2400	0.9654	3.9062	-0.1330	0.0463	4.0460
0.500	0.00	6.97	0.9842	0.9789	0.0508	-0.1206	0.1658	0.9690	4.7069	0.0430	-0.7748	4.8575
0.599	-6.03	1.03	0.0000	0.0000	0.1050	-0.1796	0.2061	0.0000	-0.1533	-0.1796	0.2061	0.0084
0.599	-5.99	2.01	0.9853	0.7957	0.0915	-0.1805	0.2269	0.7431	0.6830	-0.3326	0.4795	0.9191
0.599	-6.00	3.03	0.9857	0.8881	0.0943	-0.1683	0.1954	0.8595	1.4561	-0.5003	0.8320	1.6940
0.599	-6.03	4.97	0.9852	0.9474	0.0969	-0.1909	0.3358	0.9324	3.0120	-0.6844	0.9208	3.2301
0.599	-6.00	7.00	0.9839	0.9728	0.0738	-0.1517	0.1171	0.9630	4.7209	-0.4899	-0.8508	4.9024
1.117	-0.01	0.86	0.0000	0.0000	0.2917	-0.1712	0.6868	0.0000	-0.3346	-0.1712	0.6868	0.0040
1.199	0.00	1.52	1.0141	-0.8232	0.2292	-0.1237	0.5017	-1.1418	-0.1543	-0.1319	0.5340	0.1351
1.201	-0.01	2.03	0.9780	-0.1650	0.2481	-0.1621	0.6603	-0.3525	-0.0810	-0.1786	0.7240	0.2297
1.200	-0.04	3.99	0.9859	0.5701	0.2467	-0.1390	0.5745	0.4996	0.3052	-0.2225	0.8905	0.6109
1.200	-0.02	6.03	0.9849	0.7687	0.2259	-0.0962	0.3364	0.7264	0.7412	-0.0937	0.2814	1.0203
1.202	0.00	8.01	0.9858	0.8392	0.2084	-0.0898	0.2706	0.8090	1.1565	-0.0075	-0.1598	1.4295
1.199	0.01	9.98	0.9850	0.8734	0.1957	-0.0816	0.2139	0.8501	1.5760	0.0811	-0.5941	1.8539
1.200	0.01	12.01	0.9842	0.8923	0.1836	-0.0752	0.1679	0.8734	1.9977	0.1694	-1.0252	2.2872
0.951	-0.01	1.01	0.0000	0.0000	0.1493	-0.0079	-0.2379	0.0000	-0.1944	-0.0079	-0.2379	0.0047
0.952	0.00	2.01	0.9870	0.5616	0.1256	-0.0989	0.2323	0.4379	0.1597	-0.1249	0.3324	0.3646
0.953	-0.03	3.00	0.9867	0.7422	0.1423	-0.1238	0.3674	0.6742	0.4463	-0.1868	0.6120	0.6620
0.951	-0.03	5.03	0.9853	0.8831	0.1367	-0.1176	0.3008	0.8485	1.1038	-0.1772	0.5153	1.3009
0.949	0.02	6.97	0.9848	0.9245	0.1250	-0.1065	0.1366	0.9013	1.7513	-0.0404	-0.2396	1.9432
0.952	-0.01	9.01	0.9847	0.9378	0.1175	-0.1031	0.0870	0.9205	2.4038	0.0921	-0.9017	2.6113
0.902	5.98	1.03	0.0000	0.0000	0.1099	-0.0635	0.0632	0.0000	-0.1554	-0.0635	0.0632	0.0049
0.901	5.99	2.00	0.9867	0.7085	0.0807	-0.1289	0.3644	0.5958	0.2406	-0.1192	0.4750	0.4038
0.902	5.99	3.02	0.9864	0.8520	0.0825	-0.1445	0.4429	0.7909	0.5884	-0.1409	0.7208	0.7440
0.903	5.95	5.02	0.9853	0.9284	0.0853	-0.1634	0.5284	0.8968	1.2917	-0.0810	0.7675	1.4404
0.904	5.99	7.00	0.9856	0.9460	0.0711	-0.1361	0.3349	0.9249	1.9934	0.1596	-0.0883	2.1553
0.903	6.00	9.05	0.9850	0.9463	0.0662	-0.1274	0.2501	0.9308	2.7155	0.3910	-0.8625	2.9175
0.903	-0.02	1.05	0.0000	0.0000	0.0892	-0.0852	-0.0137	0.0000	-0.1347	-0.0852	-0.0137	0.0049
0.902	0.02	1.54	1.0160	0.6332	0.0588	-0.0849	0.0123	0.4502	0.1119	-0.1002	0.0720	0.2485
0.902	0.00	2.03	0.9865	0.7186	0.0777	-0.1520	0.2961	0.6080	0.2502	-0.1813	0.4094	0.4114
0.901	-0.01	3.01	0.9864	0.8463	0.0830	-0.1599	0.3359	0.7851	0.5835	-0.2309	0.6127	0.7433
0.902	-0.04	4.03	0.9860	0.8918	0.0900	-0.1890	0.5607	0.8502	0.9296	-0.3396	1.0910	1.0934
0.902	-0.02	5.01	0.9851	0.9261	0.0897	-0.1744	0.4289	0.8945	1.2892	-0.2413	0.6719	1.4411
0.899	0.00	7.01	0.9857	0.9547	0.0722	-0.1479	0.2241	0.9339	2.0378	-0.0720	-0.2084	2.1821
0.899	-0.01	9.05	0.9849	0.9601	0.0658	-0.1406	0.1479	0.9446	2.7799	0.0808	-0.9741	2.9429
0.900	-6.01	1.07	0.0000	0.0000	0.1358	-0.2158	0.3330	0.0000	-0.1813	-0.2158	0.3330	0.0050
0.899	-6.00	2.07	0.9853	0.6496	0.1065	-0.2091	0.3183	0.5433	0.2326	-0.2804	0.4372	0.4282
0.899	-5.99	3.07	0.9860	0.7975	0.1123	-0.2078	0.3333	0.7379	0.5641	-0.3594	0.6266	0.7644
0.899	-6.03	5.07	0.9852	0.8976	0.1189	-0.2530	0.5465	0.8667	1.2738	-0.4680	0.7718	1.4698
0.899	-6.02	6.95	0.9853	0.9430	0.0937	-0.2152	0.3082	0.9219	1.9905	-0.3680	-0.1028	2.1591
0.899	-6.00	9.03	0.9848	0.9563	0.0845	-0.1978	0.2038	0.9408	2.7614	-0.2799	-0.9114	2.9352
0.798	-0.02	1.06	0.0000	0.0000	0.0644	-0.1471	0.1897	0.0000	-0.1108	-0.1471	0.1897	0.0057
0.799	0.01	2.10	0.9894	0.8115	0.0535	-0.1623	0.2771	0.7278	0.4032	-0.2020	0.4308	0.5541
0.799	-0.02	3.06	0.9864	0.8965	0.0605	-0.1456	0.2284	0.8483	0.8184	-0.2404	0.5964	0.9647
0.801	-0.02	5.02	0.9863	0.9507	0.0670	-0.1863	0.4335	0.9255	1.6993	-0.2704	0.7375	1.8362
0.801	-0.02	6.98	0.9848	0.9701	0.0512	-0.1545	0.2182	0.9531	2.6002	-0.0631	-0.3111	2.7282

Table 18. Internal and Aeropropulsive Characteristics for Nozzle 15

## (a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	-0.02	1.55	1.0190	0.8094	0.8006	-8.49	0.1141	-0.0170	0.0821	0.1425
0.000	0.01	2.01	0.9886	0.8557	0.8519	-5.41	0.1962	-0.0186	0.0543	0.2303
0.000	-0.01	2.49	0.9862	0.8999	0.8961	-5.26	0.2890	-0.0266	0.0655	0.3225
0.000	0.00	2.96	0.9859	0.9257	0.9226	-4.68	0.3806	-0.0311	0.0633	0.4125
0.000	0.02	3.46	0.9877	0.9421	0.9390	-4.67	0.4786	-0.0391	0.0796	0.5097
0.000	0.02	3.96	0.9871	0.9514	0.9484	-4.54	0.5770	-0.0459	0.0915	0.6084
0.000	0.01	4.47	0.9869	0.9598	0.9551	-5.68	0.6800	-0.0676	0.1907	0.7120
0.000	-0.03	4.99	0.9870	0.9637	0.9613	-3.99	0.7862	-0.0548	0.1000	0.8178
0.000	0.01	5.97	0.9869	0.9652	0.9616	-4.96	0.9793	-0.0851	0.2313	1.0184
0.000	0.00	6.98	0.9871	0.9666	0.9592	-7.11	1.1804	-0.1472	0.5108	1.2307

## (b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.602	5.81	1.01	0.0000	0.0000	0.0711	-0.2667	0.7809	0.0000	-0.1195	-0.2667	0.7809	0.0084
0.600	5.82	2.00	0.9878	0.8113	0.0404	-0.1809	0.3986	0.7578	0.6865	-0.1759	0.6159	0.9059
0.601	5.85	3.03	0.9877	0.9037	0.0386	-0.1863	0.4445	0.8750	1.4742	-0.1539	0.7022	1.6848
0.601	5.82	5.03	0.9880	0.9512	0.0367	-0.1804	0.4387	0.9363	3.0571	-0.0835	0.8523	3.2650
0.601	5.80	6.97	0.9871	0.9602	0.0294	-0.2662	0.9943	0.9502	4.6102	-0.3709	2.9939	4.8516
0.601	-0.19	1.00	0.0000	0.0000	0.0887	-0.2632	0.6013	0.0000	-0.1372	-0.2632	0.6013	0.0084
0.601	-0.16	1.54	1.0219	0.7523	0.0258	-0.2070	0.4119	0.6659	0.3736	-0.2754	0.7377	0.5610
0.601	-0.18	1.98	0.9887	0.7992	0.0454	-0.2069	0.3531	0.7450	0.6662	-0.2826	0.5733	0.8941
0.601	-0.15	3.00	0.9876	0.8937	0.0475	-0.2166	0.4179	0.8645	1.4349	-0.3454	0.6719	1.6598
0.601	-0.20	3.99	0.9866	0.9294	0.0479	-0.1597	0.1070	0.9094	2.2106	-0.3513	0.4726	2.4307
0.601	-0.15	5.04	0.9880	0.9459	0.0468	-0.1935	0.3220	0.9311	3.0453	-0.4252	0.7403	3.2706
0.600	-0.19	6.01	0.9870	0.9484	0.0521	-0.2202	0.5199	0.9365	3.8089	-0.5785	1.4766	4.0673
0.601	-0.19	7.02	0.9870	0.9466	0.0594	-0.2566	0.8224	0.9367	4.5878	-0.8635	2.8803	4.8980
0.600	-6.19	0.98	0.0000	0.0000	0.1848	-0.3420	0.8163	0.0000	-0.2333	-0.3420	0.8163	0.0085
0.600	-6.18	2.00	0.9885	0.7101	0.1168	-0.3073	0.6692	0.6570	0.5991	-0.4643	0.8854	0.9119
0.601	-6.16	3.00	0.9869	0.8357	0.1233	-0.3159	0.7474	0.8066	1.3406	-0.6050	1.0019	1.6621
0.600	-6.20	5.03	0.9883	0.9137	0.1098	-0.2786	0.5614	0.9899	2.9448	-0.8399	0.9765	3.2759
0.599	-6.18	7.03	0.9872	0.9129	0.1349	-0.3682	1.1456	0.9031	4.4556	-1.4711	3.2256	4.9337
1.201	-0.19	0.75	0.0000	0.0000	0.2970	-0.2877	1.1642	0.0000	-0.3403	-0.2877	1.1642	0.0040
1.200	-0.18	1.54	1.0127	-0.5440	0.1873	-0.2147	0.8986	-0.8558	-0.1188	-0.2319	0.9806	1.3388
1.199	-0.19	2.02	0.9833	-0.1120	0.2233	-0.2569	1.0241	-0.2999	-0.0691	-0.2761	1.0771	0.2304
1.199	-0.20	3.99	0.9875	0.5881	0.2198	-0.2363	0.9361	0.5171	0.3157	-0.2844	1.0278	0.6104
1.199	-0.20	6.03	0.9872	0.7559	0.2100	-0.3115	1.3946	0.7136	0.7310	-0.4030	1.6413	1.0243
1.200	-0.20	7.99	0.9882	0.8320	0.1752	-0.2025	0.9353	0.8018	1.1489	-0.4148	1.7169	1.4331
1.200	-0.20	9.99	0.9876	0.8841	0.1172	0.0445	-0.2863	0.8608	1.5982	-0.2907	1.0392	1.8567
1.199	-0.19	12.00	0.9870	0.9137	0.0612	0.2773	-1.4782	0.8948	2.0542	-0.1826	0.4015	2.2957
0.947	-0.18	0.99	0.0000	0.0000	0.1537	-0.2690	0.7823	0.0000	-0.1990	-0.2690	0.7823	0.0047
0.949	-0.17	2.00	0.9896	0.5705	0.1015	-0.2131	0.5585	0.4458	0.1618	-0.2435	0.6456	0.3629
0.951	-0.16	3.01	0.9874	0.7547	0.1123	-0.2272	0.6278	0.6869	0.4585	-0.2792	0.7300	0.6674
0.951	-0.18	5.04	0.9876	0.8715	0.1167	-0.2708	0.9248	0.8369	1.0952	-0.3643	1.0929	1.3087
0.949	-0.18	6.98	0.9873	0.9067	0.1011	-0.2178	0.7107	0.8834	1.7208	-0.4562	1.5166	1.9479
0.951	-0.20	9.01	0.9871	0.9254	0.0686	-0.1122	0.3284	0.9081	2.3838	-0.5502	2.0157	2.6249
0.898	5.84	1.02	0.0000	0.0000	0.0817	-0.2605	0.7956	0.0000	-0.1275	-0.2605	0.7956	0.0050
0.899	5.83	2.01	0.9898	0.7425	0.0461	-0.1912	0.4920	0.6310	0.2585	-0.1886	0.5875	0.4097
0.898	5.83	2.99	0.9885	0.8587	0.0489	-0.1931	0.4735	0.7972	0.5928	-0.1791	0.5873	0.7436
0.900	5.83	5.03	0.9879	0.9255	0.0539	-0.2291	0.7205	0.8941	1.3015	-0.1856	0.9055	1.4556
0.899	5.80	7.00	0.9878	0.9443	0.0466	-0.2302	0.8364	0.9234	2.0175	-0.2795	1.7478	2.1848
0.897	5.80	8.96	0.9868	0.9565	0.0224	-0.0802	0.2310	0.9409	2.7562	-0.2728	2.1040	2.9293
0.902	-0.20	1.00	0.0000	0.0000	0.1172	-0.2752	0.6721	0.0000	-0.1628	-0.2752	0.6721	0.0050
0.902	-0.15	1.54	1.0165	0.5775	0.0559	-0.2094	0.4574	0.3939	0.0979	-0.2398	0.6016	0.2485
0.903	-0.18	2.04	0.9885	0.6893	0.0680	-0.2243	0.4705	0.5789	0.2392	-0.2582	0.5625	0.4132
0.903	-0.16	3.02	0.9881	0.8271	0.0710	-0.2304	0.5016	0.7658	0.5694	-0.2884	0.6153	0.7435
0.899	-0.19	4.02	0.9880	0.8836	0.0712	-0.1939	0.2779	0.8421	0.9269	-0.2803	0.4431	1.1007
0.898	-0.19	4.99	0.9873	0.9063	0.0791	-0.2550	0.6732	0.8747	1.2672	-0.3575	0.8512	1.4487
0.900	-0.17	6.99	0.9876	0.9258	0.0705	-0.2427	0.7339	0.9048	1.9649	-0.5091	1.6364	2.1717
0.896	-0.19	9.00	0.9869	0.9411	0.0313	-0.0969	0.1549	0.9256	2.7294	-0.5878	2.0478	2.9487
0.898	-6.19	0.98	0.0000	0.0000	0.2134	-0.3956	1.0694	0.0000	-0.2591	-0.3956	1.0694	0.0050
0.899	-6.19	2.02	0.9882	0.5138	0.1343	-0.3159	0.6794	0.4029	0.1659	-0.3866	0.7737	0.4118
0.898	-6.18	3.02	0.9879	0.7194	0.1429	-0.3336	0.7714	0.6586	0.4947	-0.4644	0.8862	0.7511
0.899	-6.18	5.03	0.9872	0.8529	0.1393	-0.3297	0.7834	0.8217	1.2004	-0.5800	0.9695	1.4609
0.897	-6.19	6.98	0.9877	0.8756	0.1410	-0.3670	1.1121	0.8547	1.8680	-0.8525	2.0166	2.1855
0.896	-6.20	8.98	0.9869	0.9021	0.0798	-0.2047	0.3723	0.8865	2.6105	-0.9853	2.2599	2.9447
0.802	-0.18	1.00	0.0000	0.0000	0.0991	-0.2744	0.6320	0.0000	-0.1457	-0.2744	0.6320	0.0057
0.803	-0.17	2.01	0.9892	0.7540	0.0499	-0.2204	0.4086	0.6630	0.3391	-0.2628	0.5284	0.5114
0.802	-0.17	3.00	0.9897	0.8664	0.0508	-0.2175	0.3825	0.8167	0.7656	-0.2905	0.5256	0.9374
0.799	-0.15	5.04	0.9885	0.9313	0.0530	-0.2216	0.4516	0.9062	1.6810	-0.3533	0.6901	1.8551
0.800	-0.18	7.00	0.9875	0.9380	0.0560	-0.2506	0.7463	0.9211	2.5360	-0.5897	1.8953	2.7533





Table 20. Internal and Aeropropulsive Characteristics for Nozzle 17

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	-0.08	1.57	1.0130	0.9571	0.9565	-2.01	0.1383	-0.0048	0.0088	0.1445
0.000	-0.06	2.02	0.9801	0.9778	0.9771	-2.15	0.2221	-0.0084	0.0113	0.2273
0.000	-0.04	2.55	0.9814	0.9852	0.9846	-2.02	0.3229	-0.0114	0.0133	0.3280
0.000	0.00	3.04	0.9803	0.9879	0.9870	-2.44	0.4143	-0.0177	0.0349	0.4198
0.000	-0.04	3.53	0.9818	0.9893	0.9893	-0.44	0.5089	-0.0039	-0.0496	0.5145
0.000	0.02	4.01	0.9820	0.9885	0.9884	-0.88	0.6028	-0.0093	-0.0308	0.6099
0.000	0.13	4.50	0.9817	0.9855	0.9845	-2.61	0.6944	-0.0316	0.0839	0.7054
0.000	0.09	4.98	0.9817	0.9815	0.9789	-4.16	0.7853	-0.0572	0.1966	0.8022
0.000	0.11	6.03	0.9836	0.9768	0.9752	-3.24	0.9912	-0.0561	0.2083	1.0164
0.000	-0.01	7.00	0.9834	0.9743	0.9742	-0.88	1.1831	-0.0181	0.0585	1.2143

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.600	0.00	1.02	0.0000	0.0000	0.0657	-0.1795	0.1578	0.0000	-0.1137	-0.1795	0.1578	0.0084
0.600	0.00	1.47	1.0221	0.8800	0.0429	-0.1439	0.0725	0.7828	0.3878	-0.1600	0.1053	0.4953
0.601	0.01	2.03	0.9789	0.9134	0.0607	-0.1494	0.0980	0.8607	0.7853	-0.1830	0.1432	0.9124
0.600	-0.02	3.04	0.9806	0.9528	0.0563	-0.1567	0.1240	0.9238	1.5364	-0.2273	0.2624	1.6631
0.600	0.02	3.97	0.9796	0.9658	0.0604	-0.1239	-0.0636	0.9455	2.2491	-0.1617	-0.1734	2.3786
0.599	0.01	4.97	0.9815	0.9615	0.0563	-0.1600	0.2149	0.9463	3.0038	-0.3832	0.9788	3.1743
0.599	-0.01	5.98	0.9810	0.9620	0.0631	-0.1571	0.2431	0.9499	3.7856	-0.3799	1.0684	3.9852
0.601	-0.03	6.98	0.9818	0.9639	0.0566	-0.1622	0.2671	0.9539	4.5693	-0.2392	0.5084	4.7903
0.798	-0.02	1.04	0.0000	0.0000	0.0768	-0.1970	0.1906	0.0000	-0.1228	-0.1970	0.1906	0.0057
0.800	0.01	2.05	0.9848	0.8531	0.0634	-0.1591	0.1003	0.7649	0.3995	-0.1783	0.1259	0.5223
0.802	-0.03	3.02	0.9819	0.9228	0.0578	-0.1599	0.1037	0.8730	0.8078	-0.2000	0.1841	0.9253
0.800	0.01	4.96	0.9813	0.9459	0.0599	-0.1559	0.1538	0.9199	1.6346	-0.2800	0.5773	1.7770
0.800	-0.02	6.97	0.9818	0.9544	0.0578	-0.1691	0.2531	0.9373	2.5258	-0.2132	0.3946	2.6948
0.900	-0.01	1.02	0.0000	0.0000	0.1096	-0.2049	0.2916	0.0000	-0.1548	-0.2049	0.2916	0.0049
0.900	0.00	1.49	1.0232	0.6248	0.0768	-0.1489	0.1112	0.4273	0.0980	-0.1561	0.1260	0.2294
0.900	0.02	2.05	0.9835	0.7620	0.0883	-0.1573	0.1425	0.6524	0.2696	-0.1725	0.1628	0.4132
0.900	0.01	3.00	0.9815	0.8653	0.0880	-0.1551	0.1167	0.8032	0.5868	-0.1867	0.1822	0.7305
0.900	0.00	4.03	0.9811	0.9083	0.0872	-0.1188	-0.0977	0.8664	0.9361	-0.1350	-0.1537	1.0805
0.899	0.00	4.98	0.9811	0.9208	0.0829	-0.1453	0.1389	0.8888	1.2562	-0.2455	0.4824	1.4134
0.901	-0.02	6.97	0.9822	0.9370	0.0817	-0.1857	0.3640	0.9156	1.9456	-0.2203	0.4751	2.1250
0.900	0.00	9.03	0.9821	0.9442	0.0731	-0.1003	-0.2218	0.9285	2.6816	0.0095	-0.6763	2.8880
0.950	-0.01	0.99	0.0000	0.0000	0.1485	-0.1936	0.4125	0.0000	-0.1935	-0.1936	0.4125	0.0047
0.951	0.00	2.02	0.9836	0.6431	0.1197	-0.1490	0.2486	0.5184	0.1870	-0.1623	0.2665	0.3608
0.949	-0.02	3.00	0.9834	0.7984	0.1217	-0.1514	0.2233	0.7299	0.4791	-0.1802	0.2827	0.6564
0.950	0.01	5.03	0.9823	0.8871	0.1165	-0.1341	0.2215	0.8521	1.0945	-0.2280	0.5496	1.2845
0.950	-0.03	6.99	0.9828	0.9166	0.1117	-0.1817	0.4437	0.8931	1.7126	-0.2120	0.5393	1.9177
0.951	0.00	9.02	0.9824	0.9288	0.1045	-0.1035	-0.1260	0.9114	2.3563	-0.0062	-0.5304	2.5853
1.200	-0.03	0.79	0.0000	0.0000	0.2806	-0.2015	0.5941	0.0000	-0.3237	-0.2015	0.5941	0.0040
1.200	-0.01	1.51	1.0169	-0.5751	0.2029	-0.1312	0.3423	-0.9022	-0.1191	-0.1356	0.3508	0.1320
1.201	0.00	2.07	0.9828	0.0574	0.2164	-0.1531	0.4415	-0.1262	-0.0297	-0.1618	0.4530	0.2353
1.200	-0.02	4.01	0.9836	0.6372	0.2113	-0.1683	0.5470	0.5657	0.3420	-0.1779	0.5171	0.6045
1.200	-0.01	6.03	0.9827	0.7933	0.1839	-0.0990	0.2813	0.7503	0.7547	-0.1549	0.4877	1.0059
1.199	0.00	7.96	0.9830	0.8523	0.1681	-0.0484	-0.0719	0.8215	1.1530	-0.0290	-0.1614	1.4035
1.200	0.01	9.99	0.9828	0.8775	0.1608	0.0222	-0.5258	0.8539	1.5602	0.1216	-0.9286	1.8273
1.200	0.02	12.02	0.9827	0.8883	0.1588	0.1047	-1.0459	0.8692	1.9622	0.2839	-1.7616	2.2575

Table 21. Internal and Aeropropulsive Characteristics for Nozzle 18

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	0.09	1.50	1.0266	0.8765	0.8737	-4.53	0.1161	-0.0092	0.0778	0.1329
0.000	0.17	2.01	0.9854	0.8732	0.8654	-7.66	0.1980	-0.0266	0.1504	0.2287
0.000	0.27	2.52	0.9857	0.9093	0.8997	-8.30	0.2932	-0.0428	0.2411	0.3259
0.000	0.38	2.98	0.9846	0.9300	0.9182	-9.14	0.3808	-0.0612	0.3389	0.4147
0.000	0.54	3.48	0.9853	0.9450	0.9271	-11.15	0.4742	-0.0935	0.4931	0.5115
0.000	0.71	3.98	0.9856	0.9630	0.9360	-13.60	0.5704	-0.1380	0.6640	0.6094
0.000	0.72	4.48	0.9844	0.9699	0.9508	-11.38	0.6746	-0.1358	0.6657	0.7095
0.000	0.72	5.01	0.9843	0.9748	0.9622	-9.24	0.7845	-0.1277	0.6474	0.8154
0.000	0.68	6.00	0.9846	0.9780	0.9724	-6.15	0.9899	-0.1067	0.5835	1.0180
0.000	0.64	7.01	0.9833	0.9804	0.9781	-3.90	1.2008	-0.0819	0.5064	1.2276

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
1.201	0.04	0.98	0.0000	0.0000	0.2526	0.1580	-0.6427	0.0000	-0.2956	0.1580	-0.6427	0.0040
1.200	0.00	1.50	0.9881	-0.8228	0.2176	0.1453	-0.5665	-1.1659	-0.1465	0.1365	-0.4901	0.1256
1.200	0.03	2.03	0.9768	-0.0910	0.2218	0.2059	-0.8236	-0.2785	-0.0641	0.1785	-0.6704	0.2300
1.200	0.01	4.00	0.9845	0.6013	0.2045	0.1226	-0.3357	0.5304	0.3229	-0.0162	0.3312	0.6088
1.201	-0.01	6.00	0.9823	0.7722	0.2039	0.1695	-0.5585	0.7293	0.7340	0.0637	0.0194	1.0065
1.199	-0.01	8.00	0.9837	0.8429	0.1941	0.1762	-0.6067	0.8126	1.1599	0.1183	-0.1775	1.4273
1.201	-0.01	9.99	0.9829	0.8819	0.1771	0.1708	-0.5960	0.8584	1.5791	0.1617	-0.3176	1.8395
1.200	-0.01	12.09	0.9831	0.9041	0.1602	0.1618	-0.5631	0.8853	2.0295	0.2025	-0.4416	2.2926
0.950	0.01	1.05	0.0000	0.0000	0.1676	0.0993	-0.6424	0.0000	-0.2128	0.0993	-0.6424	0.0047
0.950	0.02	2.02	0.9839	0.5886	0.1018	0.1530	-0.8524	0.4650	0.1700	0.1100	-0.6111	0.3657
0.952	-0.03	3.02	0.9840	0.7347	0.1227	-0.0604	0.1533	0.6665	0.4420	-0.1610	0.7038	0.6631
0.950	-0.02	5.01	0.9840	0.8729	0.1152	-0.0514	0.2138	0.8378	1.0797	-0.2538	1.2378	1.2887
0.951	-0.04	7.02	0.9843	0.9252	0.1008	-0.0081	-0.0129	0.9019	1.7525	-0.1382	0.7855	1.9431
0.950	-0.02	8.98	0.9832	0.9466	0.0845	0.0236	-0.1740	0.9292	2.4152	-0.0315	0.3926	2.5991
0.900	0.00	1.08	0.0000	0.0000	0.0820	0.0750	-0.5888	0.0000	-0.1277	0.0750	-0.5888	0.0050
0.902	0.00	1.51	0.9902	0.6522	0.0573	0.0568	-0.5072	0.4531	0.1038	0.0403	-0.3681	0.2291
0.899	0.04	2.00	0.9834	0.7303	0.0551	0.1744	-1.0123	0.6166	0.2475	0.1277	-0.7480	0.4014
0.901	-0.04	3.00	0.9852	0.8303	0.0646	-0.0358	-0.0810	0.7684	0.5658	-0.1464	0.5256	0.7364
0.901	-0.01	4.00	0.9840	0.8748	0.0680	-0.0527	0.1459	0.8325	0.8994	-0.2995	1.3303	1.0803
0.897	-0.03	4.98	0.9819	0.9164	0.0680	-0.0360	0.0885	0.8845	1.2669	-0.2638	1.2376	1.4324
0.901	-0.04	7.02	0.9838	0.9548	0.0492	0.0099	-0.1536	0.9337	2.0186	-0.1355	0.7371	2.1621
0.900	-0.02	8.99	0.9830	0.9686	0.0311	0.0395	-0.2891	0.9529	2.7638	-0.0209	0.3401	2.9005
0.803	0.00	1.06	0.0000	0.0000	0.0781	0.0839	-0.5783	0.0000	-0.1246	0.0839	-0.5783	0.0056
0.801	0.04	2.05	0.9857	0.7688	0.0509	0.2358	-1.2270	0.6803	0.3578	0.1734	-0.8795	0.5259
0.800	0.00	3.01	0.9854	0.8598	0.0547	-0.0194	-0.1140	0.8101	0.7590	-0.1600	0.6598	0.9370
0.801	-0.03	5.00	0.9841	0.9310	0.0563	-0.0173	0.0649	0.9053	1.6393	0.3026	1.5065	1.8109
0.800	-0.04	6.99	0.9835	0.9626	0.0415	0.0333	-0.1896	0.9455	2.5834	-0.1524	0.9447	2.7322
0.600	-0.01	1.03	0.0000	0.0000	0.0822	0.0857	-0.5622	0.0000	-0.1310	0.0857	-0.5622	0.0084
0.602	0.02	1.53	1.0172	0.7841	0.0484	0.1095	-0.6781	0.6950	0.3799	0.0696	-0.3542	0.5465
0.601	0.02	2.01	0.9850	0.8217	0.0404	0.2907	-1.4125	0.7683	0.6995	0.1838	-0.8128	0.9105
0.600	0.00	3.01	0.9848	0.8863	0.0544	-0.0225	-0.0968	0.8571	1.4303	-0.2743	1.2861	1.6688
0.600	-0.05	4.01	0.9841	0.9121	0.0618	-0.0331	0.1427	0.8921	2.1773	-0.5924	2.8187	2.4406
0.601	-0.05	4.99	0.9850	0.9426	0.0588	-0.0091	0.0689	0.9275	2.9817	-0.5183	2.6330	3.2149
0.600	-0.05	6.00	0.9840	0.9595	0.0545	0.0271	-0.0763	0.9474	3.8272	-0.3999	2.2399	4.0395
0.598	-0.02	7.01	0.9840	0.9697	0.0375	0.0476	-0.1841	0.9598	4.7082	-0.2818	1.8399	4.9054



Table 23. Internal and Aeropropulsive Characteristics for Nozzle 20

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTA P	CFJ	CFN	CMJ	CFI
0.000	-0.05	1.45	1.0102	0.9692	0.9671	-3.76	0.1135	-0.0075	0.0417	0.1173
0.000	0.01	2.01	0.9706	0.9691	0.9679	-2.85	0.2181	-0.0109	0.0684	0.2254
0.000	0.01	2.55	0.9712	0.9847	0.9842	-1.91	0.3194	-0.0107	0.0858	0.3245
0.000	0.00	2.99	0.9698	0.9875	0.9869	-2.03	0.4020	-0.0142	0.1140	0.4073
0.000	0.00	3.48	0.9708	0.9893	0.9893	-0.64	0.4950	-0.0055	0.0905	0.5003
0.000	-0.03	3.97	0.9707	0.9933	0.9931	1.22	0.5918	0.0126	0.0174	0.5959
0.000	-0.04	4.47	0.9708	0.9939	0.9927	2.81	0.6875	0.0337	-0.0668	0.6925
0.000	-0.04	4.97	0.9705	0.9912	0.9888	3.98	0.7826	0.0545	-0.1501	0.7915
0.000	-0.03	6.06	0.9721	0.9894	0.9830	6.54	0.9932	0.1138	-0.3878	1.0104
0.000	0.00	6.96	0.9710	0.9882	0.9781	8.18	1.1668	0.1676	-0.5986	1.1929

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.600	-0.01	1.04	0.0000	0.0000	0.0633	0.0937	-0.6035	0.0000	-0.1114	0.0937	-0.6035	0.0085
0.599	0.00	1.49	0.9936	0.8906	0.0396	0.0514	-0.4088	0.7941	0.3975	0.0205	-0.2341	0.5006
0.601	0.00	2.01	0.9702	0.9195	0.0431	0.0470	-0.3643	0.8651	0.7688	0.0040	-0.0943	0.8887
0.600	-0.02	3.03	0.9700	0.9601	0.0445	0.0478	-0.3594	0.9307	1.5316	-0.0052	-0.0788	1.6457
0.600	-0.01	4.00	0.9695	0.9688	0.0609	0.0612	-0.3924	0.9484	2.2566	0.1120	-0.3320	2.3793
0.600	0.02	4.98	0.9718	0.9691	0.0586	0.0925	-0.5412	0.9537	3.0041	0.3088	-1.1410	3.1499
0.599	0.01	5.96	0.9710	0.9689	0.0596	0.0808	-0.5558	0.9566	3.7754	0.5121	-2.0125	3.9467
0.601	0.03	7.01	0.9701	0.9644	0.0693	0.0920	-0.6712	0.9542	4.5299	0.7682	-3.0819	4.7474
1.200	-0.01	0.93	0.0000	0.0000	0.2666	0.0656	-0.2755	0.0000	-0.3098	0.0656	-0.2755	0.0040
1.200	0.00	1.50	0.9931	-0.8625	0.2312	0.0905	-0.3427	-1.2053	-0.1522	0.0827	-0.2989	0.1263
1.198	0.01	2.01	0.9677	-0.1370	0.2464	0.0961	-0.3663	-0.3320	-0.0739	0.0853	-0.2985	0.2225
1.202	0.00	4.04	0.9732	0.5731	0.2521	0.1145	-0.4582	0.5013	0.3027	0.1293	-0.4518	0.6038
1.200	0.01	6.02	0.9708	0.7319	0.2503	0.1381	-0.6167	0.6881	0.6834	0.2488	-0.9924	0.9931
1.201	0.02	7.99	0.9706	0.7959	0.2461	0.1548	-0.7316	0.7647	1.0628	0.3819	-1.5619	1.3898
1.202	-0.01	9.24	0.9780	0.8016	0.2610	0.1996	-0.7296	0.7754	1.2851	0.4994	-1.8476	1.6573
1.201	0.01	9.67	0.9858	0.7968	0.2689	0.2131	-0.7261	0.7722	1.3627	0.5394	-1.9462	1.7647
0.949	0.01	1.08	0.0000	0.0000	0.1594	0.0895	-0.7005	0.0000	-0.2048	0.0895	-0.7005	0.0048
0.952	0.03	2.07	0.9748	0.6342	0.1238	-0.0540	-0.0201	0.5129	0.1918	-0.0713	-0.0921	0.3740
0.951	0.02	3.04	0.9725	0.7839	0.1321	-0.0424	-0.0702	0.7150	0.4706	-0.0628	-0.1031	0.6582
0.950	-0.01	5.03	0.9703	0.8846	0.1328	-0.0140	-0.2034	0.8489	1.0793	0.0752	-0.4571	1.2714
0.950	0.02	7.00	0.9710	0.9102	0.1292	0.0170	-0.4665	0.8863	1.6833	0.2864	-1.4269	1.8993
0.951	0.02	8.64	0.9703	0.9133	0.1373	0.0453	-0.6286	0.8946	2.1764	0.4698	-2.1959	2.4327
0.899	0.00	1.10	0.0000	0.0000	0.0844	0.0696	-0.5981	0.0000	-0.1302	0.0696	-0.5981	0.0050
0.899	0.02	1.47	0.9409	0.6633	0.0743	0.0186	-0.3529	0.4378	0.0889	0.0051	-0.2771	0.2030
0.900	0.00	2.04	0.9722	0.8021	0.0668	0.0111	-0.3073	0.6893	0.2796	-0.0083	-0.1848	0.4057
0.900	0.01	3.03	0.9717	0.8869	0.0721	0.0195	-0.3441	0.8243	0.6030	-0.0036	-0.1496	0.7316
0.901	0.00	4.01	0.9716	0.9250	0.0714	0.0069	-0.2720	0.8821	0.9388	0.0315	-0.2532	1.0643
0.901	0.00	4.98	0.9699	0.9342	0.0772	0.0342	-0.4097	0.9014	1.2546	0.1293	-0.6746	1.3919
0.898	0.02	6.98	0.9707	0.9438	0.0739	0.0495	-0.5802	0.9222	1.9538	0.3489	-1.6483	2.1186
0.901	0.02	7.96	0.9711	0.9426	0.0743	0.0558	-0.6724	0.9240	2.2754	0.4567	-2.1370	2.4625
0.800	0.01	1.07	0.0000	0.0000	0.0742	0.0779	-0.5984	0.0000	-0.1209	0.0779	-0.5984	0.0057
0.800	0.02	2.03	0.9720	0.8545	0.0573	0.0306	-0.3436	0.7630	0.3891	0.0063	-0.1893	0.5100
0.801	0.03	3.05	0.9729	0.9257	0.0550	0.0367	-0.3579	0.8758	0.8189	0.0092	-0.1170	0.9350
0.799	-0.01	4.97	0.9694	0.9511	0.0690	0.0636	-0.4907	0.9247	1.6336	0.1836	-0.8243	1.7666
0.800	0.01	7.04	0.9710	0.9526	0.0685	0.0731	-0.6341	0.9353	2.5214	0.4581	-2.0104	2.6960

Table 24. Internal and Aeropropulsive Characteristics for Nozzle 21

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	0.06	1.52	1.0140	0.9134	0.9114	-3.82	0.1223	-0.0082	0.0543	0.1342
0.000	0.09	2.02	0.9736	0.9403	0.9393	-2.65	0.2127	-0.0098	0.0593	0.2264
0.000	0.12	2.49	0.9719	0.9674	0.9666	-2.32	0.3040	-0.0123	0.0709	0.3145
0.000	0.16	2.99	0.9718	0.9760	0.9755	-1.95	0.3978	-0.0135	0.0709	0.4078
0.000	0.27	3.47	0.9728	0.9799	0.9779	-3.64	0.4883	-0.0310	0.1687	0.4994
0.000	0.21	3.96	0.9724	0.9839	0.9834	-1.68	0.5839	-0.0172	0.0872	0.5938
0.000	0.27	4.47	0.9720	0.9808	0.9801	-2.10	0.6797	-0.0249	0.1313	0.6934
0.000	0.44	4.98	0.9717	0.9748	0.9720	-4.33	0.7723	-0.0585	0.3125	0.7945
0.000	0.76	6.02	0.9724	0.9723	0.9647	-7.15	0.9692	-0.1216	0.6502	1.0046
0.000	0.87	6.99	0.9724	0.9729	0.9655	-7.09	1.1594	-0.1441	0.7472	1.2009

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.598	0.01	1.01	0.0000	0.0000	0.0610	-0.1379	0.1933	0.0000	-0.1091	-0.1379	0.1933	0.0086
0.599	0.01	1.52	1.0084	0.8594	0.0304	-0.0963	-0.0030	0.7690	0.4101	-0.1288	0.2124	0.5333
0.598	0.01	2.05	0.9736	0.8981	0.0394	-0.1110	0.0142	0.8464	0.7879	-0.1505	0.2544	0.9310
0.597	0.01	3.04	0.9716	0.9540	0.0367	-0.1027	-0.0389	0.9251	1.5416	-0.1570	0.2479	1.6664
0.599	-0.02	3.98	0.9698	0.9676	0.0429	-0.0754	-0.1900	0.9474	2.2525	-0.1453	0.1590	2.3776
0.598	-0.01	4.98	0.9719	0.9578	0.0448	-0.1596	0.2834	0.9426	2.9910	-0.3936	1.5312	3.1730
0.598	-0.02	5.98	0.9716	0.9554	0.0401	-0.1424	0.3745	0.9432	3.7536	-0.6197	2.9192	3.9796
0.597	-0.03	7.05	0.9714	0.9604	0.0287	-0.0605	0.2027	0.9505	4.6186	-0.6463	3.2218	4.8594
1.200	-0.03	0.85	0.0000	0.0000	0.2240	-0.1035	0.3991	0.0000	-0.2670	-0.1035	0.3991	0.0040
1.200	0.04	1.49	1.0104	-0.3828	0.1654	-0.0297	0.0619	-0.7218	-0.0917	-0.0377	0.1152	0.1270
1.201	-0.02	2.07	0.9725	0.1715	0.1797	-0.0755	0.2659	-0.0131	-0.0031	-0.0855	0.3256	0.2333
1.201	0.01	4.00	0.9735	0.6782	0.1811	-0.1219	0.5263	0.6060	0.3616	-0.1390	0.6133	0.5967
1.201	-0.01	6.05	0.9725	0.8146	0.1502	-0.0252	0.0911	0.7716	0.7722	-0.1464	0.7379	1.0009
1.200	-0.02	7.99	0.9712	0.8716	0.1308	0.0756	-0.2880	0.8408	1.1740	-0.0913	0.5542	1.3964
1.201	-0.02	10.00	0.9717	0.9026	0.1040	0.2041	-0.8145	0.8787	1.5904	-0.0089	0.2260	1.8098
1.200	-0.01	11.97	0.9709	0.9195	0.0793	0.3452	-1.4111	0.9001	2.0023	0.0865	-0.1729	2.2244
0.948	0.00	1.04	0.0000	0.0000	0.0872	-0.1310	0.1435	0.0000	-0.1323	-0.1310	0.1435	0.0048
0.950	0.01	2.04	0.9739	0.7692	0.0624	-0.1166	0.0667	0.6459	0.2361	-0.1322	0.1616	0.3656
0.951	0.00	3.03	0.9735	0.8723	0.0669	-0.1325	0.1541	0.8037	0.5283	-0.1541	0.2672	0.6573
0.951	0.01	5.04	0.9708	0.9250	0.0603	-0.1154	0.0790	0.8896	1.1335	-0.2136	0.6055	1.2742
0.952	-0.02	6.98	0.9720	0.9369	0.0547	-0.0942	0.2481	0.9131	1.7271	-0.3218	1.4259	1.8916
0.951	-0.05	8.99	0.9714	0.9544	0.0215	0.0640	-0.3899	0.9367	2.3896	-0.2397	1.1091	2.5510
0.892	-0.03	1.02	0.0000	0.0000	0.0765	-0.1305	0.1307	0.0000	-0.1221	-0.1305	0.1307	0.0051
0.903	0.00	1.53	0.9996	0.7523	0.0402	-0.0973	-0.0327	0.5588	0.1313	-0.1118	0.0622	0.2350
0.902	-0.01	2.04	0.9747	0.8339	0.0427	-0.1121	0.0161	0.7219	0.2931	-0.1295	0.1214	0.4061
0.900	0.02	3.03	0.9734	0.9092	0.0477	-0.1178	0.0433	0.8472	0.6218	-0.1417	0.1696	0.7340
0.900	-0.03	4.05	0.9726	0.9421	0.0430	-0.0900	-0.1415	0.8999	0.9708	-0.1215	0.0484	1.0788
0.900	0.00	5.01	0.9716	0.9423	0.0418	-0.1209	0.0816	0.9100	1.2833	-0.2271	0.6483	1.4102
0.900	-0.02	6.97	0.9721	0.9506	0.0317	-0.0811	0.1709	0.9291	1.9630	-0.3353	1.4866	2.1128
0.900	-0.06	9.03	0.9714	0.9624	0.0011	0.1080	-0.5935	0.9466	2.7120	-0.2333	1.0887	2.8651
0.798	-0.02	1.01	0.0000	0.0000	0.0731	-0.1294	0.1624	0.0000	-0.1195	-0.1294	0.1624	0.0057
0.799	0.00	2.03	0.9736	0.8521	0.0448	-0.1026	0.0076	0.7615	0.3899	-0.1246	0.1416	0.5121
0.799	-0.01	3.00	0.9736	0.9237	0.0458	-0.0950	-0.0401	0.8733	0.8027	-0.1255	0.1190	0.9192
0.799	-0.01	4.98	0.9716	0.9481	0.0430	-0.1279	0.1613	0.9220	1.6382	-0.2589	0.8600	1.7768
0.798	-0.02	7.00	0.9719	0.9539	0.0323	-0.0648	0.1656	0.9367	2.5310	-0.3900	1.8466	2.7020







Table 27. Internal and Aeropropulsive Characteristics for Nozzle 24

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI'
0.000	0.04	1.49	1.0212	0.9699	0.9680	-3.59	0.1255	-0.0079	0.0300	0.1297
0.000	0.08	2.06	0.9786	0.9737	0.9725	-2.87	0.2282	-0.0114	0.0387	0.2347
0.000	0.10	2.51	0.9762	0.9873	0.9867	-2.04	0.3140	-0.0112	0.0269	0.3182
0.000	0.15	2.99	0.9755	0.9899	0.9890	-2.42	0.4050	-0.0171	0.0574	0.4095
0.000	0.13	3.47	0.9766	0.9921	0.9919	-1.22	0.4970	-0.0105	0.0139	0.5010
0.000	0.06	3.96	0.9760	0.9936	0.9936	0.59	0.5930	0.0061	-0.0878	0.5969
0.000	-0.03	4.46	0.9758	0.9930	0.9922	2.30	0.6889	0.0277	-0.2102	0.6943
0.000	-0.13	4.98	0.9752	0.9911	0.9890	3.74	0.7890	0.0516	-0.3375	0.7978
0.000	-0.37	6.00	0.9764	0.9868	0.9807	6.38	0.9842	0.1101	-0.6413	1.0036

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.598	0.01	1.04	0.0000	0.0000	0.0682	-0.1995	0.4013	0.0000	-0.1163	-0.1995	0.4013	0.0085
0.599	0.00	1.52	0.9931	0.8620	0.0635	-0.1620	0.2636	0.7697	0.4018	-0.1941	0.3845	0.5220
0.598	0.00	2.04	0.9761	0.9017	0.0726	-0.1706	0.3065	0.8495	0.7848	-0.2157	0.4602	0.9238
0.597	-0.02	3.03	0.9743	0.9510	0.0631	-0.1642	0.2848	0.9221	1.5390	-0.2292	0.4893	1.6690
0.597	-0.01	3.97	0.9735	0.9668	0.0693	-0.1563	0.2737	0.9466	2.2590	-0.1321	-0.0799	2.3864
0.598	-0.01	4.98	0.9748	0.9701	0.0618	-0.1435	0.0987	0.9549	3.0401	0.0616	-1.2467	3.1836
0.598	-0.01	6.00	0.9748	0.9675	0.0532	-0.1645	0.0247	0.9554	3.8189	0.2771	-2.5284	3.9973
0.598	0.01	6.37	0.9743	0.9646	0.0582	-0.1588	-0.0394	0.9534	4.0969	0.3699	-3.0319	4.2972
1.200	-0.03	0.98	0.0000	0.0000	0.2302	-0.2067	0.7817	0.0000	-0.2732	-0.2067	0.7817	0.0040
1.199	-0.02	1.52	0.9731	-0.5181	0.1942	-0.1712	0.6200	-0.8554	-0.1091	-0.1793	0.6502	0.1276
1.203	-0.02	2.03	0.9677	0.0874	0.2026	-0.1853	0.6951	-0.1040	-0.0234	-0.1965	0.7329	0.2248
1.200	0.00	4.00	0.9752	0.6590	0.2004	-0.1833	0.6811	0.5868	0.3508	-0.1764	0.5891	0.5977
1.201	-0.01	6.06	0.9737	0.8031	0.1788	-0.1501	0.4445	0.7601	0.7622	-0.0371	-0.2066	1.0028
1.200	-0.01	7.98	0.9741	0.8473	0.1656	-0.1394	0.2960	0.8165	1.1398	0.0849	-0.9241	1.3961
1.199	0.02	9.55	0.9792	0.8619	0.1535	-0.1359	0.2091	0.8370	1.4508	0.1804	-1.4770	1.7333
1.201	0.22	4.72	0.9858	0.7237	0.1913	-0.1664	0.5786	0.6660	0.4976	-0.1240	0.3070	0.7472
0.951	-0.01	1.11	0.0000	0.0000	0.0913	-0.2184	0.4423	0.0000	-0.1364	-0.2184	0.4423	0.0047
0.949	-0.02	2.02	0.9743	0.7564	0.0815	-0.2068	0.4136	0.6318	0.2286	-0.2248	0.4743	0.3618
0.949	-0.01	3.01	0.9751	0.8595	0.0841	-0.1995	0.3766	0.7905	0.5168	-0.2261	0.4636	0.6538
0.949	0.00	5.03	0.9742	0.9303	0.0760	-0.2091	0.4054	0.8951	1.1451	-0.1240	-0.1487	1.2794
0.949	0.00	6.99	0.9748	0.9385	0.0654	-0.2089	0.1909	0.9149	1.7463	0.0581	-1.2903	1.9088
0.948	0.02	7.60	0.9742	0.9388	0.0628	-0.2093	0.1185	0.9175	1.9400	0.1162	-1.6585	2.1144
0.899	0.01	1.09	0.0000	0.0000	0.0733	-0.2249	0.4068	0.0000	-0.1188	-0.2249	0.4068	0.0050
0.899	0.02	1.47	0.9420	0.6924	0.0728	-0.1920	0.2906	0.4697	0.0960	-0.2057	0.3431	0.2043
0.899	-0.02	2.03	0.9760	0.8094	0.0690	-0.2043	0.3526	0.6969	0.2818	-0.2242	0.4202	0.4044
0.900	0.00	3.01	0.9761	0.8963	0.0662	-0.1947	0.2986	0.8339	0.6084	-0.2240	0.3946	0.7295
0.900	-0.02	3.97	0.9752	0.9307	0.0670	-0.2141	0.4298	0.8876	0.9375	-0.2033	0.2725	1.0562
0.901	-0.01	4.97	0.9736	0.9459	0.0626	-0.1966	0.3090	0.9134	1.2748	-0.1072	-0.2781	1.3957
0.899	0.01	6.99	0.9752	0.9487	0.0502	-0.1974	0.0883	0.9274	1.9762	0.1012	-1.5665	2.1310
0.901	0.02	7.28	0.9753	0.9484	0.0478	-0.1972	0.0572	0.9280	2.0647	0.1300	-1.7408	2.2250
0.800	0.01	1.06	0.0000	0.0000	0.0740	-0.2174	0.4080	0.0000	-0.1204	-0.2174	0.4080	0.0057
0.802	-0.02	2.02	0.9754	0.8404	0.0706	-0.1908	0.2264	0.7485	0.3773	-0.2158	0.4111	0.5041
0.802	-0.02	2.98	0.9769	0.9181	0.0618	-0.1784	0.2555	0.8669	0.7854	-0.2172	0.3862	0.9060
0.803	-0.01	4.97	0.9751	0.9540	0.0620	-0.1722	0.2125	0.9277	1.6358	-0.0593	-0.5287	1.7633
0.803	0.00	6.97	0.9749	0.9543	0.0492	-0.1736	0.0074	0.9368	2.4894	0.1969	-2.0485	2.6573

Table 28. Internal and Aeropropulsive Characteristics for Nozzle 25

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	0.04	1.54	1.0163	0.9235	0.9218	-3.50	0.1285	-0.0078	0.0160	0.1394
0.000	0.06	2.02	0.9821	0.9487	0.9473	-3.15	0.2164	-0.0119	0.0175	0.2284
0.000	0.09	2.50	0.9800	0.9739	0.9727	-2.81	0.3079	-0.0151	0.0143	0.3165
0.000	0.10	2.97	0.9798	0.9826	0.9819	-2.11	0.3978	-0.0147	-0.0164	0.4051
0.000	0.21	3.47	0.9811	0.9845	0.9822	-3.98	0.4919	-0.0342	0.0916	0.5009
0.000	0.11	3.97	0.9812	0.9878	0.9873	-1.87	0.5905	-0.0193	-0.0330	0.5981
0.000	0.15	4.47	0.9810	0.9849	0.9842	-2.11	0.6853	-0.0253	-0.0101	0.6963
0.000	0.34	4.99	0.9813	0.9771	0.9743	-4.38	0.7783	-0.0596	0.1915	0.7989
0.000	0.67	6.05	0.9829	0.9731	0.9661	-6.90	0.9794	-0.1186	0.5277	1.0138
0.000	0.75	6.98	0.9833	0.9722	0.9659	-6.55	1.1651	-0.1339	0.6037	1.2063

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.599	0.00	1.00	0.0000	0.0000	0.0992	-0.3223	0.8691	0.0000	-0.1472	-0.3223	0.8691	0.0084
0.598	0.00	1.51	1.0211	0.8087	0.0595	-0.2511	0.5593	0.7180	0.3803	-0.2811	0.6228	0.5297
0.599	0.01	2.05	0.9827	0.8723	0.0688	-0.2409	0.4827	0.8207	0.7641	-0.2891	0.5528	0.9310
0.599	0.01	3.00	0.9801	0.9389	0.0702	-0.2220	0.3451	0.9095	1.4885	-0.2807	0.2777	1.6366
0.599	-0.03	3.97	0.9795	0.9573	0.0752	-0.2011	0.2244	0.9371	2.2295	-0.2792	0.0929	2.3791
0.600	-0.02	5.01	0.9812	0.9499	0.0771	-0.2731	0.6344	0.9348	2.9762	-0.5153	1.4210	3.1838
0.600	-0.02	5.98	0.9808	0.9492	0.0741	-0.2753	0.7537	0.9370	3.7134	-0.7328	2.7640	3.9629
0.600	-0.04	7.03	0.9816	0.9552	0.0590	-0.2272	0.5531	0.9452	4.5478	-0.7641	2.9614	4.8116
1.199	-0.06	0.85	0.0000	0.0000	0.2466	-0.3378	1.2891	0.0000	-0.2895	-0.3378	1.2891	0.0040
1.199	-0.03	1.50	1.0204	-0.4873	0.1817	-0.2547	0.8612	-0.8208	-0.1057	-0.2621	0.8770	0.1287
1.200	-0.01	2.02	0.9741	0.0931	0.1933	-0.2636	0.8868	-0.0981	-0.0220	-0.2754	0.9042	0.2246
1.201	-0.03	4.01	0.9809	0.6583	0.1972	-0.2946	1.0992	0.5866	0.3518	-0.3141	1.0658	0.5998
1.199	-0.02	6.04	0.9795	0.8003	0.1694	-0.2424	0.8089	0.7574	0.7589	-0.3604	1.3325	1.0021
1.199	-0.05	7.97	0.9811	0.8632	0.1446	-0.1637	0.3425	0.8325	1.1653	-0.3141	1.0224	1.3998
1.200	-0.03	10.01	0.9808	0.8992	0.1133	-0.0526	-0.2741	0.8756	1.5926	-0.2354	0.5675	1.8189
1.200	-0.05	12.03	0.9813	0.9192	0.0807	0.0772	-0.9586	0.9000	2.0222	-0.1390	0.0455	2.2468
0.949	-0.02	1.02	0.0000	0.0000	0.1131	-0.3780	1.0415	0.0000	-0.1581	-0.3780	1.0415	0.0047
0.951	-0.02	2.02	0.9835	0.7297	0.0773	-0.2880	0.5653	0.6049	0.2178	-0.3068	0.5929	0.3600
0.949	0.01	2.99	0.9818	0.8520	0.0832	-0.3002	0.6198	0.7828	0.5089	-0.3235	0.5932	0.6501
0.949	-0.01	5.00	0.9799	0.9185	0.0726	-0.2765	0.4884	0.8831	1.1230	-0.3727	0.8010	1.2717
0.949	-0.02	6.96	0.9812	0.9322	0.0677	-0.2663	0.6178	0.9086	1.7274	-0.4788	1.5722	1.9012
0.950	-0.06	9.03	0.9812	0.9518	0.0309	-0.1379	-0.1412	0.9344	2.4067	-0.4049	1.0755	2.5757
0.900	-0.01	1.00	0.0000	0.0000	0.1094	-0.3717	0.9854	0.0000	-0.1547	-0.3717	0.9854	0.0050
0.902	-0.01	1.53	1.0100	0.6563	0.0649	-0.2846	0.5475	0.4672	0.1120	-0.2982	0.5755	0.2398
0.898	-0.01	2.03	0.9827	0.7664	0.0726	-0.2837	0.5176	0.6545	0.2654	-0.3048	0.5486	0.4056
0.899	-0.01	3.01	0.9810	0.8787	0.0745	-0.2838	0.5179	0.8166	0.5957	-0.3102	0.4878	0.7296
0.900	-0.01	4.03	0.9808	0.9215	0.0702	-0.2581	0.3803	0.8793	0.9450	-0.2928	0.3204	1.0747
0.899	-0.03	5.00	0.9804	0.9258	0.0697	-0.2832	0.5343	0.8937	1.2642	-0.3898	0.8766	1.4145
0.899	-0.03	6.97	0.9816	0.9398	0.0588	-0.2588	0.5589	0.9184	1.9508	-0.4961	1.6244	2.1241
0.899	-0.06	9.05	0.9819	0.9561	0.0201	-0.1056	-0.3265	0.9405	2.7178	-0.4048	1.0371	2.8899
0.800	-0.03	1.00	0.0000	0.0000	0.1088	-0.3594	0.9268	0.0000	-0.1550	-0.3594	0.9268	0.0057
0.800	0.00	2.06	0.9848	0.8093	0.0715	-0.2684	0.4923	0.7217	0.3811	-0.2957	0.5316	0.5281
0.801	-0.03	3.04	0.9824	0.9010	0.0735	-0.2549	0.3972	0.8515	0.7947	-0.2888	0.3582	0.9333
0.801	-0.01	4.97	0.9818	0.9352	0.0687	-0.2774	0.5268	0.9092	1.6114	-0.4092	0.9456	1.7724
0.802	-0.03	6.99	0.9815	0.9457	0.0585	-0.2472	0.5328	0.9284	2.4870	-0.5463	1.8754	2.6786

Table 29. Internal and Aeropropulsive Characteristics for Nozzle 26

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	0.00	1.50	1.0259	0.8793	0.8756	-5.21	0.1174	-0.0107	0.0850	0.1341
0.000	-0.01	2.01	0.9838	0.9092	0.9071	-3.86	0.2094	-0.0141	0.1089	0.2309
0.000	0.02	2.54	0.9826	0.9436	0.9404	-4.69	0.3113	-0.0255	0.1906	0.3310
0.000	0.01	2.99	0.9830	0.9599	0.9572	-4.32	0.3986	-0.0301	0.2309	0.4164
0.000	-0.02	3.49	0.9833	0.9713	0.9635	-7.29	0.4953	-0.0633	0.4195	0.5141
0.000	-0.03	3.97	0.9834	0.9791	0.9713	-7.22	0.5926	-0.0751	0.4987	0.6100
0.000	-0.06	4.47	0.9830	0.9839	0.9805	-4.74	0.6952	-0.0576	0.4310	0.7091
0.000	-0.06	4.99	0.9828	0.9862	0.9852	-2.58	0.8032	-0.0362	0.3391	0.8152
0.000	-0.05	6.04	0.9832	0.9908	0.9908	0.44	1.0214	0.0078	0.1498	1.0309
0.000	-0.05	6.98	0.9823	0.9930	0.9923	2.10	1.2155	0.0446	-0.0173	1.2249

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
1.201	-0.04	1.52	1.0006	-0.4986	0.1853	0.2029	-0.9036	-0.8227	-0.1094	0.1921	-0.8187	0.1330
1.199	0.16	2.12	0.9869	0.1806	0.1817	0.1103	-0.3832	0.0079	0.0020	0.0963	-0.2701	0.2497
1.200	0.09	3.94	0.9823	0.6791	0.1761	0.1552	-0.5968	0.6071	0.3641	0.0828	-0.1087	0.5997
1.201	-0.05	6.03	0.9818	0.8127	0.1823	0.1717	-0.7481	0.7703	0.7838	0.1777	-0.5988	1.0174
1.201	-0.07	8.00	0.9825	0.8601	0.1871	0.1744	-0.7848	0.8298	1.1833	0.2565	-0.9820	1.4260
1.199	-0.06	10.00	0.9816	0.8855	0.1895	0.1705	-0.7754	0.8622	1.5985	0.3308	-1.3278	1.8540
0.949	-0.05	1.09	0.0000	0.0000	0.0815	0.0591	-0.6074	0.0000	-0.1266	0.0591	-0.6074	0.0047
0.951	0.08	2.03	0.9814	0.7467	0.0604	0.0070	-0.2414	0.6242	0.2303	-0.0150	-0.0681	0.3690
0.951	0.11	3.01	0.9822	0.8588	0.0664	-0.0076	-0.1493	0.7908	0.5253	-0.0556	0.2250	0.6643
0.950	0.06	5.00	0.9821	0.9397	0.0601	-0.0146	-0.0614	0.9048	1.1704	-0.0698	0.4721	1.2935
0.950	-0.11	6.99	0.9815	0.9630	0.0586	0.0142	-0.3038	0.9397	1.8217	0.0817	-0.3338	1.9385
0.949	-0.12	8.98	0.9817	0.9642	0.0682	0.0218	-0.4400	0.9469	2.4752	0.2116	-1.0332	2.6140
0.900	5.92	1.05	0.0000	0.0000	0.1270	0.1040	-0.6653	0.0000	-0.1726	0.1040	-0.6653	0.0050
0.901	6.05	2.02	0.9832	0.6890	0.0896	0.0779	-0.4400	0.5769	0.2347	0.0921	-0.2481	0.4069
0.900	6.10	3.00	0.9824	0.8447	0.0857	0.0503	-0.2602	0.7830	0.5790	0.0716	0.1541	0.7395
0.899	6.04	5.02	0.9817	0.9290	0.0823	0.0616	-0.2677	0.8976	1.3014	0.1506	0.3235	1.4500
0.901	5.88	6.97	0.9829	0.9420	0.0880	0.0879	-0.5261	0.9209	1.9835	0.3843	-0.5533	2.1540
0.902	5.90	9.00	0.9816	0.9420	0.1020	0.0989	-0.6666	0.9262	2.6835	0.6098	-1.3285	2.8972
0.901	-0.01	1.07	0.0000	0.0000	0.0753	0.0599	-0.6157	0.0000	-0.1210	0.0599	-0.6157	0.0050
0.899	0.01	1.53	1.0026	0.6914	0.0486	0.0704	-0.6282	0.5043	0.1231	0.0512	-0.4754	0.2440
0.901	-0.01	2.11	0.9840	0.7879	0.0537	-0.0059	-0.1983	0.6835	0.2990	-0.0318	0.0010	0.4374
0.901	-0.01	3.05	0.9840	0.8808	0.0582	-0.0079	-0.1795	0.8203	0.6190	-0.0660	0.2567	0.7546
0.902	0.00	4.06	0.9835	0.9230	0.0539	-0.0182	0.0144	0.8816	0.9724	-0.1575	0.8651	1.1030
0.901	-0.03	5.08	0.9821	0.9495	0.0546	-0.0075	-0.1331	0.9183	1.3451	-0.0658	0.4381	1.4647
0.901	-0.01	6.93	0.9828	0.9679	0.0514	0.0199	-0.3573	0.9466	2.0280	0.0950	-0.3742	2.1425
0.902	0.00	9.00	0.9820	0.9680	0.0630	0.0291	-0.4809	0.9523	2.7638	0.2470	-1.1440	2.9023
0.900	-6.01	1.08	0.0000	0.0000	0.0742	0.0280	-0.6138	0.0000	-0.1199	0.0280	-0.6138	0.0050
0.899	-5.98	2.01	0.9840	0.7539	0.0575	-0.0270	-0.2663	0.6413	0.2604	-0.0901	-0.0743	0.4060
0.900	-6.01	3.00	0.9837	0.8602	0.0622	-0.0435	-0.1736	0.7985	0.5913	-0.1717	0.2411	0.7405
0.897	-6.00	5.01	0.9820	0.9366	0.0576	-0.0476	-0.1002	0.9051	1.3134	-0.2602	0.4971	1.4511
0.901	-6.03	6.97	0.9830	0.9657	0.0524	-0.0158	-0.3370	0.9444	2.0347	-0.1628	-0.3643	2.1544
0.899	-5.99	8.99	0.9821	0.9722	0.0581	-0.0026	-0.4439	0.9566	2.7920	-0.0868	-1.1091	2.9188
0.802	-0.02	1.05	0.0000	0.0000	0.0765	0.0648	-0.5925	0.0000	-0.1231	0.0648	-0.5925	0.0057
0.800	0.01	2.00	0.9823	0.7975	0.0561	0.0079	-0.2320	0.7057	0.3583	-0.0233	0.0095	0.5078
0.800	-0.04	2.99	0.9831	0.8934	0.0592	-0.0028	-0.1626	0.8433	0.7839	-0.0706	0.3531	0.9295
0.800	-0.02	5.02	0.9828	0.9572	0.0519	0.0060	-0.1509	0.9317	1.7058	-0.0734	0.5971	1.8308
0.799	-0.02	6.98	0.9827	0.9728	0.0528	0.0376	-0.3945	0.9558	2.6199	0.1364	-0.4332	2.7411
0.601	5.98	1.01	0.0000	0.0000	0.1260	0.1181	-0.6209	0.0000	-0.1748	0.1181	-0.6209	0.0084
0.602	5.97	1.99	0.9838	0.8047	0.0921	0.1039	-0.4590	0.7501	0.6699	0.1334	-0.0336	0.8931
0.601	5.98	3.02	0.9829	0.9114	0.0826	0.0612	-0.2130	0.8822	1.4728	0.1038	0.7344	1.6695
0.601	5.96	4.98	0.9836	0.9590	0.0796	0.0930	-0.3143	0.9439	3.0367	0.2772	1.0375	3.2173
0.601	5.98	6.98	0.9825	0.9644	0.0904	0.1300	-0.6085	0.9543	4.6345	0.8083	-0.6797	4.8562
0.600	-0.01	1.02	0.0000	0.0000	0.0754	0.0684	-0.5574	0.0000	-0.1241	0.0684	-0.5574	0.0084
0.600	0.00	1.53	1.0189	0.7997	0.0425	0.0853	-0.5987	0.7119	0.3948	0.0421	-0.2563	0.5546
0.600	-0.01	2.00	0.9853	0.8326	0.0659	-0.0040	-0.1372	0.7789	0.7062	-0.0598	0.2922	0.9066
0.600	0.00	3.00	0.9839	0.9202	0.0605	-0.0016	-0.1274	0.8909	1.4784	-0.1229	0.7990	1.6594
0.600	-0.02	4.04	0.9826	0.9477	0.0615	0.0054	0.0437	0.9280	2.2906	-0.3052	1.9781	2.4684
0.600	-0.05	4.98	0.9836	0.9674	0.0551	0.0192	-0.1497	0.9523	3.0788	-0.1284	1.2018	3.2330
0.601	-0.03	5.98	0.9827	0.9769	0.0561	0.0372	-0.2951	0.9648	3.8849	0.0552	0.3433	4.0268
0.601	-0.04	7.02	0.9823	0.9809	0.0562	0.0516	-0.4086	0.9709	4.7455	0.2319	-0.5100	4.8875
0.600	-6.01	1.02	0.0000	0.0000	0.0740	0.0296	-0.5403	0.0000	-0.1226	0.0296	-0.5403	0.0084
0.600	-5.99	2.01	0.9834	0.8183	0.0712	-0.0455	-0.1070	0.7650	0.6992	-0.1876	0.3249	0.9140
0.600	-6.02	3.03	0.9837	0.9065	0.0638	-0.0466	-0.0888	0.8776	1.4756	-0.3412	0.8689	1.6815
0.600	-6.02	4.99	0.9833	0.9569	0.0576	-0.0265	-0.1147	0.9419	3.0470	-0.5042	1.2344	3.2349
0.601	-6.03	6.98	0.9824	0.9801	0.0514	0.0078	-0.3671	0.9701	4.7084	-0.3218	-0.4381	4.8537

Table 30. Internal and Aeropropulsive Characteristics for Nozzle 27

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	0.13	1.53	1.0185	0.8321	0.8243	-7.86	0.1149	-0.0159	0.1314	0.1394
0.000	0.11	1.99	0.9828	0.8557	0.8541	-3.54	0.1937	-0.0120	0.0971	0.2268
0.000	0.17	2.49	0.9813	0.8990	0.8973	-3.55	0.2874	-0.0178	0.1350	0.3203
0.000	0.22	2.96	0.9807	0.9247	0.9233	-3.17	0.3798	-0.0210	0.1567	0.4114
0.000	0.28	3.47	0.9819	0.9429	0.9418	-2.78	0.4803	-0.0233	0.1803	0.5100
0.000	0.33	3.96	0.9818	0.9517	0.9505	-2.83	0.5779	-0.0286	0.2166	0.6080
0.000	0.48	4.48	0.9817	0.9571	0.9542	-4.48	0.6780	-0.0531	0.3802	0.7106
0.000	0.43	5.02	0.9812	0.9629	0.9618	-2.75	0.7881	-0.0379	0.2979	0.8194
0.000	0.64	6.04	0.9824	0.9620	0.9595	-4.12	0.9879	-0.0712	0.5146	1.0296
0.000	0.96	6.99	0.9811	0.9636	0.9572	-6.64	1.1750	-0.1367	0.8517	1.2276

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
1.199	-0.01	0.91	0.0000	0.0000	0.1533	-0.0208	0.0643	0.0000	-0.1967	-0.0208	0.0643	0.0041
1.201	0.01	1.49	1.0037	-0.0255	0.1110	0.0356	-0.2129	-0.3649	-0.0467	0.0195	-0.0800	0.1279
1.196	0.01	2.05	0.9782	0.2793	0.1369	-0.0471	0.2720	0.0949	0.0224	-0.0586	0.3648	0.2356
1.200	0.00	4.00	0.9833	0.7141	0.1441	-0.0572	0.3195	0.6431	0.3935	-0.0859	0.5367	0.6119
1.201	-0.04	6.03	0.9810	0.8359	0.1271	-0.1043	0.6656	0.7933	0.8077	-0.1754	1.1748	1.0182
1.197	-0.04	7.96	0.9814	0.8894	0.0901	0.0594	-0.0575	0.8589	1.2253	-0.1438	1.1305	1.4266
1.199	-0.03	9.96	0.9815	0.9206	0.0429	0.2967	-1.2422	0.8970	1.6563	-0.0413	0.6404	1.8465
1.200	-0.04	12.00	0.9804	0.9408	-0.0099	0.5493	-2.5563	0.9217	2.1023	0.0726	0.0368	2.2810
0.949	0.01	1.02	0.0000	0.0000	0.0708	-0.0849	-0.0218	0.0000	-0.1162	-0.0849	-0.0218	0.0048
0.953	-0.02	2.04	0.9853	0.7384	0.0428	-0.0857	0.1860	0.6160	0.2286	-0.1040	0.3333	0.3712
0.949	-0.01	3.03	0.9827	0.8409	0.0562	-0.1397	0.3233	0.7733	0.5201	-0.1738	0.5777	0.6726
0.950	-0.02	5.04	0.9816	0.9182	0.0565	-0.1555	0.5284	0.8834	1.1527	-0.2162	1.0027	1.3049
0.949	-0.08	6.98	0.9814	0.9309	0.0503	-0.1768	0.8798	0.9075	1.7646	-0.3951	2.2255	1.9444
0.948	-0.08	9.02	0.9808	0.9503	-0.0052	0.0919	-0.3626	0.9331	2.4555	-0.3491	2.1241	2.6316
0.899	5.98	0.99	0.0000	0.0000	0.0903	-0.0632	0.0683	0.0000	-0.1362	-0.0632	0.0683	0.0050
0.900	6.00	2.03	0.9834	0.7156	0.0575	-0.0786	0.1845	0.6041	0.2485	-0.0624	0.3512	0.4114
0.900	5.99	3.01	0.9824	0.8488	0.0561	-0.1039	0.3206	0.7871	0.5846	-0.0697	0.6020	0.7428
0.901	5.98	5.01	0.9810	0.9227	0.0558	-0.1264	0.5495	0.8908	1.2825	-0.0484	1.0729	1.4397
0.901	5.95	6.97	0.9814	0.9435	0.0427	-0.1758	1.0254	0.9221	1.9831	-0.1987	2.5080	2.1506
0.897	5.94	8.98	0.9803	0.9553	0.0177	-0.1661	-0.5769	0.9395	2.7461	-0.0280	2.1756	2.9228
0.898	0.00	1.02	0.0000	0.0000	0.0714	-0.0926	-0.0077	0.0000	-0.1173	-0.0926	-0.0077	0.0050
0.898	-0.02	1.51	1.0027	0.6714	0.0398	-0.0694	-0.0990	0.4766	0.1123	-0.0979	0.1361	0.2357
0.898	0.01	2.05	0.9832	0.7300	0.0530	-0.1345	-0.2495	0.6209	0.2611	-0.1548	0.4139	0.4205
0.899	-0.01	3.04	0.9817	0.8522	0.0553	-0.1444	0.2916	0.7912	0.5951	-0.1826	0.5761	0.7522
0.899	0.00	4.04	0.9815	0.9018	0.0549	-0.1365	0.2614	0.8601	0.9457	-0.1879	0.6518	1.0996
0.897	-0.01	4.98	0.9809	0.9208	0.0591	-0.1615	0.4863	0.8889	1.2799	-0.2284	1.0097	1.4399
0.897	-0.05	6.97	0.9812	0.9326	0.0531	-0.1804	0.8686	0.9114	1.9761	-0.4216	2.3630	2.1682
0.898	-0.07	9.01	0.9805	0.9510	-0.0068	-0.1070	-0.4598	0.9354	2.7387	-0.3827	2.3060	2.9279
0.906	-6.04	1.01	0.0000	0.0000	0.1118	-0.1706	0.2313	0.0000	-0.1576	-0.1706	0.2313	0.0050
0.895	-6.00	2.01	0.9814	0.6287	0.0887	-0.1747	0.2893	0.5162	0.2109	-0.2323	0.4607	0.4086
0.900	-6.02	3.02	0.9822	0.7857	0.0959	-0.1988	0.3805	0.7242	0.5404	-0.3087	0.6630	0.7462
0.899	-6.03	5.04	0.9805	0.8884	0.0930	-0.2022	0.4444	0.8568	1.2467	-0.4161	0.9738	1.4550
0.900	-6.07	7.00	0.9810	0.8966	0.0941	-0.2381	0.9118	0.8755	1.8980	-0.6983	2.4196	2.1680
0.901	-6.08	9.02	0.9789	0.9247	0.0080	0.0295	-0.3510	0.9089	2.6454	-0.7458	2.4059	2.9105
0.799	-0.02	1.01	0.0000	0.0000	0.0760	-0.0978	0.0539	0.0000	-0.1228	-0.0978	0.0539	0.0058
0.800	-0.01	2.03	0.9838	0.7447	0.0574	-0.1318	0.2409	0.6550	0.3419	-0.1581	0.4520	0.5220
0.801	-0.01	3.03	0.9831	0.8649	0.0563	-0.1398	0.2725	0.8155	0.7728	-0.1878	0.6306	0.9476
0.800	-0.02	5.04	0.9824	0.9300	0.0564	-0.1513	0.4195	0.9046	1.6646	-0.2370	1.0878	1.8403
0.801	-0.06	7.01	0.9815	0.9369	0.0541	-0.1789	0.8753	0.9198	2.5236	-0.4885	2.7845	2.7435
0.597	5.99	0.99	0.0000	0.0000	0.0843	-0.0822	0.2448	0.0000	-0.1333	-0.0822	0.2448	0.0086
0.598	6.00	2.03	0.9819	0.7899	0.0627	-0.0871	0.2330	0.7375	0.6894	-0.0499	0.6100	0.9349
0.599	5.98	3.02	0.9822	0.8949	0.0509	-0.0856	0.2137	0.8658	1.4604	-0.0080	0.8520	1.6867
0.599	5.98	4.98	0.9822	0.9443	0.0511	-0.1103	0.4206	0.9292	3.0013	0.0642	1.5931	3.2301
0.600	5.94	7.00	0.9807	0.9545	0.0462	-0.1585	1.0323	0.9444	4.5959	-0.2167	4.4148	4.8663
0.599	-0.03	1.00	0.0000	0.0000	0.0727	-0.1114	0.1388	0.0000	-0.1216	-0.1114	0.1388	0.0086
0.600	0.01	1.53	1.0165	0.7483	0.0431	-0.1097	0.1589	0.6594	0.3626	-0.1729	0.6817	0.5499
0.600	-0.04	2.03	0.9834	0.7902	0.0599	-0.1429	0.2724	0.7374	0.6829	-0.1898	0.6474	0.9261
0.598	0.00	3.02	0.9831	0.8931	0.0525	-0.1392	0.2406	0.8642	1.4644	-0.2249	0.8812	1.6945
0.599	-0.02	3.97	0.9811	0.9258	0.0617	-0.1424	0.2573	0.9056	2.1978	-0.2574	1.1220	2.4268
0.599	-0.02	4.98	0.9821	0.9427	0.0582	-0.1570	0.3959	0.9276	3.0060	-0.3079	1.5724	3.2407
0.599	-0.03	6.00	0.9816	0.9455	0.0601	-0.1859	0.6615	0.9335	3.7985	-0.4673	2.6828	4.0689
0.599	-0.05	7.01	0.9812	0.9457	0.0551	-0.1791	0.9381	0.9357	4.5792	-0.7308	4.3445	4.8938
0.601	-6.02	0.99	0.0000	0.0000	0.1242	-0.1983	0.4064	0.0000	-0.1730	-0.1983	0.4064	0.0085
0.599	-6.00	2.03	0.9831	0.7357	0.1019	-0.2022	0.3795	0.6832	0.6349	-0.3315	0.7547	0.9293
0.600	-6.01	3.03	0.9827	0.8605	0.0906	-0.1952	0.3088	0.8316	1.4036	-0.4435	0.9469	1.6878
0.600	-6.02	4.97	0.9824	0.9221	0.0902	-0.2068	0.4328	0.9069	2.9163	-0.6787	1.5997	3.2155
0.600	-6.06	7.07	0.9818	0.9190	0.0978	-0.2347	0.9704	0.9092	4.4936	-1.2942	4.4588	4.9426

Table 31. Internal and Aeropulsive Characteristics for Nozzle 28

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	-0.02	1.50	1.0165	0.9086	0.9004	-7.71	0.1168	-0.0158	0.1060	0.1297
0.000	0.00	1.98	0.9718	0.9343	0.9318	-4.15	0.2037	-0.0148	0.1047	0.2186
0.000	0.00	2.50	0.9733	0.9636	0.9621	-3.20	0.3020	-0.0169	0.1241	0.3139
0.000	0.01	2.99	0.9735	0.9741	0.9734	-2.18	0.3945	-0.0150	0.1239	0.4053
0.000	0.10	3.52	0.9754	0.9738	0.9714	-4.08	0.4917	-0.0350	0.2463	0.5062
0.000	0.02	4.03	0.9754	0.9779	0.9748	-4.58	0.5896	-0.0472	0.3205	0.6048
0.000	-0.06	4.50	0.9755	0.9808	0.9772	-4.87	0.6809	-0.0581	0.3966	0.6968
0.000	-0.05	5.03	0.9764	0.9836	0.9817	-3.49	0.7877	-0.0480	0.3554	0.8023
0.000	-0.05	5.99	0.9772	0.9888	0.9888	-0.61	0.9843	-0.0104	0.1876	0.9955
0.000	-0.03	7.01	0.9775	0.9910	0.9908	1.25	1.1917	0.0260	0.0138	1.2028
0.000	-0.04	7.77	0.9774	0.9893	0.9886	2.19	1.3426	0.0515	-0.1127	1.3581

(b) Aeropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.599	-0.16	1.03	0.0000	0.0000	0.0582	0.0172	-0.3687	0.0000	-0.1065	0.0172	-0.3687	0.0085
0.600	-0.13	1.50	1.0203	0.8557	0.0217	-0.0296	-0.1201	0.7612	0.3907	-0.0934	0.3005	0.5133
0.600	-0.18	2.02	0.9696	0.8945	0.0360	-0.0530	0.0125	0.8399	0.7462	-0.1143	0.4301	0.8884
0.600	-0.15	3.00	0.9717	0.9512	0.0328	-0.0623	0.0304	0.9211	1.4860	-0.1275	0.5313	1.6132
0.601	-0.18	3.99	0.9712	0.9592	0.0587	-0.0792	0.1327	0.9386	2.2124	-0.2682	1.3750	2.3571
0.600	-0.16	5.01	0.9737	0.9707	0.0426	-0.0715	0.1235	0.9554	3.0190	-0.2738	1.5437	3.1600
0.600	-0.19	5.99	0.9745	0.9811	0.0396	-0.0394	-0.0409	0.9687	3.8140	-0.1005	0.7070	3.9372
0.600	-0.19	7.01	0.9748	0.9867	0.0333	-0.0279	-0.1507	0.9765	4.6452	0.0581	-0.0955	4.7569
1.203	-0.15	0.97	0.0000	0.0000	0.1994	0.1140	-0.5522	0.0000	-0.2427	0.1140	-0.5522	0.0040
1.204	-0.13	1.53	0.9871	-0.3400	0.1641	0.0921	-0.3657	-0.6740	-0.0876	0.0763	-0.2612	0.1299
1.201	-0.15	1.99	0.9625	0.1224	0.1756	0.0470	-0.1087	-0.0800	-0.0172	0.0318	-0.0050	0.2146
1.201	-0.16	3.99	0.9727	0.6857	0.1756	0.0413	-0.0579	0.6122	0.3620	-0.0059	0.2535	0.5913
1.201	-0.17	6.00	0.9718	0.8232	0.1678	0.0874	-0.3485	0.7790	0.7655	0.0728	-0.1631	0.9826
1.201	-0.15	8.00	0.9736	0.8722	0.1704	0.0867	-0.3995	0.8409	1.1656	0.1451	-0.5551	1.3862
1.201	-0.15	10.02	0.9742	0.8984	0.1680	0.0832	-0.4159	0.8743	1.5773	0.2152	-0.9173	1.8041
1.201	-0.15	12.00	0.9743	0.9111	0.1681	0.0796	-0.4102	0.8915	1.9795	0.2841	-1.2507	2.2204
0.952	-0.11	1.10	0.0000	0.0000	0.0627	0.0209	-0.3856	0.0000	-0.1082	0.0209	-0.3856	0.0047
0.950	-0.16	1.96	0.9715	0.7862	0.0491	-0.0357	-0.0367	0.6525	0.2216	-0.0601	0.1293	0.3396
0.950	-0.16	3.00	0.9713	0.8835	0.0568	-0.0547	0.0682	0.8129	0.5225	-0.0801	0.2646	0.6427
0.948	-0.16	4.98	0.9720	0.9427	0.0518	-0.0772	0.2016	0.9065	1.1377	-0.1576	0.7641	1.2550
0.950	-0.17	6.97	0.9742	0.9684	0.0488	-0.0447	0.0088	0.9443	1.7803	-0.0115	0.0391	1.8852
0.951	-0.17	9.01	0.9743	0.9749	0.0471	-0.0381	-0.1250	0.9570	2.4361	0.1128	-0.6495	2.5455
0.903	-0.16	1.08	0.0000	0.0000	0.0514	0.0132	-0.4145	0.0000	-0.0972	0.0132	-0.4145	0.0050
0.901	-0.15	1.55	0.9821	0.7836	0.0336	-0.0173	-0.2039	0.5908	0.1403	-0.0455	-0.0176	0.2376
0.899	-0.14	2.00	0.9725	0.8227	0.0428	-0.0475	-0.0416	0.7060	0.2772	-0.0745	0.1441	0.3927
0.899	-0.15	3.01	0.9720	0.9024	0.0500	-0.0624	0.0458	0.8391	0.6071	-0.0921	0.2728	0.7236
0.900	-0.15	4.01	0.9721	0.9320	0.0543	-0.0681	0.0811	0.8887	0.9404	-0.1536	0.6454	1.0582
0.902	-0.15	5.00	0.9716	0.9503	0.0500	-0.0797	0.1715	0.9175	1.2780	-0.1696	0.8022	1.3930
0.898	-0.18	7.03	0.9745	0.9745	0.0416	-0.0428	-0.0595	0.9530	2.0292	-0.0028	-0.0409	2.1293
0.899	-0.16	9.03	0.9746	0.9786	0.0412	-0.0372	-0.1860	0.9626	2.7464	0.1334	-0.7786	2.8532
0.799	-0.16	1.05	0.0000	0.0000	0.0530	0.0184	-0.3952	0.0000	-0.0997	0.0184	-0.3952	0.0057
0.801	-0.16	2.00	0.9721	0.8537	0.0387	-0.0431	-0.0258	0.7592	0.3750	-0.0773	0.2079	0.4940
0.799	-0.14	3.02	0.9737	0.9209	0.0450	-0.0561	0.0482	0.8700	0.7980	-0.0937	0.3363	0.9173
0.800	-0.15	5.00	0.9726	0.9582	0.0479	-0.0672	0.1504	0.9319	1.6519	-0.1813	0.9518	1.7726
0.800	-0.17	6.97	0.9748	0.9794	0.0380	-0.0276	-0.0970	0.9618	2.5549	0.0187	-0.0520	2.6563

Table 32. Internal and Aeropropulsive Characteristics for Nozzle 29

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTA P	CFJ	CFN	CMJ	CFI
0.000	0.07	1.98	0.9715	0.9606	0.9603	-1.37	0.2096	-0.0050	0.0525	0.2182
0.000	0.13	2.50	0.9718	0.9788	0.9782	-1.85	0.3061	-0.0099	0.0931	0.3129
0.000	0.19	3.01	0.9714	0.9822	0.9818	-1.68	0.4009	-0.0118	0.1182	0.4083
0.000	0.17	3.50	0.9732	0.9873	0.9873	-0.14	0.4961	-0.0012	0.0581	0.5025
0.000	0.21	3.99	0.9744	0.9852	0.9852	-0.39	0.5878	-0.0040	0.0910	0.5967
0.000	0.37	4.51	0.9746	0.9799	0.9792	-2.22	0.6840	-0.0265	0.2597	0.6985
0.000	0.51	4.99	0.9751	0.9760	0.9743	-3.32	0.7726	-0.0449	0.3995	0.7929
0.000	-0.03	6.00	0.9770	0.9726	0.9716	-2.65	0.9690	-0.0448	0.4573	0.9973
0.000	-0.05	7.00	0.9773	0.9725	0.9724	-0.47	1.1682	-0.0095	0.3176	1.2014

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.948	-0.02	1.05	0.0000	0.0000	0.0566	-0.0503	-0.2548	0.0000	-0.1013	-0.0503	-0.2548	0.0047
0.951	0.01	1.97	0.9736	0.8497	0.0369	-0.0538	-0.1787	0.7182	0.2450	-0.0615	-0.0976	0.3411
0.947	0.00	3.01	0.9717	0.9238	0.0376	-0.0692	-0.1380	0.8548	0.5565	-0.0880	0.0501	0.6510
0.950	0.01	5.02	0.9712	0.9473	0.0385	-0.0813	0.0769	0.9116	1.1491	-0.1543	0.7244	1.2605
0.949	-0.02	6.97	0.9730	0.9576	0.0360	-0.0289	-0.2619	0.9337	1.7593	-0.0465	0.2498	1.8841
0.951	-0.03	8.99	0.9739	0.9552	0.0450	0.0528	-0.8765	0.9375	2.3812	0.1469	-0.8122	2.5399
0.899	0.01	1.02	0.0000	0.0000	0.0564	-0.0893	-0.0425	0.0000	-0.1018	-0.0893	-0.0425	0.0050
0.898	0.02	1.47	1.0116	0.8013	0.0285	-0.0413	-0.2701	0.5900	0.1269	-0.0441	-0.2360	0.2151
0.900	0.00	2.03	0.9688	0.8772	0.0353	-0.0569	-0.1980	0.7634	0.3048	-0.0662	-0.1003	0.3992
0.900	-0.01	2.96	0.9697	0.9302	0.0373	-0.0635	-0.1583	0.8654	0.6071	-0.0838	0.0439	0.7014
0.900	-0.03	4.03	0.9698	0.9506	0.0412	-0.0967	0.1075	0.9079	0.9652	-0.1037	0.2659	1.0632
0.902	-0.01	5.03	0.9698	0.9498	0.0410	-0.0790	0.0621	0.9173	1.2833	-0.1611	0.7855	1.3990
0.900	-0.04	6.98	0.9731	0.9589	0.0372	-0.0203	-0.2987	0.9372	1.9691	-0.0401	0.2675	2.1009
0.900	-0.01	9.20	0.9744	0.9576	0.0417	0.0778	-1.0725	0.9420	2.7455	0.1974	-1.0525	2.9145
1.201	-0.01	0.90	0.0000	0.0000	0.1689	0.0051	-0.1103	0.0000	-0.2122	0.0051	-0.1103	0.0040
1.201	0.02	1.55	0.9907	-0.0686	0.1376	0.0478	-0.3098	-0.3854	-0.0526	0.0457	-0.2853	0.1365
1.199	0.02	2.02	0.9613	0.3254	0.1433	0.0214	-0.1632	0.1301	0.0288	0.0162	-0.1088	0.2214
1.202	0.00	4.00	0.9714	0.7530	0.1391	0.0012	0.0048	0.6798	0.4019	-0.0026	0.0943	0.5913
1.200	0.00	6.00	0.9711	0.8488	0.1267	0.1002	-0.6067	0.8048	0.7919	0.0558	-0.1537	0.9839
1.198	0.00	7.96	0.9719	0.8770	0.1382	0.1302	-0.8311	0.8457	1.1694	0.1543	-0.6478	1.3828
1.200	-0.01	8.99	0.9737	0.8858	0.1391	0.1562	-1.0198	0.8586	1.3680	0.2159	-0.9794	1.5932
0.799	0.00	1.01	0.0000	0.0000	0.0602	-0.0862	0.0162	0.0000	-0.1068	-0.0862	0.0162	0.0056
0.799	-0.02	2.00	0.9701	0.8764	0.0426	-0.0472	-0.1802	0.7820	0.3858	-0.0587	-0.0612	0.4934
0.801	-0.01	2.98	0.9716	0.9310	0.0452	-0.0589	-0.1002	0.8791	0.7871	-0.0848	0.1578	0.8954
0.817	-0.02	5.10	0.9727	0.9554	0.0350	-0.0680	0.0581	0.9288	1.6134	-0.1740	0.9832	1.7371
0.798	-0.01	5.03	0.9727	0.9525	0.0424	-0.0749	0.1015	0.9266	1.6630	-0.1800	1.0289	1.7946
0.799	-0.04	6.99	0.9737	0.9607	0.0410	-0.0109	-0.2763	0.9433	2.5206	-0.0350	0.4387	2.6721
0.600	0.03	1.01	0.0000	0.0000	0.0555	-0.0895	0.0854	0.0000	-0.1043	-0.0895	0.0854	0.0084
0.602	0.01	1.53	1.0054	0.8795	0.0259	-0.0389	-0.1416	0.7887	0.4220	-0.0468	-0.0486	0.5350
0.601	-0.02	2.01	0.9700	0.9180	0.0402	-0.0491	-0.1140	0.8630	0.7630	-0.0700	0.1006	0.8840
0.600	0.01	3.01	0.9709	0.9579	0.0398	-0.0502	-0.0959	0.9279	1.5039	-0.0967	0.3730	1.6208
0.602	0.02	4.04	0.9713	0.9653	0.0538	-0.1021	0.2741	0.9450	2.2506	-0.1157	0.6272	2.3817
0.599	-0.02	4.97	0.9734	0.9603	0.0495	-0.0898	0.2818	0.9448	2.9653	-0.2671	1.8522	3.1386
0.600	-0.01	5.99	0.9737	0.9622	0.0502	-0.0395	0.0344	0.9498	3.7356	-0.2180	1.8458	3.9330
0.600	-0.05	7.00	0.9749	0.9656	0.0437	-0.0133	-0.1536	0.9553	4.5360	-0.0561	1.1087	4.7480

Table 33. Internal and Aeropropulsive Characteristics for Nozzle 30

## (a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	-0.15	1.49	1.0326	0.9096	0.9041	-6.32	0.1204	-0.0133	0.0742	0.1332
0.000	-0.11	2.03	0.9879	0.9406	0.9363	-5.48	0.2205	-0.0212	0.1069	0.2355
0.000	-0.12	2.50	0.9877	0.9611	0.9565	-5.58	0.3115	-0.0304	0.1550	0.3256
0.000	-0.12	3.00	0.9877	0.9710	0.9665	-5.54	0.4074	-0.0395	0.2036	0.4215
0.000	-0.15	3.49	0.9884	0.9810	0.9793	-3.41	0.5072	-0.0302	0.1398	0.5179
0.000	-0.14	4.01	0.9901	0.9789	0.9743	-5.56	0.6075	-0.0592	0.2993	0.6235
0.000	-0.14	4.46	0.9897	0.9791	0.9733	-6.24	0.6957	-0.0760	0.3964	0.7148
0.000	-0.13	4.99	0.9901	0.9800	0.9743	-6.22	0.8018	-0.0874	0.4517	0.8230
0.000	-0.14	6.03	0.9920	0.9768	0.9732	-4.91	1.0127	-0.0871	0.4620	1.0406
0.000	-0.15	7.04	0.9920	0.9780	0.9774	-1.94	1.2235	-0.0415	0.2397	1.2518

## (b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FT	CDN	CLCN	CMCN	F-D/FT	C(F-D)	CL	CM	CFI
0.599	5.98	1.02	0.0000	0.0000	0.0435	-0.0438	-0.0151	0.0000	-0.0919	-0.0438	-0.0151	0.0085
0.600	5.99	1.96	0.9826	0.8969	0.0444	-0.0654	0.0886	0.8415	0.7364	-0.0603	0.4951	0.8751
0.600	6.02	2.99	0.9851	0.9530	0.0323	-0.0772	0.1190	0.9239	1.5372	-0.0638	0.9249	1.6639
0.601	6.01	4.97	0.9880	0.9714	0.0345	-0.0718	0.1620	0.9564	3.0952	-0.0832	1.9383	3.2362
0.599	5.96	6.99	0.9898	0.9722	0.0272	-0.0332	-0.0320	0.9624	4.7430	0.2956	0.9624	4.9283
0.600	-0.02	1.01	0.0000	0.0000	0.0498	-0.1506	0.2519	0.0000	-0.0983	-0.1506	0.2519	0.0085
0.600	-0.02	1.52	1.0256	0.8776	0.0118	-0.1089	0.0799	0.7897	0.4357	-0.1648	0.3615	0.5518
0.600	0.01	2.01	0.9868	0.9006	0.0383	-0.1249	0.1427	0.8479	0.7809	-0.2095	0.5630	0.9210
0.600	0.01	3.00	0.9877	0.9493	0.0268	-0.1342	0.1670	0.9203	1.5386	-0.2906	0.9747	1.6718
0.599	-0.03	4.03	0.9875	0.9623	0.0365	-0.1374	0.2139	0.9428	2.3462	-0.3755	1.4116	2.4885
0.600	0.00	4.96	0.9889	0.9647	0.0351	-0.1242	0.2169	0.9496	3.0648	-0.4662	1.9844	3.2274
0.601	-0.01	5.99	0.9890	0.9683	0.0308	-0.0816	0.1138	0.9563	3.8853	-0.4406	1.9391	4.0626
0.601	-0.02	7.01	0.9897	0.9735	0.0298	-0.0896	0.0599	0.9637	4.7296	-0.2606	1.0337	4.9079
0.600	-6.02	1.00	0.0000	0.0000	0.1056	-0.2130	0.3621	0.0000	-0.1542	-0.2130	0.3621	0.0085
0.600	-6.00	2.00	0.9870	0.8367	0.0823	-0.2012	0.3067	0.7836	0.7168	-0.3750	0.7248	0.9147
0.599	-5.99	3.01	0.9875	0.9088	0.0706	-0.2029	0.2913	0.8800	1.4855	-0.5304	1.1070	1.6880
0.600	-6.01	4.97	0.9898	0.9364	0.0704	-0.1915	0.3118	0.9215	2.9860	-0.8638	2.0870	3.2406
0.600	-6.03	7.01	0.9903	0.9588	0.0548	-0.1403	0.0722	0.9490	4.6819	-0.8164	1.0491	4.9335
1.199	-0.03	0.90	0.0000	0.0000	0.2155	-0.1160	0.4901	0.0000	-0.2589	-0.1160	0.4901	0.0040
1.196	0.01	1.51	1.0231	-0.2835	0.1605	-0.0583	0.1920	-0.6043	-0.0817	-0.0722	0.2670	0.1353
1.199	0.00	2.00	0.9836	0.1632	0.1779	-0.0936	0.3919	-0.0273	-0.0062	-0.1146	0.4964	0.2277
1.200	-0.02	3.96	0.9894	0.6931	0.1711	-0.0948	0.4311	0.6216	0.3775	-0.1527	0.7229	0.6073
1.199	-0.03	5.99	0.9890	0.8251	0.1540	-0.0258	0.0959	0.7827	0.8002	-0.1163	0.5549	1.0224
1.201	-0.02	8.00	0.9902	0.8776	0.1481	-0.0024	-0.1040	0.8475	1.2204	-0.0007	-0.0773	1.4400
1.200	0.02	9.96	0.9912	0.8980	0.1493	0.0621	-0.3620	0.8747	1.6319	-0.1535	-0.7674	1.8655
1.200	0.01	12.01	0.9909	0.9114	0.1460	0.0992	-0.5952	0.8926	2.0632	0.2831	-1.4520	2.3113
0.950	0.02	1.06	0.0000	0.0000	0.0750	-0.1280	0.2687	0.0000	-0.1204	-0.1280	0.2687	0.0047
0.950	-0.01	1.99	0.9904	0.7876	0.0542	-0.1071	0.1860	0.6620	0.2392	-0.1404	0.3512	0.3614
0.951	-0.03	2.98	0.9899	0.8836	0.0527	-0.1137	0.2493	0.8151	0.5399	-0.1759	0.5685	0.6623
0.951	0.00	5.00	0.9892	0.9308	0.0577	-0.1102	0.3050	0.8959	1.1658	-0.2484	1.0203	1.3013
0.952	-0.03	6.97	0.9902	0.9515	0.0537	-0.1105	0.3418	0.9282	1.8068	-0.1816	0.7418	1.9466
0.951	-0.01	8.96	0.9910	0.9623	0.0446	-0.0622	0.0017	0.9451	2.4807	0.0098	-0.2931	2.6249
0.902	5.98	1.05	0.0000	0.0000	0.0539	-0.0821	0.1483	0.0000	-0.0997	-0.0821	0.1483	0.0050
0.901	6.00	1.99	0.9900	0.8443	0.0397	-0.0608	0.0756	0.7308	0.2949	-0.0581	0.2599	0.4036
0.900	6.01	2.99	0.9893	0.9263	0.0312	-0.0713	0.1284	0.8647	0.6425	-0.0655	0.4867	0.7431
0.900	6.01	5.00	0.9888	0.9548	0.0383	-0.0556	0.1644	0.9232	1.3390	-0.0610	0.9617	1.4503
0.898	5.97	7.00	0.9905	0.9621	0.0330	-0.0360	0.0614	0.9413	2.0696	0.1114	0.5019	2.1986
0.900	5.98	9.00	0.9911	0.9567	0.0420	-0.0241	-0.3002	0.9411	2.7722	0.4086	-0.6462	2.9456
0.899	-0.03	1.04	0.0000	0.0000	0.0606	-0.1342	0.2257	0.0000	-0.1064	-0.1342	0.2257	0.0050
0.899	0.03	1.53	1.0249	0.8060	0.0230	-0.0906	0.0412	0.6202	0.1529	-0.1155	0.1757	0.2465
0.900	0.01	2.01	0.9908	0.8412	0.0396	-0.1095	0.1359	0.7291	0.2978	-0.1469	0.3217	0.4085
0.898	-0.02	3.00	0.9900	0.9174	0.0342	-0.1181	0.1769	0.8560	0.6396	-0.1883	0.5371	0.7472
0.900	0.00	4.00	0.9895	0.9414	0.0367	-0.0949	0.0823	0.8996	0.9853	-0.1990	0.6084	1.0953
0.901	0.00	5.04	0.9887	0.9484	0.0396	-0.0995	0.2200	0.9171	1.3423	-0.2583	1.0160	1.4637
0.900	-0.05	6.97	0.9907	0.9635	0.0328	-0.0913	0.1557	0.9425	2.0542	-0.1711	0.6023	2.1795
0.901	0.00	9.02	0.9909	0.9685	0.0322	-0.0354	-0.1891	0.9530	2.8094	0.0502	-0.5406	2.9479
0.900	-6.02	1.03	0.0000	0.0000	0.1106	-0.1908	0.3178	0.0000	-0.1564	-0.1908	0.3178	0.0050
0.900	-6.00	2.00	0.9880	0.7265	0.0809	-0.1733	0.2460	0.6138	0.2493	-0.2504	0.4316	0.4063
0.899	-5.99	3.00	0.9870	0.8471	0.0774	-0.1860	0.3300	0.7857	0.5858	-0.3307	0.6905	0.7456
0.899	-6.00	5.01	0.9879	0.9090	0.0737	-0.1596	0.2968	0.8775	1.2775	-0.4667	1.0947	1.4558
0.900	-6.04	6.97	0.9897	0.9400	0.0660	-0.1424	0.1827	0.9190	2.0019	-0.4448	0.6310	2.1783
0.899	-6.02	9.00	0.9902	0.9587	0.0565	-0.0770	-0.1860	0.9431	2.7842	-0.2962	-0.5321	2.9520
0.801	-0.03	1.03	0.0000	0.0000	0.0591	-0.1325	0.2426	0.0000	-0.1058	-0.1325	0.2426	0.0057
0.800	0.00	2.00	0.9870	0.8558	0.0437	-0.1037	0.1276	0.7645	0.3908	-0.1508	0.3616	0.5112
0.801	0.00	3.01	0.9877	0.9271	0.0362	-0.1161	0.1841	0.8777	0.8287	-0.2047	0.6402	0.9442
0.799	0.00	5.02	0.9890	0.9524	0.0422	-0.0889	0.1986	0.9272	1.7169	-0.2907	1.2088	1.8517
0.800	-0.04	6.97	0.9897	0.9660	0.0371	-0.0745	0.0912	0.9491	2.6180	-0.1755	0.6580	2.7585

Table 34. Internal and Aeropropulsive Characteristics for Nozzle 31

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	0.08	1.50	1.0321	0.9075	0.9042	-4.87	0.1204	-0.0103	0.0618	0.1331
0.000	0.10	2.00	0.9881	0.9359	0.9343	-3.35	0.2133	-0.0125	0.0637	0.2283
0.000	0.14	2.51	0.9881	0.9622	0.9608	-3.06	0.3129	-0.0167	0.0773	0.3257
0.000	0.21	3.00	0.9881	0.9730	0.9712	-3.51	0.4079	-0.0250	0.1208	0.4200
0.000	0.14	3.48	0.9897	0.9804	0.9803	-0.87	0.5039	-0.0077	0.0146	0.5140
0.000	0.27	3.99	0.9901	0.9777	0.9763	-3.07	0.6008	-0.0322	0.1504	0.6154
0.000	0.41	4.49	0.9903	0.9769	0.9736	-4.71	0.6977	-0.0575	0.2936	0.7166
0.000	0.50	4.99	0.9902	0.9784	0.9743	-5.22	0.7976	-0.0729	0.3848	0.8186
0.000	0.59	6.01	0.9921	0.9779	0.9739	-5.15	1.0030	-0.0904	0.4619	1.0299
0.000	0.48	7.00	0.9922	0.9794	0.9784	-2.59	1.2121	-0.0547	0.3011	1.2388

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.600	5.97	1.02	0.0000	0.0000	0.0528	-0.0718	0.0977	0.0000	-0.1011	-0.0718	0.0977	0.0085
0.598	6.01	2.00	0.9846	0.8964	0.0451	-0.0475	-0.0326	0.8434	0.7686	-0.0070	0.2216	0.9114
0.598	6.02	3.02	0.9863	0.9509	0.0358	-0.0373	-0.0773	0.9222	1.5559	-0.0348	0.4071	1.6871
0.598	6.01	5.00	0.9950	0.9646	0.0298	-0.0718	0.1323	0.9499	3.1251	-0.0283	1.6746	3.2900
0.598	6.01	7.04	0.9900	0.9740	0.0296	-0.0202	-0.0005	0.9642	4.7914	-0.2730	1.1789	4.9692
0.602	-0.02	1.02	0.0000	0.0000	0.0491	-0.1356	0.1865	0.0000	-0.0975	-0.1356	0.1865	0.0084
0.601	0.00	1.55	1.0204	0.8695	0.0168	-0.1000	0.0108	0.7837	0.4417	-0.1416	0.2560	0.5636
0.600	0.02	2.01	0.9856	0.9031	0.0378	-0.1063	0.0292	0.8498	0.7730	-0.1558	0.2819	0.9096
0.601	-0.02	3.03	0.9867	0.9542	0.0279	-0.0996	-0.0141	0.9254	1.5561	-0.1999	0.4676	1.6814
0.600	0.00	3.99	0.9872	0.9645	0.0360	-0.1023	-0.0019	0.9447	2.3055	-0.2304	0.5959	2.4405
0.599	0.00	4.98	0.9851	0.9670	0.0404	-0.1246	0.1830	0.9520	3.0728	-0.4124	1.7011	3.2277
0.600	-0.02	5.96	0.9893	0.9680	0.0340	-0.0766	0.0944	0.9560	3.8608	-0.4334	1.9141	4.0386
0.600	-0.05	7.03	0.9903	0.9742	0.0304	-0.0787	0.0908	0.9644	4.7501	-0.2962	1.2694	4.9255
0.599	-6.03	1.00	0.0000	0.0000	0.1042	-0.1976	0.3006	0.0000	-0.1526	-0.1976	0.3006	0.0085
0.598	-5.99	2.01	0.9868	0.8453	0.0802	-0.1813	0.1857	0.7925	0.7273	-0.3215	0.4404	0.9177
0.598	-5.99	2.95	0.9879	0.9167	0.0670	-0.1792	0.1567	0.8871	1.4550	-0.4430	0.6334	1.6402
0.598	-5.99	3.99	0.9889	0.9386	0.0732	-0.1918	0.2959	0.9238	3.0321	-0.8174	1.8390	3.2822
0.598	-6.00	5.01	0.9889	0.9386	0.0732	-0.1918	0.2959	0.9238	4.7080	-0.8593	1.3057	4.9644
0.598	-6.04	7.03	0.9908	0.9581	0.0585	-0.1344	0.1226	0.9484	0.0000	-0.2573	0.2143	0.0040
1.199	-0.01	0.95	0.0000	0.0000	0.2140	-0.0713	0.2143	0.0000	-0.0979	-0.0568	0.1685	0.1326
1.200	0.01	1.51	1.0188	-0.4109	0.1744	-0.0465	0.1071	-0.7380	-0.0709	-0.0932	0.3459	0.2294
1.200	0.01	2.02	0.9815	0.1182	0.1907	-0.0808	0.2826	0.6030	-0.0163	-0.1323	0.5965	0.6089
1.202	-0.03	3.99	0.9886	0.6743	0.1848	-0.1001	0.4475	0.6030	0.3671	-0.1064	0.4990	1.0231
1.200	0.00	6.04	0.9880	0.8177	0.1642	-0.0177	0.0456	0.7753	0.7932	-0.0043	-0.0667	1.4252
1.201	-0.01	7.97	0.9894	0.8726	0.1569	0.0160	-0.2108	0.8421	1.2007	-0.4430	-0.8228	1.8576
1.199	-0.01	9.97	0.9902	0.8949	0.1597	0.0959	-0.6462	0.8715	1.6189	-0.1468	-0.8228	1.8576
1.201	0.00	11.99	0.9903	0.9091	0.1561	0.1553	-0.9885	0.8901	2.0389	0.2783	-1.4876	2.2906
0.948	0.01	1.06	0.0000	0.0000	0.0828	-0.1167	0.1445	0.0000	-0.1281	-0.1167	0.1445	0.0047
0.948	0.01	2.06	0.9891	0.7762	0.0639	-0.1038	0.0810	0.6570	0.2499	-0.1240	0.1825	0.3804
0.951	-0.01	3.04	0.9888	0.8701	0.0666	-0.0980	0.0825	0.8029	0.5412	-0.1380	0.2748	0.6740
0.952	0.01	5.05	0.9885	0.9256	0.0657	-0.1058	0.2454	0.8909	1.1638	-0.2220	0.8588	1.3063
0.951	-0.01	6.94	0.9891	0.9481	0.0639	-0.1119	0.3358	0.9246	1.7834	-0.2023	0.8283	1.9288
0.951	-0.03	8.92	0.9906	0.9624	0.0497	-0.0367	-0.2017	0.9450	2.4531	-0.0157	-0.2153	2.5961
0.902	5.99	1.06	0.0000	0.0000	0.0562	-0.0734	0.0583	0.0000	-0.1020	-0.0734	0.0583	0.0050
0.902	6.02	2.01	0.9907	0.8366	0.0419	-0.0529	-0.0350	0.7235	0.2925	-0.0349	0.0768	0.4043
0.904	6.01	3.01	0.9900	0.9205	0.0353	-0.0488	-0.0539	0.8585	0.6327	-0.0177	0.1574	0.7370
0.903	5.99	5.03	0.9890	0.9521	0.0396	-0.0603	0.1231	0.9205	1.3329	-0.0411	0.8032	1.4481
0.901	5.97	6.96	0.9902	0.9626	0.0370	-0.0461	0.1247	0.9414	2.0319	0.0757	0.6661	2.1584
0.902	5.99	9.00	0.9909	0.9594	0.0450	0.0605	-0.5553	0.9437	2.7534	0.3886	-0.5930	2.9176
0.900	-0.04	1.05	0.0000	0.0000	0.0591	-0.1239	0.1374	0.0000	-0.1048	-0.1239	0.1374	0.0050
0.904	0.02	1.54	1.0141	0.8008	0.0257	-0.0876	-0.0364	0.6154	0.1517	-0.1059	0.0720	0.2465
0.901	0.02	2.06	0.9911	0.8468	0.0406	-0.1027	0.0381	0.7390	0.3136	-0.1250	0.1508	0.4243
0.898	-0.01	3.01	0.9885	0.9201	0.0365	-0.0957	-0.0070	0.8588	0.6406	-0.1402	0.2073	0.7459
0.901	0.01	4.01	0.9895	0.9443	0.0357	-0.0545	-0.2456	0.9024	0.9853	-0.1128	0.0294	1.0918
0.899	0.01	5.02	0.9894	0.9455	0.0431	-0.1065	0.1597	0.9141	1.3314	-0.2361	0.8439	1.4566
0.899	-0.01	6.98	0.9903	0.9631	0.0373	-0.0979	0.2027	0.9421	2.0498	-0.1968	-0.7427	2.1758
0.899	-0.01	9.01	0.9911	0.9704	0.0312	-0.0007	-0.4374	0.9548	2.7984	0.0288	-0.4760	2.9310
0.898	-6.02	1.03	0.0000	0.0000	0.1070	-0.1829	0.2360	0.0000	-0.1527	-0.1829	0.2360	0.0050
0.900	-5.99	2.01	0.9904	0.7408	0.0769	-0.1644	0.1394	0.6286	0.2563	-0.2264	0.2520	0.4076
0.898	-5.99	2.99	0.9900	0.8556	0.0746	-0.1630	0.1359	0.7940	0.5899	-0.2819	0.3495	0.7430
0.897	-6.00	5.01	0.9894	0.9098	0.0738	-0.1694	0.2584	0.8785	1.2833	-0.4478	0.9448	1.4607
0.899	-6.03	6.97	0.9901	0.9393	0.0673	-0.1538	0.2567	0.9183	1.9966	-0.4761	0.7989	2.1743
0.901	-6.02	9.00	0.9910	0.9609	0.0462	-0.0428	-0.4245	0.9453	2.7632	-0.3142	-0.4609	2.9232
0.801	-0.03	1.03	0.0000	0.0000	0.0589	-0.1246	0.1611	0.0000	-0.1055	-0.1246	0.1611	0.0057
0.800	0.00	2.01	0.9884	0.8593	0.0425	-0.0949	0.0210	0.7685	0.3949	-0.1228	0.1633	0.5138
0.800	-0.02	3.01	0.9890	0.9320	0.0345	-0.0910	-0.0104	0.8825	0.8325	-0.1474	0.2601	0.9433
0.801	-0.01	4.99	0.9890	0.9526	0.0418	-0.1022	-0.1582	0.9270	1.6860	-0.2646	1.0138	1.8189
0.800	-0.04	6.98	0.9906	0.9662	0.0378	-0.0805	0.1557	0.9492	2.6115	-0.2063	0.8373	2.7511



Table 35. Internal and Aeropropulsive Characteristics for Nozzle 32

(a) Internal performance

M	ALPHA	NPR	WP/VI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	0.06	1.50	1.0285	0.9249	0.9212	-5.09	0.1235	-0.0110	0.0605	0.1341
0.000	0.07	2.01	0.9872	0.9480	0.9462	-3.49	0.2181	-0.0133	0.0613	0.2305
0.000	0.10	2.50	0.9859	0.9717	0.9704	-2.96	0.3130	-0.0162	0.0706	0.3225
0.000	0.16	2.97	0.9863	0.9790	0.9769	-3.75	0.4036	-0.0265	0.1208	0.4132
0.000	0.10	3.45	0.9881	0.9862	0.9861	-0.90	0.5026	-0.0079	0.1201	0.4132
0.000	0.25	3.95	0.9884	0.9832	0.9819	-2.95	0.5970	-0.0308	0.0151	0.5097
0.000	0.39	4.47	0.9888	0.9818	0.9780	-5.01	0.6966	-0.0611	0.1368	0.6080
0.000	0.49	4.99	0.9897	0.9834	0.9780	-5.98	0.8015	-0.0839	0.2831	0.7122
0.000	0.58	5.97	0.9916	0.9816	0.9764	-5.93	0.9982	-0.1038	0.3726	0.8195
0.000	0.48	6.96	0.9921	0.9817	0.9804	-2.98	1.2069	-0.0628	0.4423	1.0223
									0.3005	1.2311

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/VI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.597	6.00	1.02	0.0000	0.0000	0.0542	-0.0900	0.2188	0.0000	-0.1025	-0.0900	0.2188	0.0085
0.598	6.01	2.04	0.9864	0.8911	0.0545	-0.0557	0.0495	0.8398	0.7927	-0.0154	0.2947	0.9439
0.600	6.00	3.03	0.9862	0.9497	0.0496	-0.0449	-0.0200	0.9210	1.5546	0.0219	0.4636	1.6878
0.600	6.00	4.96	0.9885	0.9678	0.0543	-0.0649	0.2141	0.9528	3.0769	-0.0605	1.6697	3.2293
0.599	5.96	7.02	0.9899	0.9719	0.0517	-0.0075	0.0883	0.9621	4.7587	-0.2593	1.2476	4.9460
0.599	-0.02	1.02	0.0000	0.0000	0.0676	-0.1539	0.3352	0.0000	-0.1161	-0.1539	0.3352	0.0084
0.598	0.02	1.53	1.0214	0.8443	0.0435	-0.0945	0.0748	0.7567	0.4187	-0.1388	0.3168	0.5533
0.598	-0.02	2.04	0.9891	0.8894	0.0533	-0.1072	0.1120	0.8382	0.7942	-0.1607	0.3569	0.9475
0.598	0.01	3.05	0.9868	0.9483	0.0506	-0.0963	0.0408	0.9201	1.5826	-0.2042	0.5290	1.7200
0.598	-0.01	4.96	0.9869	0.9597	0.0576	-0.1048	0.0569	0.9399	2.2984	-0.2276	0.6045	2.4454
0.598	-0.01	7.01	0.9893	0.9597	0.0612	-0.1076	0.2553	0.9448	3.0654	-0.4363	1.7135	3.2446
0.599	-0.01	1.01	0.0000	0.0000	0.0542	-0.0508	0.1459	0.9538	3.9037	-0.4681	1.9194	4.0928
0.600	-6.02	2.01	0.9859	0.8283	0.1244	-0.2075	0.1736	0.9622	4.7480	-0.3105	1.3414	4.9345
0.599	-6.00	3.02	0.9873	0.9110	0.0992	-0.1732	0.2417	0.7755	0.7126	-0.3169	0.4860	0.0084
0.599	-5.99	4.96	0.9899	0.9319	0.0975	-0.1627	0.3214	0.9172	1.4915	-0.4425	0.6699	0.9189
0.599	-6.01	7.03	0.9903	0.9554	0.0819	-0.1058	0.1630	0.9456	3.0122	-0.8354	1.8240	1.6904
0.599	-6.03	1.01	0.0000	0.0000	0.2437	-0.1519	0.7053	0.0000	-0.2869	-0.1519	1.3181	4.9636
1.199	-0.02	0.88	0.0000	0.0000	0.1820	-0.0488	0.1630	0.9456	-0.0882	-0.0488	0.7053	0.0040
1.200	0.00	1.41	1.0337	-0.6712	0.1820	-0.0488	0.1630	0.9456	-0.0882	-0.0488	0.7053	0.1129
1.201	-0.02	2.02	0.9781	0.0777	0.2009	-0.0914	0.1954	-1.0537	-0.1190	-0.0593	0.2553	0.0289
1.200	-0.03	3.99	0.9871	0.6572	0.1987	-0.1167	0.4138	-0.1111	-0.0254	-0.1047	0.4745	0.1129
1.200	-0.01	6.02	0.9877	0.8075	0.1767	-0.1167	0.5653	0.5863	0.3576	-0.1477	0.7016	0.6100
1.200	-0.02	8.03	0.9897	0.8685	0.1767	-0.1167	0.5863	0.7651	0.7811	-0.1208	0.6278	1.0209
1.200	0.01	10.05	0.9901	0.8930	0.1670	-0.1077	-0.1560	0.8386	1.2105	-0.0013	-0.0093	1.4435
1.200	0.02	12.04	0.9905	0.9056	0.1675	0.0871	-0.6478	0.8699	1.6315	0.1518	-0.7876	1.8755
0.950	-0.02	1.03	0.0000	0.0000	0.1673	-0.1319	-1.0210	0.8868	2.0451	0.2784	-1.4429	2.3061
0.949	-0.00	2.01	0.9893	0.6926	0.1113	-0.0910	0.1771	0.0000	-0.1566	-0.0910	0.1771	0.0047
0.949	-0.03	3.01	0.9881	0.8351	0.0944	-0.1036	0.2312	0.5692	0.2086	-0.1254	0.3363	0.3665
0.950	-0.01	5.04	0.9883	0.9053	0.0969	-0.1037	0.3735	0.7676	0.5149	-0.1463	0.4238	0.6708
0.951	-0.03	6.98	0.9904	0.9361	0.0895	-0.1156	0.3735	0.8708	1.1412	-0.2405	0.9802	1.3106
0.951	-0.01	9.01	0.9907	0.9537	0.0770	-0.1156	0.4872	0.9129	1.7777	-0.2142	0.9570	1.9474
0.900	6.00	1.06	0.0000	0.0000	0.0719	-0.0439	-0.1644	0.9365	2.4651	-0.0098	-0.1515	2.6321
0.901	6.00	2.01	0.9878	0.8036	0.0719	-0.0978	0.2351	0.0000	-0.1176	-0.0978	0.2351	0.0050
0.903	6.01	3.02	0.9876	0.9014	0.0580	-0.0661	0.0882	0.6912	0.2806	-0.0492	0.1959	0.4060
0.900	5.98	5.00	0.9883	0.9434	0.0568	-0.0614	0.0593	0.8401	0.6254	-0.0319	0.2725	0.7447
0.900	5.97	7.00	0.9900	0.9572	0.0599	-0.0634	0.2344	0.9118	1.3195	-0.0640	0.8960	1.4471
0.904	6.00	9.04	0.9911	0.9559	0.0548	-0.0244	0.2820	0.9364	2.0458	0.0528	0.8013	2.1848
0.902	-0.02	1.05	0.0000	0.0000	0.0747	-0.1556	0.3360	0.0000	-0.1203	-0.1556	0.3360	0.0049
0.904	0.02	1.54	1.0150	0.7495	0.0436	-0.1003	0.0816	0.5648	0.1394	-0.1197	0.1874	0.2469
0.903	0.00	2.07	0.9904	0.8200	0.0531	-0.1165	0.1531	0.7125	0.3025	-0.1403	0.2607	0.4245
0.899	0.02	3.01	0.9889	0.9033	0.0536	-0.1078	0.1012	0.8422	0.6297	-0.1548	0.3161	0.7477
0.901	0.00	4.03	0.9890	0.9330	0.0530	-0.0761	-0.0919	0.8915	0.9795	-0.1309	0.1510	1.0987
0.903	-0.01	5.00	0.9882	0.9378	0.0599	-0.1062	0.2609	0.9060	1.3004	-0.2538	0.9156	1.4354
0.899	-0.01	7.00	0.9912	0.9568	0.0538	-0.1104	0.3298	0.9359	2.0485	-0.2186	0.8499	2.1887
0.900	-0.01	9.05	0.9910	0.9681	0.0429	-0.1104	0.3298	0.9359	2.0485	-0.2186	0.8499	2.1887
0.899	-6.03	1.03	0.0000	0.0000	0.1212	-0.1981	-0.3945	0.9527	2.8142	0.0163	-0.3902	2.9541
0.899	-6.00	2.02	0.9889	0.7164	0.0894	-0.1694	0.2136	0.6054	-0.1668	-0.1981	0.3533	0.0050
0.899	-6.01	3.01	0.9885	0.8460	0.0878	-0.1685	0.2071	0.6054	0.2489	-0.2335	0.3218	0.4112
0.899	-6.01	5.02	0.9886	0.9028	0.0876	-0.1581	0.3080	0.7851	0.5874	-0.2918	0.4219	0.7482
0.899	-6.03	6.99	0.9899	0.9344	0.0821	-0.1559	0.3080	0.8715	1.2728	-0.4585	0.9807	1.4604
0.900	-6.01	9.05	0.9909	0.9580	0.0613	-0.1481	0.3372	0.9135	1.9961	-0.4896	0.8609	2.1851
0.799	0.00	1.03	0.0000	0.0000	0.0700	-0.0611	-0.4349	0.9426	2.7845	-0.3237	-0.4318	2.9541
0.799	0.00	2.08	0.9921	0.8521	0.0502	-0.1064	0.3245	0.0000	-0.1166	-0.1481	0.3245	0.0057
0.801	0.00	3.02	0.9891	0.9238	0.0484	-0.1064	0.1172	0.7670	0.4196	-0.1368	0.2546	0.5471
0.802	0.00	5.01	0.9902	0.9482	0.0535	-0.0909	0.0760	0.8747	0.8285	-0.1580	0.3469	0.9472
0.802	-0.02	7.00	0.9909	0.9633	0.0502	-0.0841	0.2306	0.9228	1.6855	-0.2788	1.0682	1.8265
								0.9464	2.6002	-0.2209	0.8949	2.7474

Table 36. Internal and Aeropulsive Characteristics for Nozzle 33

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	0.05	1.52	1.0062	0.9514	0.9493	-3.87	0.1279	-0.0087	0.0451	0.1348
0.000	0.09	2.02	0.9818	0.9559	0.9539	-3.72	0.2214	-0.0144	0.0675	0.2321
0.000	0.14	2.50	0.9806	0.9544	0.9528	-3.37	0.3072	-0.0181	0.0839	0.3224
0.000	0.18	2.97	0.9798	0.9542	0.9529	-2.90	0.3930	-0.0199	0.1001	0.4124
0.000	0.27	3.47	0.9815	0.9517	0.9496	-3.82	0.4847	-0.0324	0.1758	0.5104
0.000	0.25	3.96	0.9818	0.9545	0.9538	-2.25	0.5790	-0.0228	0.1396	0.6070
0.000	0.26	4.48	0.9818	0.9548	0.9545	-1.48	0.6794	-0.0176	0.1280	0.7118
0.000	0.25	4.99	0.9823	0.9528	0.9527	-0.78	0.7770	-0.0106	0.1101	0.8155
0.000	0.33	5.99	0.9832	0.9467	0.9466	-0.80	0.9672	-0.0135	0.1665	1.0218
0.000	0.33	6.97	0.9823	0.9452	0.9452	0.04	1.1582	0.0007	0.1420	1.2252

(b) Aeropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.600	0.00	1.01	0.0000	0.0000	0.0750	-0.1540	0.2752	0.0000	-0.1232	-0.1540	0.2752	0.0084
0.598	0.00	1.48	1.0020	0.8695	0.0465	-0.0889	0.0385	0.7741	0.3914	-0.1221	0.2128	0.5056
0.598	0.02	2.04	0.9819	0.8963	0.0548	-0.0946	0.0588	0.8451	0.7959	-0.1527	0.3319	0.9418
0.598	0.01	3.03	0.9798	0.9223	0.0534	-0.0859	0.0228	0.8938	1.5159	-0.1658	0.4379	1.6960
0.599	-0.02	3.98	0.9793	0.9285	0.0676	-0.1269	0.2676	0.9086	2.2075	-0.2189	0.8273	2.4295
0.599	0.01	4.98	0.9816	0.9313	0.0714	-0.1601	0.4648	0.9164	2.9629	-0.2027	0.9050	3.2331
0.599	0.01	6.00	0.9813	0.9286	0.0810	-0.1965	0.6810	0.9168	3.7359	-0.2501	1.3474	4.0750
0.599	-0.04	6.99	0.9815	0.9340	0.0590	-0.0954	0.1899	0.9241	4.5233	-0.0948	0.7540	4.8947
1.201	-0.02	0.85	0.0000	0.0000	0.2330	-0.0579	0.2565	0.0000	-0.2761	-0.0579	0.2565	0.0040
1.195	0.01	1.49	1.0043	-0.5770	0.1976	-0.0278	0.1149	-0.9120	-0.1175	-0.0362	0.1589	0.1288
1.200	-0.01	2.00	0.9743	-0.0032	0.2174	-0.0731	0.3294	-0.1946	-0.0439	-0.0872	0.3957	0.2255
1.199	-0.01	4.03	0.9813	0.6276	0.2019	-0.0592	0.3192	0.5577	0.3446	-0.0822	0.4609	0.6179
1.200	-0.02	6.03	0.9802	0.7778	0.1749	0.0631	-0.3252	0.7353	0.7488	0.0493	-0.1579	1.0183
1.200	0.00	7.97	0.9814	0.8284	0.1628	0.1144	-0.6087	0.7981	1.1352	0.1293	-0.4924	1.4224
1.201	0.02	10.01	0.9820	0.8573	0.1437	0.2299	-1.2660	0.8340	1.5462	0.2748	-1.2004	1.8541
1.203	0.04	12.01	0.9819	0.8685	0.1344	0.3510	-1.9583	0.8496	1.9349	0.4250	-1.9423	2.2775
0.947	0.00	0.99	0.0000	0.0000	0.1153	-0.0362	-0.1296	0.0000	-0.1605	-0.0362	-0.1296	0.0047
0.951	0.00	2.02	0.9828	0.6627	0.1068	-0.0959	0.1938	0.5400	0.1986	-0.1187	0.3007	0.3677
0.950	-0.03	3.03	0.9820	0.7868	0.1110	-0.1077	0.2384	0.7199	0.4850	-0.1398	0.4009	0.6738
0.951	0.01	5.00	0.9811	0.8700	0.1081	-0.1069	0.2726	0.8351	1.0779	-0.1234	0.4462	1.2908
0.952	-0.03	6.99	0.9822	0.8980	0.0917	-0.0457	-0.0364	0.8747	1.6929	-0.0451	0.1865	1.9354
0.950	0.01	8.98	0.9819	0.9098	0.0755	0.0576	-0.6563	0.8925	2.3280	0.1048	-0.5107	2.6084
0.900	-0.02	1.00	0.0000	0.0000	0.0932	-0.1146	0.1620	0.0000	-0.1388	-0.1146	0.1620	0.0050
0.900	0.02	1.52	0.9975	0.6785	0.0659	-0.0931	0.0639	0.4858	0.1148	-0.1084	0.1436	0.2363
0.902	0.01	2.02	0.9834	0.7747	0.0726	-0.1088	0.1315	0.6632	0.2707	-0.1340	0.2500	0.4082
0.902	0.00	3.03	0.9820	0.8542	0.0726	-0.1057	0.1095	0.7931	0.5910	-0.1409	0.2892	0.7451
0.902	-0.02	4.02	0.9818	0.8834	0.0765	-0.1364	0.3289	0.8415	0.9139	-0.1771	0.5781	1.0861
0.903	0.00	4.97	0.9810	0.8991	0.0781	-0.1292	0.2961	0.8670	1.2324	-0.1483	0.4902	1.4214
0.899	-0.02	6.97	0.9820	0.9188	0.0581	-0.0574	-0.0737	0.8977	1.9418	-0.0570	0.1770	2.1631
0.900	0.00	9.03	0.9823	0.9250	0.0385	-0.0726	-0.7854	0.9095	2.6633	0.1262	-0.6254	2.9284
0.802	0.01	1.01	0.0000	0.0000	0.0829	-0.1567	0.3162	0.0000	-0.1293	-0.1567	0.3162	0.0057
0.803	0.01	2.01	0.9826	0.8378	0.0586	-0.1052	0.0985	0.7464	0.3793	-0.1366	0.2466	0.5081
0.802	0.01	3.03	0.9831	0.8933	0.0541	-0.1011	0.0823	0.8442	0.7978	-0.1455	0.3100	0.9451
0.802	0.01	4.97	0.9816	0.9152	0.0689	-0.1444	0.3815	0.8894	1.6022	-0.1683	0.6273	1.8014
0.802	-0.01	7.00	0.9824	0.9254	0.0538	-0.0601	-0.0331	0.9085	2.4835	-0.0583	0.2811	2.7337

Table 37. Internal and Aeropropulsive Characteristics for Nozzle 34

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTA P	CFJ	CFN	CMJ	CFI
0.000	-0.02	1.48	1.0086	0.9602	0.9546	-6.17	0.1218	-0.0132	0.0689	0.1276
0.000	0.01	2.02	0.9833	0.9565	0.9530	-4.92	0.2216	-0.0191	0.1062	0.2325
0.000	-0.03	2.51	0.9821	0.9561	0.9506	-6.16	0.3088	-0.0333	0.1776	0.3248
0.000	-0.02	2.98	0.9810	0.9580	0.9462	-9.00	0.3918	-0.0621	0.3111	0.4141
0.000	-0.05	3.46	0.9826	0.9611	0.9564	-5.65	0.4871	-0.0482	0.2672	0.5093
0.000	-0.04	3.96	0.9830	0.9659	0.9650	-2.42	0.5874	-0.0248	0.1721	0.6087
0.000	-0.03	4.47	0.9823	0.9709	0.9709	0.08	0.6883	0.0010	0.0565	0.7089
0.000	-0.03	4.98	0.9827	0.9715	0.9708	2.27	0.7899	0.0313	-0.0742	0.8137
0.000	0.00	6.05	0.9838	0.9716	0.9675	5.26	0.9994	0.0920	-0.3563	1.0329
0.000	0.02	7.00	0.9828	0.9720	0.9646	7.06	1.1875	0.1472	-0.6159	1.2310

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.599	-0.03	1.03	0.0000	0.0000	0.0597	0.0016	-0.2176	0.0000	-0.1078	0.0016	-0.2176	0.0084
0.600	0.01	1.51	0.9964	0.8733	0.0450	-0.0516	0.0355	0.7820	0.4126	-0.1052	0.3174	0.5277
0.599	0.00	2.00	0.9779	0.8955	0.0568	-0.0729	0.1132	0.8423	0.7634	-0.1481	0.5307	0.9064
0.600	-0.04	3.02	0.9790	0.9189	0.0477	-0.0879	0.2020	0.8900	1.4848	-0.3294	1.4142	1.6683
0.600	0.00	4.02	0.9785	0.9434	0.0650	-0.0773	0.1792	0.9237	2.2582	-0.1678	0.8327	2.4448
0.600	-0.03	4.96	0.9811	0.9555	0.0543	-0.0447	0.0023	0.9404	3.0161	0.0729	-0.2705	3.2071
0.599	-0.01	5.96	0.9812	0.9558	0.0591	-0.0030	-0.1678	0.9438	3.8099	0.3442	-1.5007	4.0367
0.599	0.01	7.00	0.9816	0.9552	0.0517	0.0184	-0.2911	0.9453	4.6237	0.6042	-2.7368	4.8913
1.207	0.02	0.91	0.0000	0.0000	0.2430	0.1167	-0.4666	0.0000	-0.2859	0.1167	-0.4666	0.0040
1.200	0.02	1.49	0.9641	-0.8428	0.2259	0.1481	-0.5895	-1.1935	-0.1466	0.1350	-0.5206	0.1228
1.202	-0.01	1.99	0.9729	-0.0747	0.2294	0.0232	-0.0208	-0.2696	-0.0596	0.0046	0.1235	0.2212
1.200	0.03	3.98	0.9791	0.5939	0.2271	0.0721	-0.2285	0.5227	0.3165	0.0485	-0.0603	0.6055
1.200	0.02	6.02	0.9798	0.7460	0.2290	0.1221	-0.5136	0.7035	0.7144	0.2121	-0.8600	1.0154
1.200	0.04	7.98	0.9817	0.8111	0.2137	0.1336	-0.5823	0.7808	1.1124	0.3367	-1.4576	1.4247
1.200	0.03	9.98	0.9813	0.8425	0.2026	0.1373	-0.6142	0.8191	1.5124	0.4546	-2.0264	1.8463
0.949	0.01	0.99	0.0000	0.0000	0.1665	0.1275	-0.7536	0.0000	-0.2116	0.1275	-0.7536	0.0047
0.951	-0.04	2.01	0.9815	0.6046	0.1269	0.0244	-0.1815	0.4803	0.1741	-0.0058	-0.0152	0.3626
0.951	-0.02	3.01	0.9806	0.7480	0.1314	0.0024	-0.0361	0.6801	0.4514	-0.0940	0.4481	0.6637
0.950	-0.01	5.00	0.9806	0.8627	0.1423	-0.0088	-0.0987	0.8278	1.0687	0.0423	-0.2241	1.2910
0.950	0.00	6.99	0.9821	0.8936	0.1395	0.0157	-0.3045	0.8704	1.6922	0.2479	-1.2753	1.9442
0.950	0.05	8.99	0.9818	0.9036	0.1374	0.0215	-0.4140	0.8864	2.3178	0.4386	-2.2454	2.6150
0.899	0.04	1.03	0.0000	0.0000	0.1008	0.0644	-0.5108	0.0000	-0.1463	0.0644	-0.5108	0.0050
0.900	0.03	1.53	0.9889	0.6828	0.0666	-0.0271	-0.0595	0.4908	0.1164	-0.0511	0.0672	0.2372
0.900	0.01	2.03	0.9811	0.7712	0.0761	-0.0802	0.2027	0.6608	0.2725	-0.1140	0.3912	0.4123
0.903	-0.01	3.02	0.9815	0.8486	0.0715	-0.0466	0.0722	0.7871	0.5826	-0.1529	0.6077	0.7402
0.901	0.01	4.02	0.9814	0.8923	0.0815	-0.0763	0.1593	0.8505	0.9261	-0.1160	0.4477	1.0889
0.897	-0.01	4.98	0.9802	0.9169	0.0811	-0.0555	0.0258	0.8852	1.2724	-0.0009	-0.1028	1.4374
0.902	0.02	6.99	0.9821	0.9285	0.0794	-0.0098	-0.2432	0.9074	1.9573	0.2485	-1.3203	2.1572
0.900	0.03	9.01	0.9817	0.9286	0.0808	0.0060	-0.3827	0.9130	2.6644	0.4716	-2.4314	2.9185
0.801	-0.01	1.04	0.0000	0.0000	0.0713	0.0141	-0.3193	0.0000	-0.1178	0.0141	-0.3193	0.0057
0.802	0.02	2.03	0.9817	0.8465	0.0564	-0.1072	0.2856	0.7571	0.3932	-0.1497	0.5228	0.5193
0.801	-0.01	3.02	0.9823	0.8934	0.0479	-0.0513	0.0679	0.8441	0.7945	-0.1864	0.7484	0.9413
0.800	-0.02	4.99	0.9818	0.9380	0.0615	-0.0528	0.0129	0.9124	1.6582	0.0173	-0.1565	1.8174
0.800	0.01	6.97	0.9824	0.9416	0.0641	0.0012	-0.2703	0.9246	2.5252	0.3263	-1.6271	2.7311

Table 38. Internal and Aeropropulsive Characteristics for Nozzle 35

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	0.05	1.52	1.0080	0.9696	0.9688	-2.32	0.1312	-0.0053	0.0307	0.1354
0.000	0.08	2.01	0.9820	0.9761	0.9753	-2.27	0.2246	-0.0089	0.0505	0.2303
0.000	0.12	2.50	0.9810	0.9743	0.9736	-2.17	0.3134	-0.0119	0.0695	0.3218
0.000	0.14	2.98	0.9806	0.9745	0.9741	-1.56	0.4025	-0.0110	0.0730	0.4132
0.000	0.23	3.47	0.9816	0.9712	0.9708	-1.59	0.4944	-0.0138	0.0999	0.5093
0.000	0.22	3.96	0.9823	0.9706	0.9706	-0.60	0.5885	-0.0062	0.0761	0.6063
0.000	0.27	4.47	0.9821	0.9658	0.9658	-0.67	0.6844	-0.0080	0.1064	0.7087
0.000	0.28	4.99	0.9819	0.9617	0.9617	-0.22	0.7826	-0.0030	0.1061	0.8138
0.000	0.23	6.02	0.9840	0.9564	0.9564	1.36	0.9802	0.0233	0.0325	1.0251
0.000	0.01	6.98	0.9842	0.9547	0.9522	4.12	1.1669	0.0841	-0.2480	1.2254

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.599	-0.02	1.02	0.0000	0.0000	0.0543	-0.0994	0.0827	0.0000	-0.1022	-0.0994	0.0827	0.0084
0.599	0.01	1.49	1.0019	0.8979	0.0433	-0.0368	-0.1450	0.8034	0.4084	-0.0570	-0.0276	0.5083
0.598	0.01	2.03	0.9815	0.9217	0.0501	-0.0502	-0.1024	0.8700	0.8080	-0.0859	0.1013	0.9287
0.600	-0.02	3.04	0.9817	0.9467	0.0442	-0.0477	-0.1193	0.9183	1.5522	-0.0906	0.1708	1.6902
0.601	0.00	3.96	0.9815	0.9492	0.0532	-0.0600	-0.0181	0.9291	2.2302	-0.0843	0.2832	2.4003
0.600	0.00	4.96	0.9826	0.9446	0.0541	-0.1145	0.2976	0.9296	2.9822	-0.1266	0.7153	3.2080
0.600	-0.02	5.98	0.9827	0.9458	0.0474	0.0010	-0.2878	0.9339	3.7623	0.0883	-0.1474	4.0285
0.598	0.00	7.04	0.9835	0.9421	0.0526	0.0011	-0.3021	0.9324	4.6054	0.3521	-1.3631	4.9394
0.799	0.01	1.02	0.0000	0.0000	0.0759	-0.1144	0.1391	0.0000	-0.1218	-0.1144	0.1391	0.0057
0.798	0.01	2.01	0.9843	0.8594	0.0586	-0.0597	-0.0932	0.7705	0.3987	-0.0796	0.0199	0.5175
0.802	-0.02	3.04	0.9853	0.9169	0.0497	-0.0589	-0.1008	0.8684	0.8228	-0.0830	0.0618	0.9475
0.798	0.02	5.02	0.9839	0.9298	0.0551	-0.0885	0.1365	0.9047	1.6663	-0.0929	0.3694	1.8417
0.798	-0.01	7.00	0.9831	0.9331	0.0556	0.0046	-0.3727	0.9163	2.5230	0.1954	-0.9405	2.7534
1.198	-0.02	0.85	0.0000	0.0000	0.2338	0.0021	-0.0240	0.0000	-0.2770	0.0021	-0.0240	0.0040
1.200	-0.02	1.48	1.0266	-0.6280	0.2019	0.0193	-0.1051	-0.9683	-0.1229	0.0143	-0.0763	0.1269
1.199	0.00	2.05	0.9792	0.0554	0.2161	-0.0168	0.0706	-0.1291	-0.0302	-0.0258	0.1220	0.2341
1.200	0.00	4.00	0.9849	0.6398	0.2005	-0.0246	0.1640	0.5692	0.3481	-0.0306	0.2396	0.6116
1.200	0.01	6.05	0.9827	0.7686	0.1928	-0.1472	-0.7675	0.7263	0.7422	0.1726	-0.7450	1.0218
1.201	0.02	7.97	0.9828	0.8160	0.1892	-0.1476	-0.7760	0.7856	1.1158	0.2939	-1.3100	1.4203
1.200	0.03	9.97	0.9835	0.8337	0.1957	-0.1590	-0.8052	0.8103	1.4960	0.4312	-1.9178	1.8463
1.200	0.04	9.58	0.9855	0.8323	0.1891	-0.1471	-0.7744	0.8078	1.4267	0.3952	-1.7743	1.7661
0.950	0.00	0.99	0.0000	0.0000	0.1226	-0.0046	-0.2469	0.0000	-0.1677	-0.0046	-0.2469	0.0047
0.952	0.03	2.02	0.9873	0.6959	0.1001	-0.0597	0.0154	0.5726	0.2093	-0.0736	0.0951	0.3655
0.952	0.01	3.06	0.9862	0.8115	0.1067	-0.0742	0.0975	0.7452	0.5066	-0.0908	0.2130	0.6798
0.951	0.01	4.98	0.9831	0.8846	0.0978	-0.0604	0.0327	0.8494	1.0888	-0.0650	0.1996	1.2818
0.950	0.00	6.84	0.9836	0.9032	0.0952	0.0043	-0.3873	0.8794	1.6650	0.1238	-0.7177	1.8934
0.951	0.00	9.04	0.9838	0.9048	0.1017	-0.0050	-0.4080	0.8876	2.3299	0.3341	-1.7516	2.6249
0.902	0.01	1.00	0.0000	0.0000	0.0894	-0.0825	0.0267	0.0000	-0.1349	-0.0825	0.0267	0.0050
0.902	-0.01	1.47	1.0078	0.6764	0.0669	-0.0461	-0.1500	0.4686	0.1025	-0.0549	-0.0994	0.2188
0.900	-0.02	2.02	0.9865	0.8005	0.0698	-0.0678	-0.0536	0.6898	0.2831	-0.0835	0.0360	0.4105
0.898	-0.01	3.01	0.9844	0.8784	0.0685	-0.0766	-0.0067	0.8173	0.6086	-0.0959	0.1228	0.7447
0.898	0.01	4.02	0.9839	0.9074	0.0672	-0.0721	-0.0118	0.8660	0.9516	-0.0823	0.1235	1.0988
0.899	0.01	4.98	0.9822	0.9155	0.0662	-0.0807	0.0703	0.8837	1.2657	-0.0859	0.2569	1.4323
0.899	0.00	6.98	0.9836	0.9236	0.0635	-0.0031	-0.3859	0.9026	1.9550	0.1456	-0.8246	2.1661
0.899	0.02	9.03	0.9834	0.9203	0.0692	-0.0095	-0.4071	0.9048	2.6517	0.3697	-1.9050	2.9307

Table 39. Internal and Aeropropulsive Characteristics for Nozzle 36

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTAP	CFJ	CFN	CMJ	CFI
0.000	0.04	1.49	0.9537	0.9834	0.9822	-2.87	0.1189	-0.0060	0.0308	0.1211
0.000	0.08	2.02	0.9803	0.9903	0.9888	-3.16	0.2290	-0.0126	0.0513	0.2316
0.000	0.14	2.50	0.9842	0.9886	0.9866	-3.60	0.3193	-0.0201	0.0879	0.3237
0.000	0.10	2.98	0.9831	0.9913	0.9911	-1.05	0.4103	-0.0075	0.0090	0.4139
0.000	0.22	3.46	0.9853	0.9835	0.9821	-3.04	0.5003	-0.0265	0.1146	0.5094
0.000	0.43	3.98	0.9863	0.9791	0.9734	-6.21	0.5958	-0.0649	0.3287	0.6122
0.000	0.50	4.47	0.9870	0.9777	0.9720	-6.16	0.6910	-0.0746	0.3866	0.7109
0.000	0.49	4.98	0.9878	0.9759	0.9723	-4.88	0.7924	-0.0676	0.3614	0.8150
0.000	0.36	5.99	0.9897	0.9763	0.9758	-1.77	1.0007	-0.0309	0.1854	1.0255
0.000	0.15	6.98	0.9901	0.9778	0.9776	1.11	1.2063	0.0235	-0.0734	1.2339

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.599	-0.03	1.02	0.0000	0.0000	0.0741	-0.1461	0.4131	0.0000	-0.1225	-0.1461	0.4131	0.0085
0.597	-0.03	1.48	0.9394	0.8585	0.0652	-0.0985	0.1854	0.7556	0.3560	-0.1224	0.3075	0.4711
0.601	-0.01	2.02	0.9778	0.9133	0.0718	-0.1001	0.2070	0.8603	0.7868	-0.1500	0.4102	0.9145
0.600	-0.01	3.01	0.9827	0.9519	0.0652	-0.0891	0.1518	0.9229	1.5415	-0.1270	0.2306	1.6704
0.567	0.25	3.97	0.9837	0.9459	0.0824	-0.1103	0.2712	0.9277	2.5094	-0.3849	1.7199	2.7049
0.598	0.00	4.97	0.9863	0.9509	0.0728	-0.1210	0.4043	0.9359	3.0379	-0.3912	1.8472	3.2458
0.597	-0.04	5.98	0.9867	0.9600	0.0787	-0.1178	0.3981	0.9481	3.8727	-0.2453	1.1461	4.0846
0.600	-0.02	7.01	0.9877	0.9664	0.0666	-0.1064	0.2663	0.9565	4.6863	-0.0098	-0.0495	4.8995
1.198	-0.02	0.88	0.0000	0.0000	0.2275	-0.0192	0.1783	0.0000	-0.2708	-0.0192	0.1783	0.0041
1.202	0.00	1.50	1.0053	-0.6365	0.2032	-0.0332	0.2656	-0.9707	-0.1259	-0.0393	0.2966	0.1297
1.198	-0.01	2.01	0.9735	-0.0266	0.2310	-0.0604	0.4105	-0.2185	-0.0494	-0.0729	0.4610	0.2262
1.200	-0.02	4.02	0.9829	0.6072	0.2265	-0.0808	0.5898	0.5366	0.3296	-0.1456	0.9173	0.6143
1.199	-0.01	5.98	0.9838	0.7764	0.2080	0.0279	-0.0683	0.7334	0.7414	-0.0032	0.1171	1.0110
1.198	0.00	7.99	0.9852	0.8368	0.2081	0.0628	-0.2802	0.8065	1.1570	-0.1411	-0.6153	1.4346
1.201	0.02	10.05	0.9867	0.8700	0.1983	0.1091	-0.5406	0.8467	1.5807	0.2997	-1.4060	1.8669
1.200	0.04	11.49	0.9872	0.8835	0.1930	0.1342	-0.7117	0.8636	1.8848	0.4045	-1.9518	2.1826
0.948	-0.01	1.00	0.0000	0.0000	0.1173	0.0044	-0.1788	0.0000	-0.1628	0.0044	-0.1788	0.0048
0.951	0.01	2.00	0.9808	0.6719	0.1124	-0.0742	0.2989	0.5450	0.1949	-0.0935	0.3782	0.3576
0.950	-0.01	2.99	0.9841	0.8014	0.1246	-0.1144	0.5082	0.7328	0.4850	-0.1280	0.5316	0.6619
0.950	-0.02	4.97	0.9848	0.8818	0.1194	-0.1116	0.5238	0.8464	1.0865	-0.2191	1.0957	1.2837
0.951	-0.01	7.02	0.9873	0.9210	0.1159	-0.0766	0.2373	0.8978	1.7531	-0.0370	0.1079	1.9527
0.868	0.00	9.00	0.9879	0.9289	0.1528	-0.0256	-0.1731	0.9141	2.8778	-0.2283	-1.3092	3.1484
0.892	0.00	1.01	0.0000	0.0000	0.0944	-0.0827	0.1448	0.0000	-0.1403	-0.0827	0.1448	0.0051
0.900	0.01	1.50	0.9587	0.6352	0.0742	-0.0871	0.1946	0.4249	0.0926	-0.0978	0.2494	0.2178
0.901	0.01	2.02	0.9821	0.7763	0.0863	-0.1052	0.2861	0.6642	0.2715	-0.1273	0.3765	0.4087
0.902	-0.01	3.07	0.9864	0.8734	0.0860	-0.1216	0.3781	0.8133	0.6198	-0.1445	0.4471	0.7620
0.900	0.01	4.00	0.9848	0.8957	0.0854	-0.0786	0.1882	0.8535	0.9265	-0.1929	0.7689	1.0855
0.901	-0.02	4.97	0.9844	0.9106	0.0923	-0.1490	0.5774	0.8785	1.2536	-0.2684	1.2133	1.4271
0.902	-0.03	6.98	0.9872	0.9422	0.0824	-0.1094	0.2901	0.9210	1.9862	-0.0698	0.1642	2.1566
0.901	0.01	8.99	0.9888	0.9471	0.0862	-0.0373	-0.1605	0.9314	2.7185	-0.1978	-1.2090	2.9188
0.798	0.00	1.01	0.0000	0.0000	0.0875	-0.1364	0.3739	0.0000	-0.1342	-0.1364	0.3739	0.0057
0.799	0.02	2.03	0.9815	0.8488	0.0734	-0.1089	0.2525	0.7595	0.3972	-0.1372	0.3682	0.5230
0.799	-0.01	3.02	0.9855	0.9148	0.0693	-0.1249	0.3247	0.8655	0.8195	-0.1475	0.3759	0.9469
0.800	-0.02	4.97	0.9860	0.9345	0.0709	-0.1506	0.4377	0.9088	1.6488	-0.3020	1.2442	1.8143
0.801	-0.03	7.00	0.9875	0.9541	0.0714	-0.1298	0.2704	0.9371	2.5721	-0.0770	0.0989	2.7448

Table 40. Internal and Aeropropulsive Characteristics for Nozzle 37

(a) Internal performance

M	ALPHA	NPR	WP/WI	FR/FI	FJ/FI	DELTA P	CFJ	CFN	CMJ	CFI
0.000	0.02	1.50	0.9823	0.9636	0.9614	-3.88	0.1240	-0.0084	0.0365	0.1290
0.000	0.00	2.01	0.9769	0.9645	0.9626	-3.62	0.2197	-0.0139	0.0600	0.2283
0.000	0.00	2.50	0.9809	0.9638	0.9625	-2.92	0.3102	-0.0158	0.0649	0.3223
0.000	0.01	3.02	0.9815	0.9628	0.9620	-2.34	0.4071	-0.0166	0.0680	0.4232
0.000	0.01	3.48	0.9839	0.9579	0.9549	-4.55	0.4917	-0.0391	0.2024	0.5150
0.000	0.01	4.02	0.9848	0.9607	0.9597	-2.69	0.5963	-0.0280	0.1488	0.6213
0.000	0.01	4.48	0.9847	0.9606	0.9596	-2.61	0.6865	-0.0313	0.1824	0.7154
0.000	0.00	5.03	0.9928	0.9508	0.9501	-2.24	0.7919	-0.0309	0.1983	0.8334
0.000	0.00	6.00	0.9876	0.9505	0.9494	-2.70	0.9763	-0.0460	0.3196	1.0283
0.000	-0.01	7.00	0.9878	0.9510	0.9509	-0.79	1.1792	-0.0162	0.2057	1.2400

(b) Aeropropulsive characteristics

M	ALPHA	NPR	WP/WI	F-DN/FI	CDN	CLCN	CMCN	F-D/FI	C(F-D)	CL	CM	CFI
0.600	0.01	1.00	0.0000	0.0000	0.0640	-0.1549	0.2776	0.0000	-0.1120	-0.1549	0.2776	0.0085
0.603	0.01	1.50	0.9795	0.9060	0.0296	-0.0910	0.0604	0.8091	0.4023	-0.1235	0.2021	0.4972
0.599	0.02	2.05	0.9766	0.9170	0.0452	-0.0938	0.0684	0.8656	0.8136	-0.1508	0.3152	0.9399
0.599	0.00	3.03	0.9804	0.9394	0.0401	-0.0842	0.0087	0.9110	1.5455	-0.1512	0.2843	1.6966
0.599	-0.01	3.97	0.9800	0.9406	0.0582	-0.1099	0.1825	0.9207	2.2391	-0.2202	0.7620	2.4319
0.598	0.01	4.97	0.9830	0.9388	0.0689	-0.1443	0.4183	0.9239	3.0027	-0.2672	1.1994	3.2501
0.598	0.00	5.98	0.9836	0.9356	0.0725	-0.1628	0.5639	0.9237	3.7627	-0.3465	1.8315	4.0735
0.598	-0.03	7.01	0.9846	0.9416	0.0612	-0.0862	0.1486	0.9318	4.5994	-0.1551	0.9673	4.9361
1.201	-0.04	0.75	0.0000	0.0000	0.2765	-0.0966	0.4628	0.0000	-0.3196	-0.0966	0.4628	0.0041
1.199	0.01	1.51	1.0091	-0.6074	0.2056	-0.0474	0.2442	-0.9314	-0.1242	-0.0509	0.2808	0.1333
1.201	0.00	2.03	0.9748	-0.0022	0.2226	-0.0699	0.3735	-0.1902	-0.0437	-0.0839	0.4340	0.2299
1.200	0.00	4.06	0.9821	0.6275	0.2084	-0.0679	0.4246	0.5581	0.3476	-0.0962	0.5754	0.6228
1.200	-0.01	6.03	0.9816	0.7491	0.2108	0.0819	-0.3471	0.7067	0.7214	0.0369	-0.0361	1.0209
1.201	-0.02	8.00	0.9830	0.7962	0.2271	0.1102	-0.4638	0.7659	1.0956	0.1217	-0.3682	1.4305
1.198	0.02	9.97	0.9842	0.8169	0.2475	0.1990	-0.9106	0.7936	1.4771	0.2688	-1.0309	1.8612
1.200	0.02	12.01	0.9846	0.8343	0.2525	0.3292	-1.4059	0.8154	1.8720	0.4579	-1.7487	2.2958
0.949	0.00	0.99	0.0000	0.0000	0.1205	-0.0257	-0.1104	0.0000	-0.1657	-0.0257	-0.1104	0.0048
0.951	0.00	2.06	0.9849	0.6808	0.1047	-0.0938	0.2170	0.5614	0.2126	-0.1167	0.3156	0.3788
0.950	-0.01	3.01	0.9817	0.7946	0.1116	-0.1086	0.2850	0.7269	0.4856	-0.1349	0.3919	0.6681
0.951	0.00	5.04	0.9822	0.8744	0.1123	-0.0955	0.2904	0.8398	1.0961	-0.1446	0.6052	1.3052
0.951	-0.03	6.97	0.9844	0.9044	0.0964	-0.0406	-0.0202	0.8811	1.7104	-0.0697	0.3110	1.9411
0.952	-0.01	9.02	0.9848	0.9148	0.0961	0.0317	-0.3606	0.8976	2.3562	0.0974	-0.3868	2.6251
0.902	0.01	1.00	0.0000	0.0000	0.0993	-0.1168	0.1990	0.0000	-0.1449	-0.1168	0.1990	0.0050
0.902	0.00	1.50	0.9874	0.6773	0.0633	-0.0920	0.0838	0.4760	0.1079	-0.1067	0.1477	0.2267
0.902	0.00	2.05	0.9800	0.7857	0.0740	-0.1059	0.1448	0.6758	0.2805	-0.1311	0.2535	0.4151
0.901	-0.02	3.02	0.9823	0.8618	0.0730	-0.1166	0.2069	0.8005	0.5963	-0.1461	0.3262	0.7449
0.900	-0.03	4.04	0.9822	0.8916	0.0775	-0.1283	0.3243	0.8501	0.9346	-0.1787	0.5896	1.0994
0.902	-0.01	4.98	0.9818	0.9051	0.0799	-0.1179	0.3034	0.8732	1.2479	-0.1722	0.6473	1.4291
0.902	-0.01	6.99	0.9843	0.9233	0.0672	-0.0545	-0.0179	0.9022	1.9547	-0.0851	0.3461	2.1667
0.899	0.00	9.00	0.9849	0.9300	0.0628	0.0315	-0.4427	0.9144	2.6861	0.1044	-0.4682	2.9374
0.793	0.01	1.01	0.0000	0.0000	0.0904	-0.1553	0.3218	0.0000	-0.1370	-0.1553	0.3218	0.0058
0.803	-0.01	2.06	0.9808	0.8471	0.0604	-0.1021	0.1082	0.7592	0.4019	-0.1342	0.2465	0.5293
0.799	-0.02	3.00	0.9827	0.9024	0.0547	-0.1073	0.1587	0.8528	0.8014	-0.1442	0.3070	0.9397
0.800	0.01	4.98	0.9829	0.9192	0.0742	-0.1235	0.3602	0.8936	1.6249	-0.1922	0.7972	1.8183
0.800	-0.03	6.97	0.9845	0.9310	0.0631	-0.0599	0.0509	0.9140	2.5040	-0.1011	0.5180	2.7395

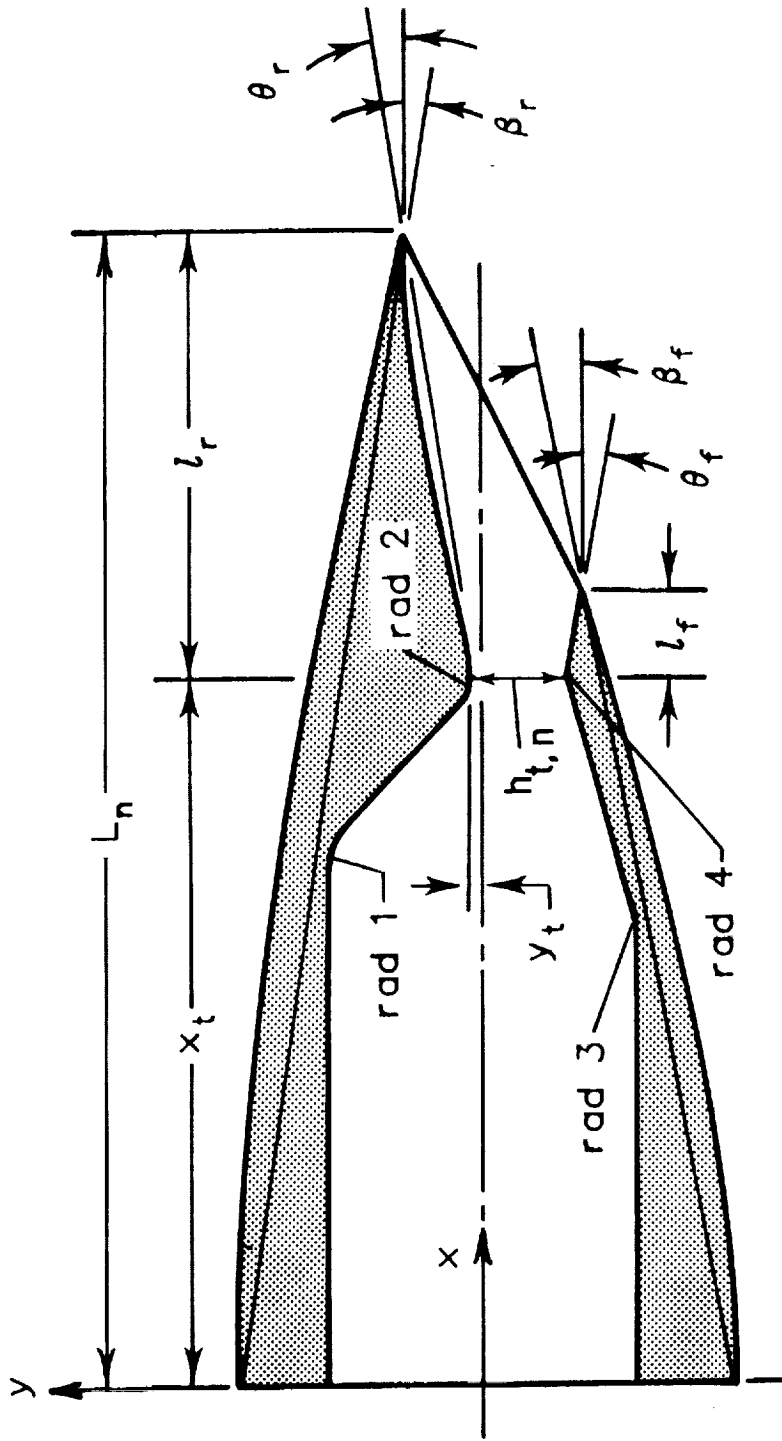
Table 41. Skin-Friction Drag Coefficients of Nozzles

Nozzle	M = 0.60	M = 0.90	M = 1.20
1	0.0258	0.0245	0.0227
2	.0226	.0215	.0200
3	.0286	.0272	.0252
4	.0254	.0242	.0224
5	.0261	.0248	.0231
6	.0251	.0239	.0222
7	.0264	.0251	.0233
8	.0260	.0248	.0230
9	.0255	.0242	.0225
10	.0188	.0179	.0166
11	.0328	.0312	.0289
12	.0258	.0245	.0228
13	.0254	.0241	.0224
14	.0170	.0161	.0150
15	.0230	.0219	.0202
16	.0195	.0185	.0172
17	.0243	.0231	.0214
18	.0233	.0222	.0206
19	.0282	.0268	.0249
20	.0229	.0217	.0202
21	.0231	.0220	.0204
22	.0272	.0258	.0240
23	.0316	.0301	.0279
24	.0246	.0234	.0217
25	.0343	.0326	.0302
26	.0342	.0325	.0301
27	.0341	.0324	.0301
28	.0321	.0304	.0282
29	.0363	.0346	.0321
30	.0258	.0245	.0227
31	.0256	.0244	.0227
32	.0258	.0245	.0227
33	.0246	.0234	.0217
34	.0211	.0200	.0186
35	.0242	.0230	.0214
36	.0244	.0232	.0216
37	.0244	.0232	.0216

Table 42. Schedule of Nozzle Pressure Ratio With Mach Number

M	NPR
0.60	3
.80	5
.90	5
.95	7
1.20	8

0-2



Sta. 55.05  
(Nozzle connect station)

Note:

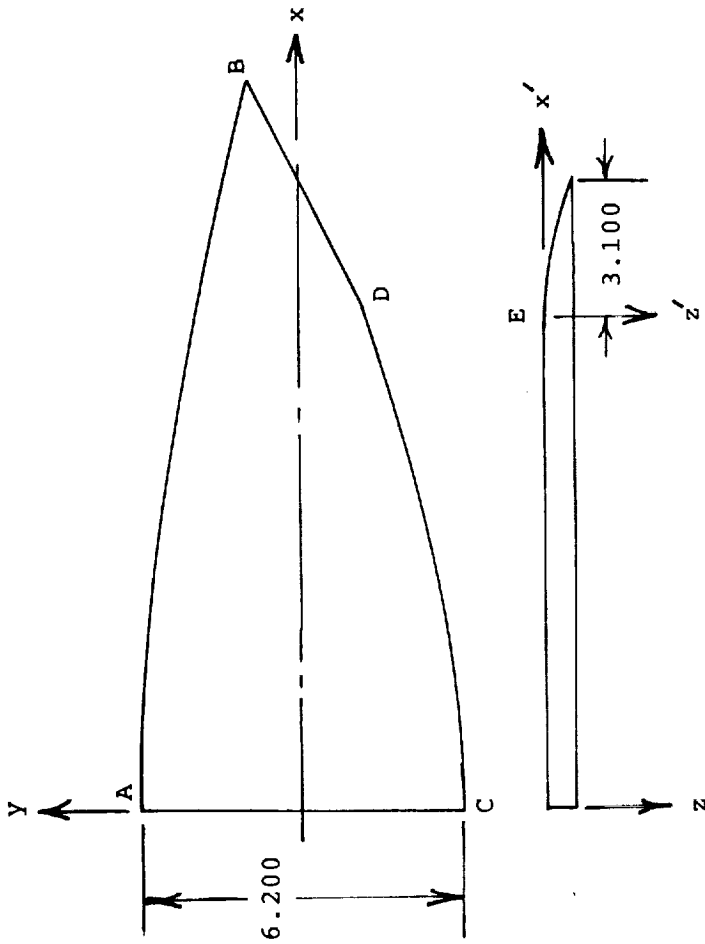
(a)  $h_{t,n} = 1.24$

(b) Nozzle width = 4.95

(a) Nozzle geometry.

Figure 1. Nozzle and sidewall geometries. All linear dimensions are given in inches.





xy-plane

- Contour A-B to match upper ramp contour
- Contour C-D to match lower flap contour
- Contour B-D straight line

xz-plane

Point E defines start of sidewall boattail

Sidewall boattail	
$x'$ , in.	$z'$ , in.
0.0	0.0
.100	.001
.200	.006
.300	.013
.400	.023
.500	.035
.600	.050
.700	.067
.800	.087
.900	.108
1.000	.132
1.100	.158
1.200	.186
1.300	.215
1.400	.246
1.500	.279
1.600	.313
1.700	.349
1.800	.386
1.900	.424
2.000	.463
2.100	.503
2.200	.544
2.300	.587
2.400	.629
2.500	.673
2.600	.716
2.700	.761
2.800	.805
2.900	.850
3.000	.895
3.100	.925

(b) Sidewall geometry.

Figure 1. Concluded.

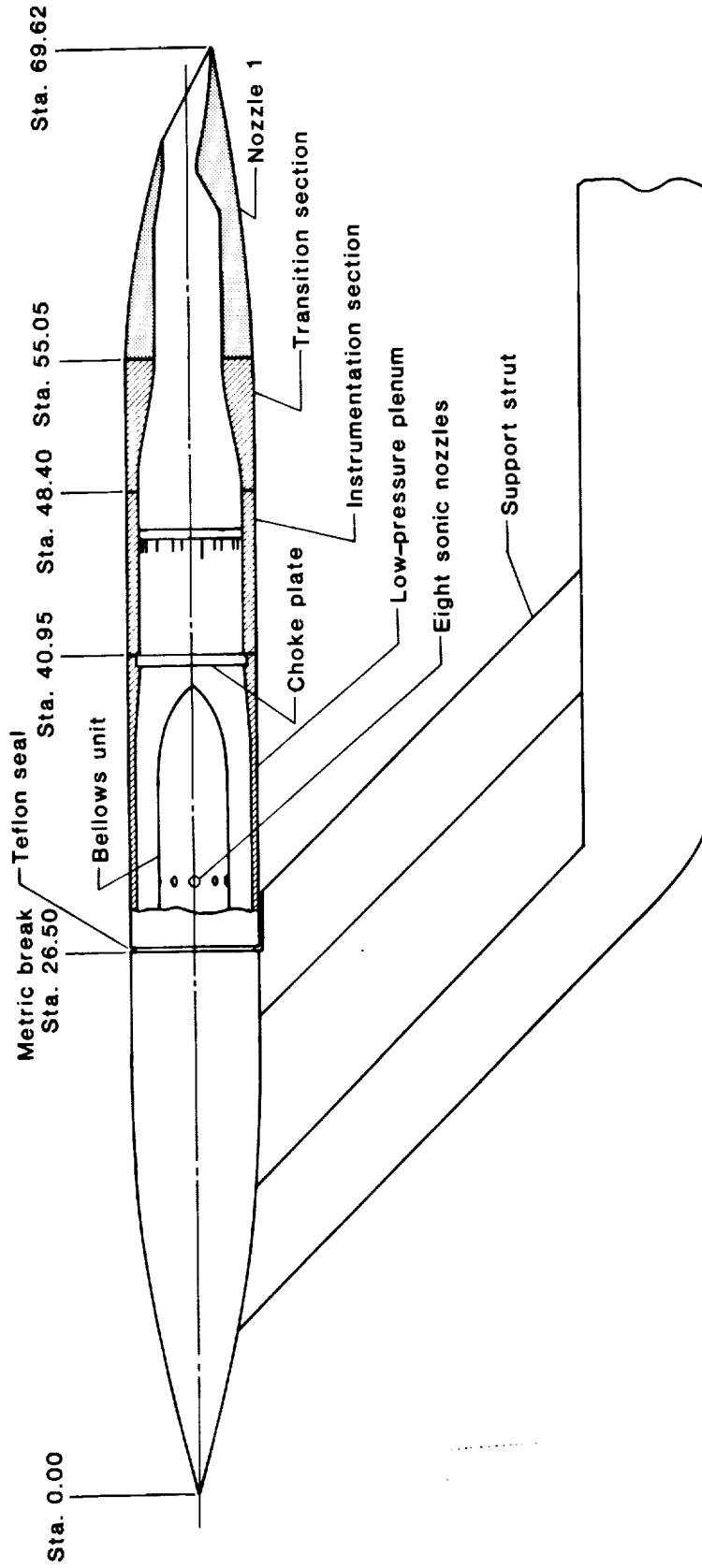


Figure 2. Propulsion simulation system with typical nozzle configuration installed. All linear dimensions are given in inches.

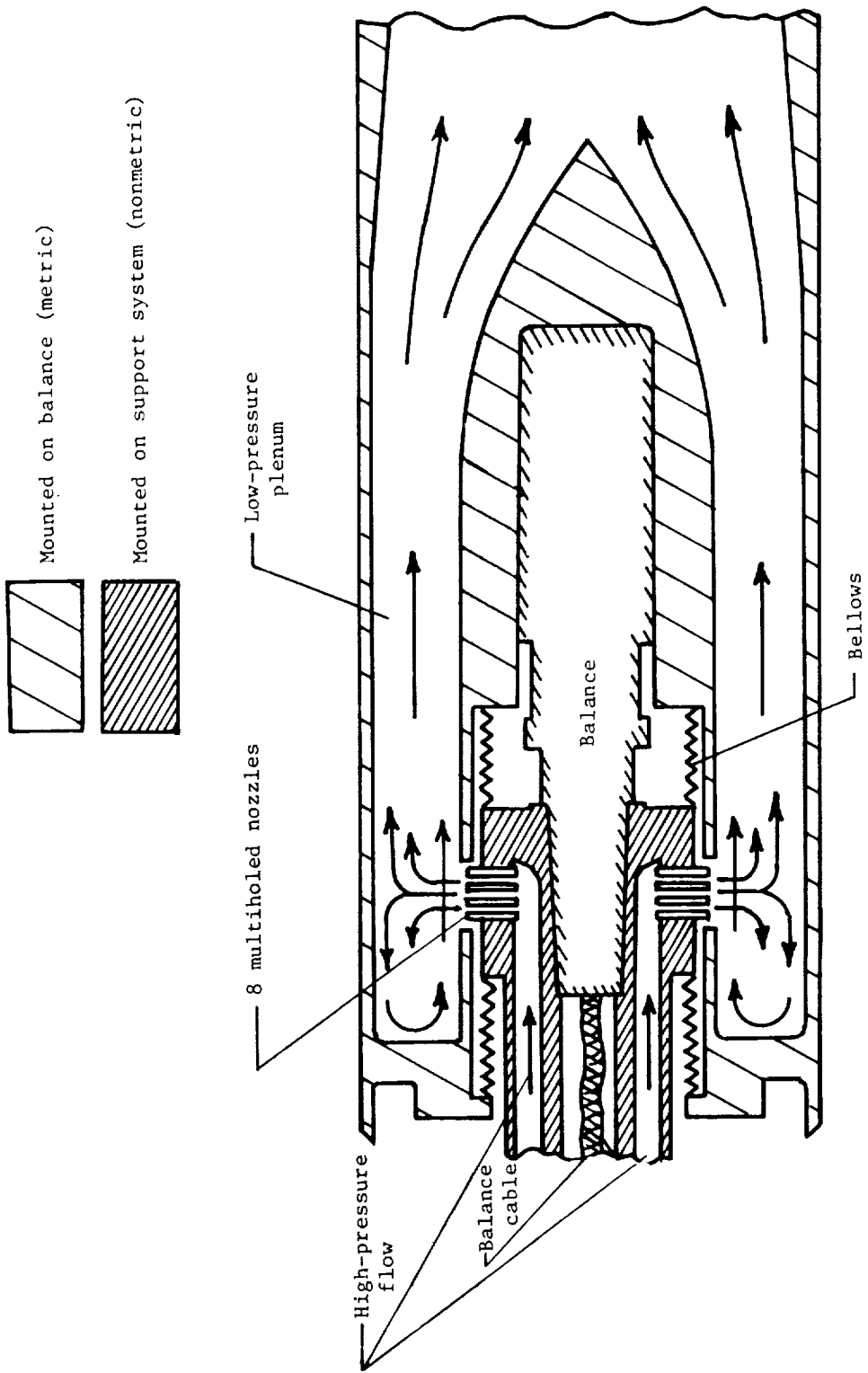


Figure 3. Schematic cross section of high-pressure airflow transfer system.

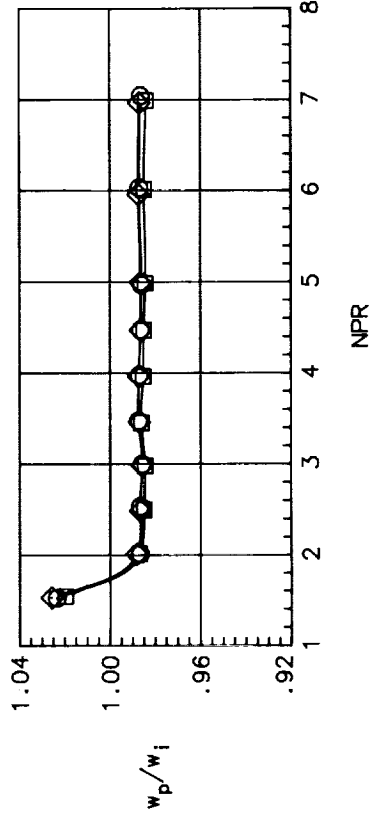
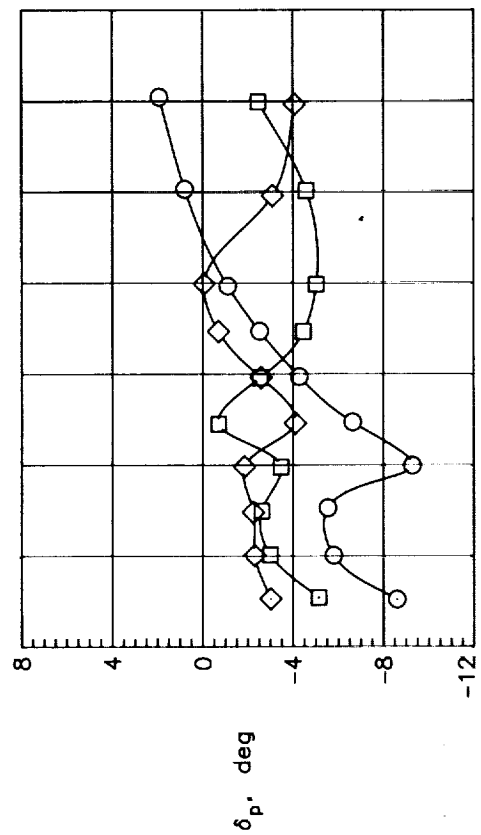
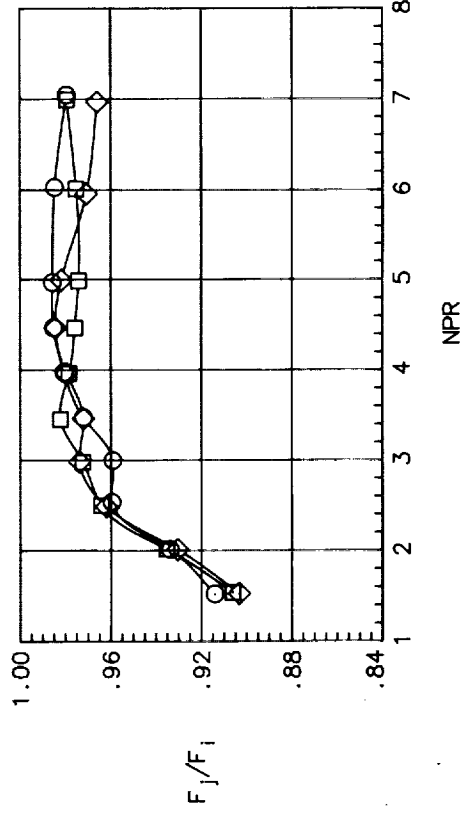
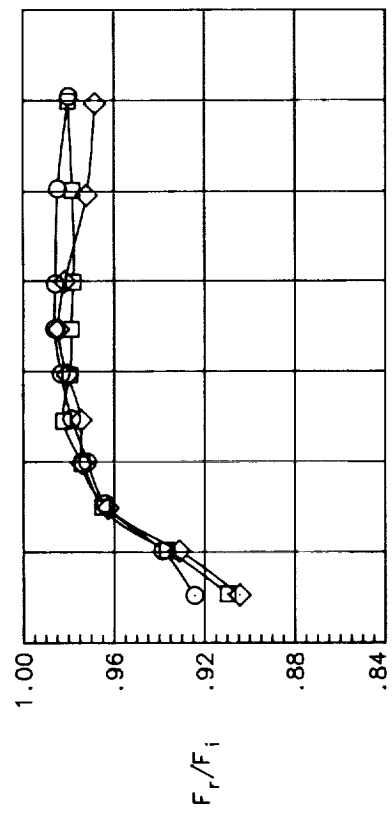
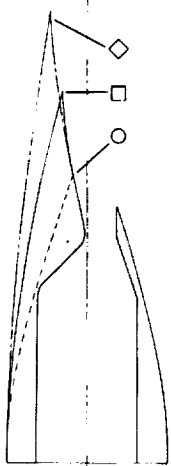


L-92-40

Figure 4. Model with nozzle 29 installed in the Langley 16-Foot Transonic Tunnel.

Nozzle	$l_r/h_{t,n}$	$\beta_r$ , deg	$(A_o/A_t)_i$	$(A_o/A_t)_e$
2	2.0	12.60	1.18	1.31
1	4.5	8.15	1.19	1.69
3	7.0	1.20	2.08	

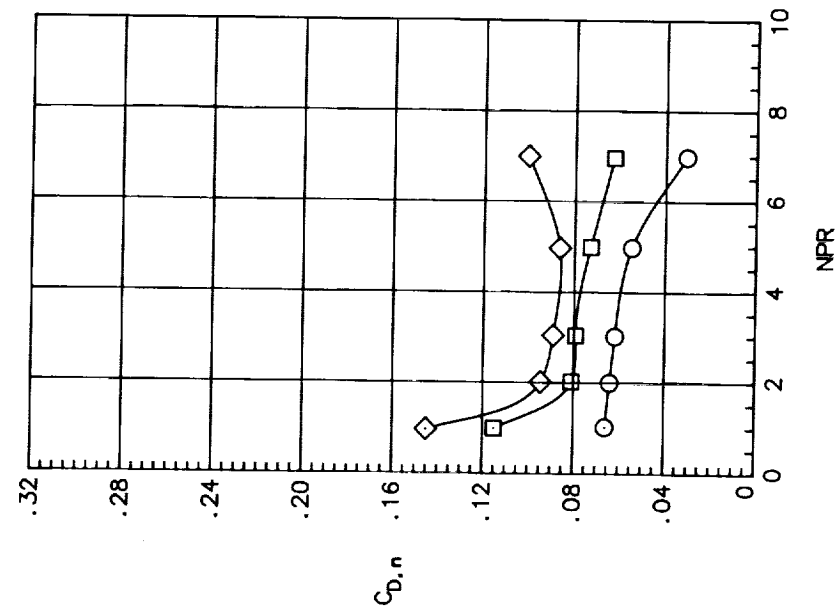
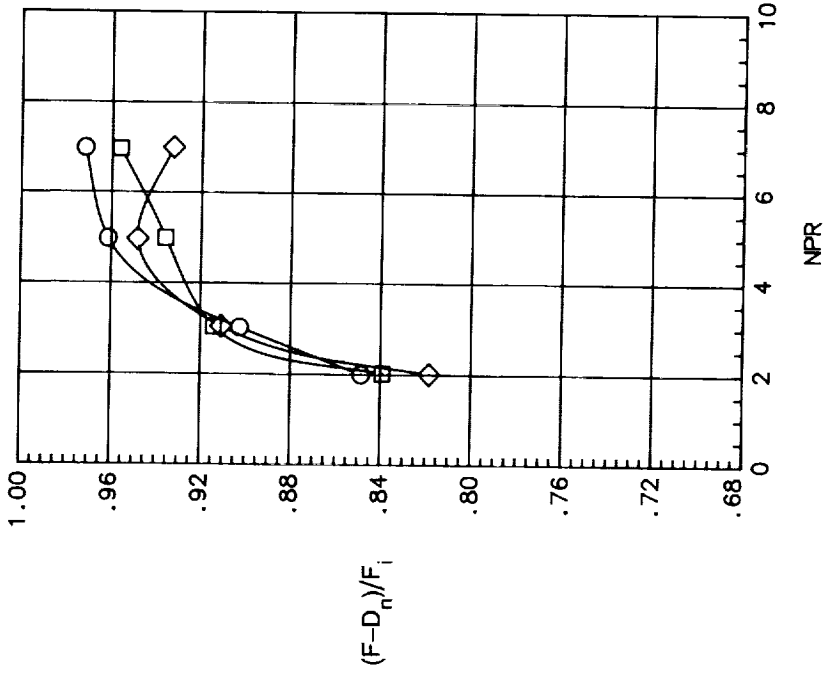
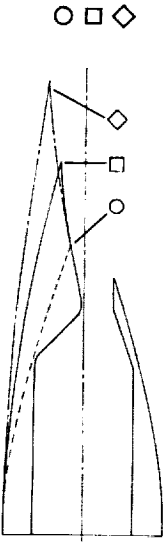
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(a)  $M = 0; \alpha = 0^\circ$ .

Figure 5. Effect of upper ramp length on aeropropulsive performance.  $\theta_r = 8.75^\circ; l_f/h_{t,n} = 0.90; \theta_f = 0^\circ; \beta_f = 11.28^\circ; x_t/h_{t,n} = 7.25; y_t/h_{t,n} = 0.12$ .

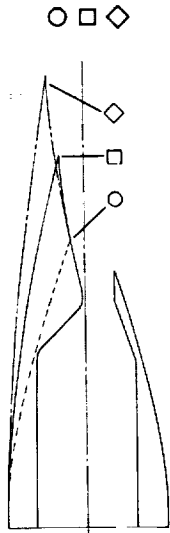
Nozzle	$l_r/h_{t,n}$	$\beta_r$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
2	2.0	12.60	1.18	1.31
1	4.5	8.15	1.19	1.69
3	7.0	5.20	1.20	2.08



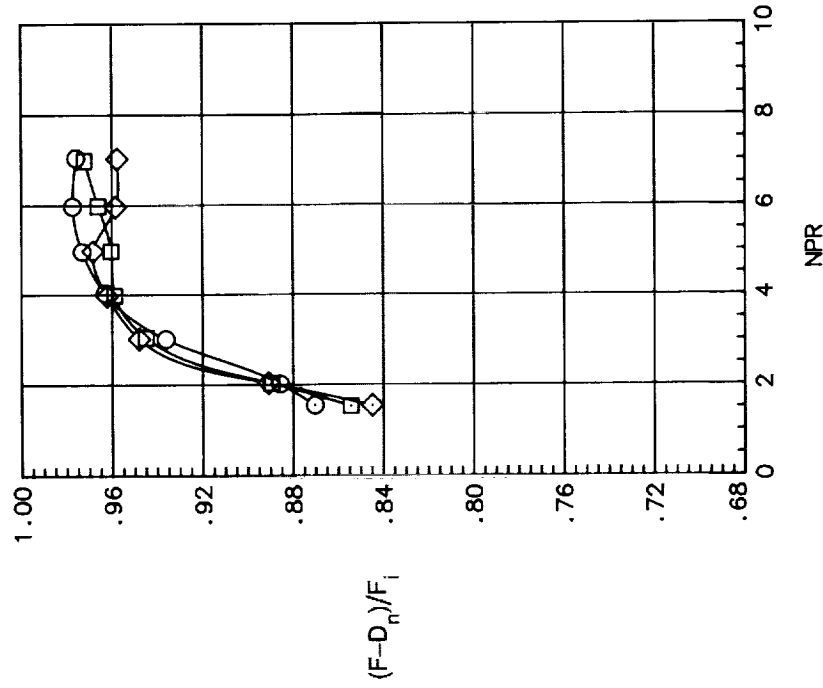
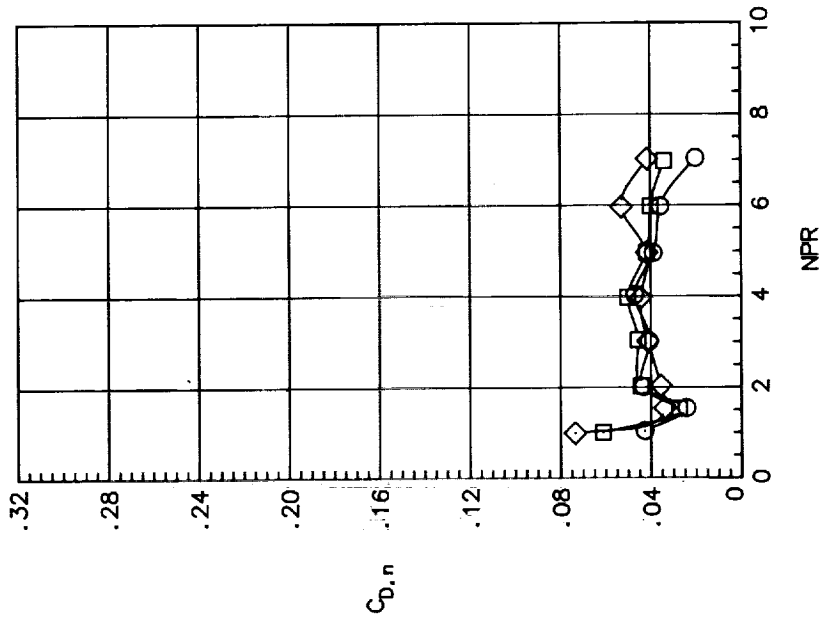
(b)  $M = 0.60; \alpha = -6^\circ$ .

Figure 5. Continued.

Nozzle	$l_r/h_{t,n}$	$\beta_r$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
2	2.0	12.60	1.18	1.31
1	4.5	8.15	1.19	1.69
3	7.0	5.20	1.20	2.08

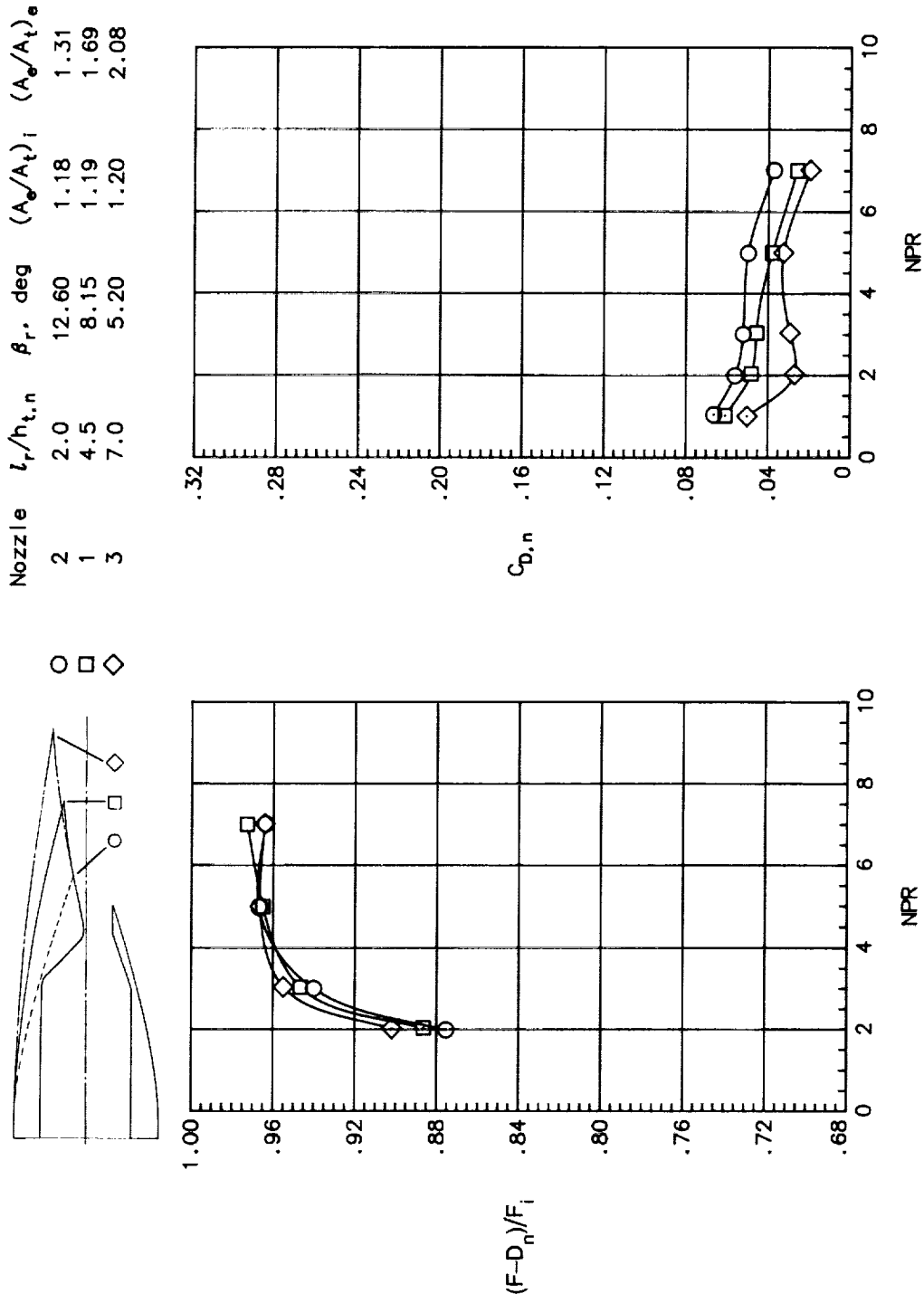


○ □ ◇



(c)  $M = 0.60; \alpha = 0^\circ$ .

Figure 5. Continued.

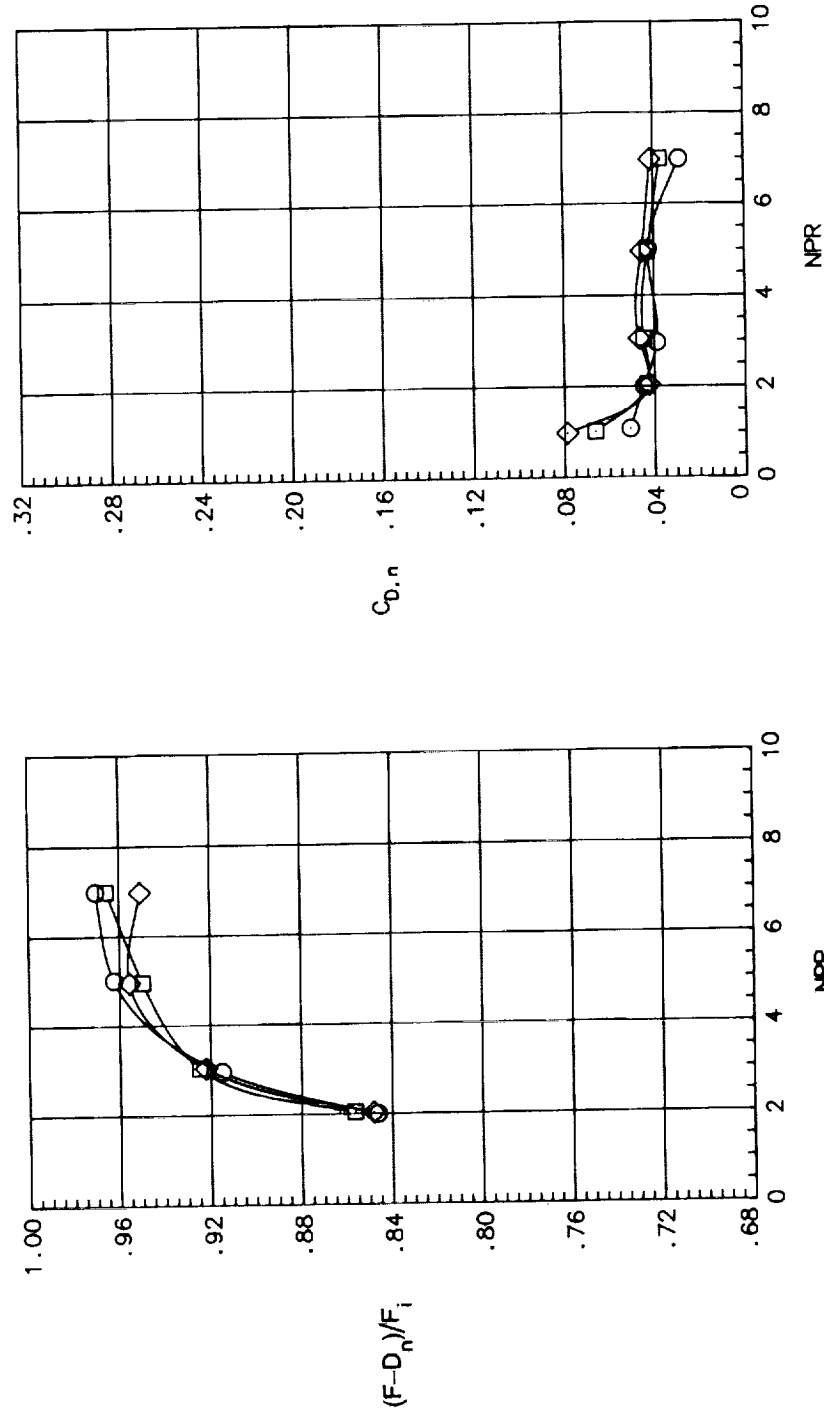
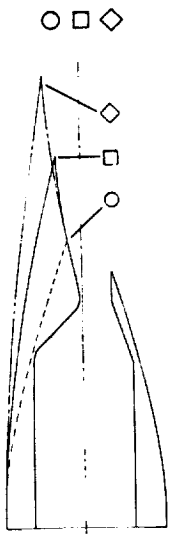


(d)  $M = 0.60; \alpha = 6^\circ$ .

Figure 5. Continued.



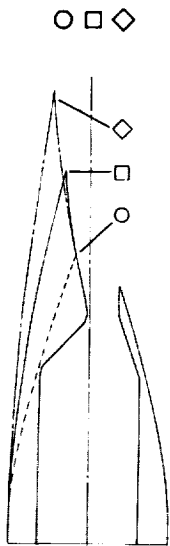
Nozzle	$l_r/n_{t,n}$	$\beta_r$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
2	2.0	12.60	1.18	1.31
1	4.5	8.15	1.19	1.69
3	7.0	5.20	1.20	2.08



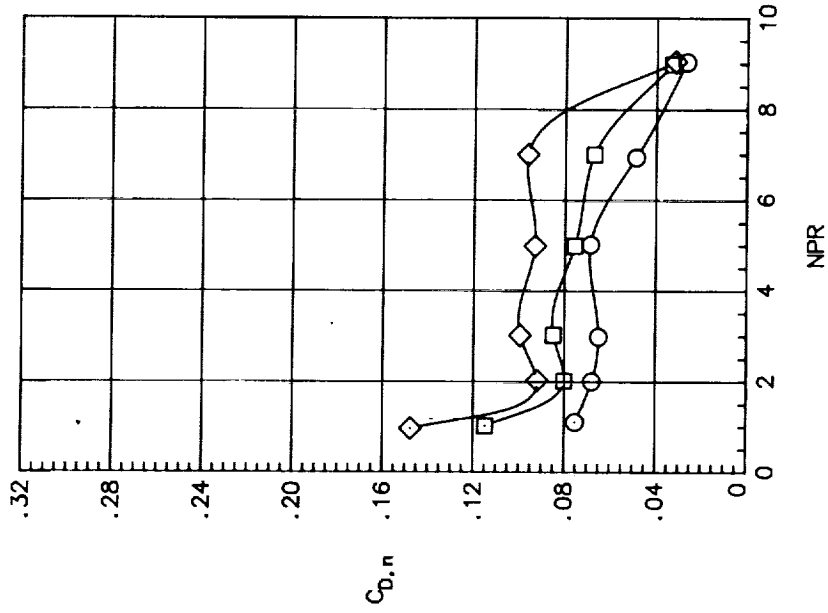
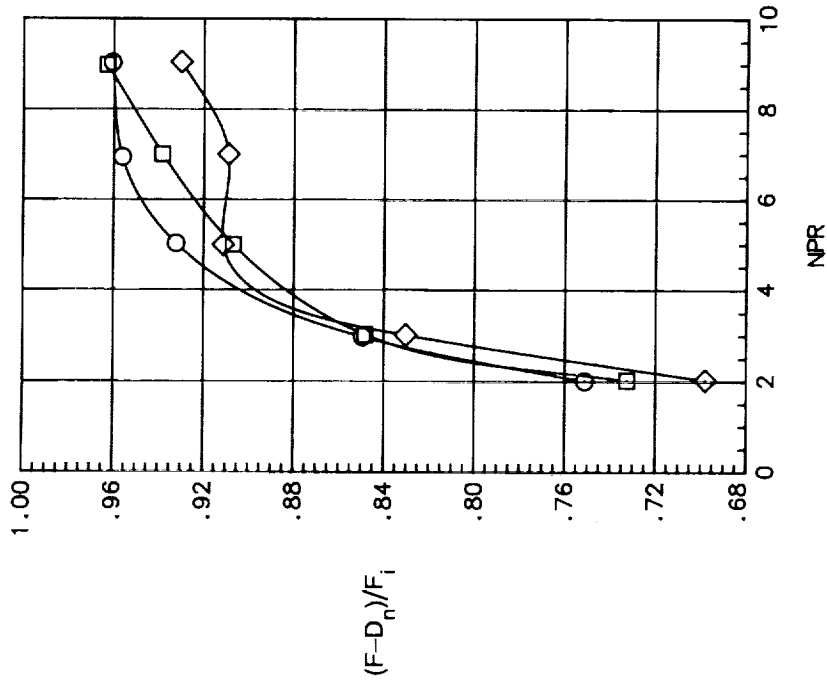
(e)  $M = 0.80; \alpha = 0^\circ$ .

Figure 5. Continued.

Nozzle	$L_r/h_{t,n}$	$\beta_r$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
2	2.0	12.60	1.18	1.31
1	4.5	8.15	1.19	1.69
3	7.0	5.20	1.20	2.08



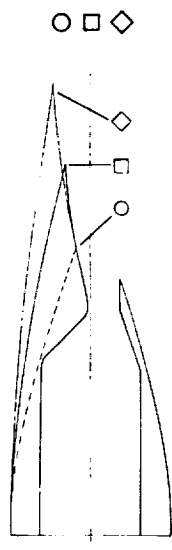
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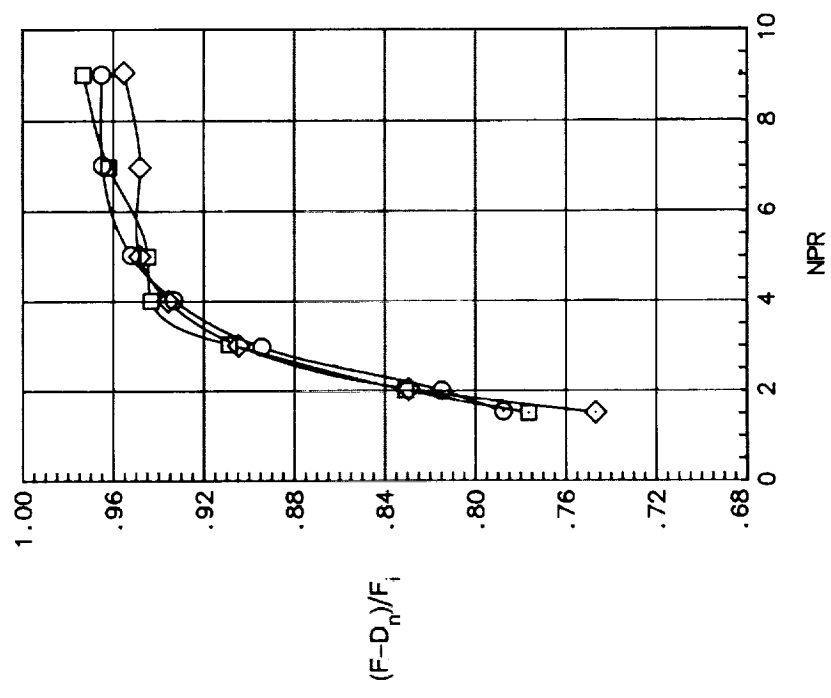
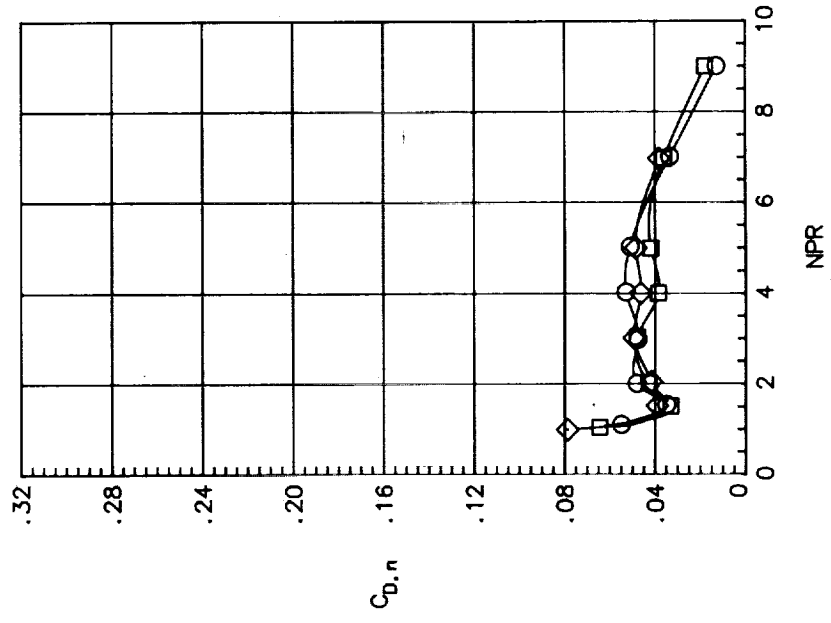
(f)  $M = 0.90; \alpha = -6^\circ$ .

Figure 5. Continued.

Nozzle	$l_r/h_{t,n}$	$\beta_r$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
2	2.0	12.60	1.18	1.31
1	4.5	8.15	1.19	1.69
3	7.0	5.20	1.20	2.08



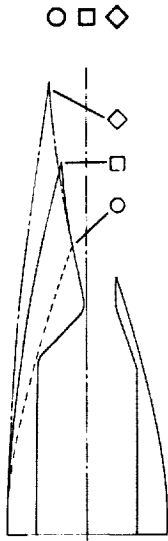
○ □ ◇



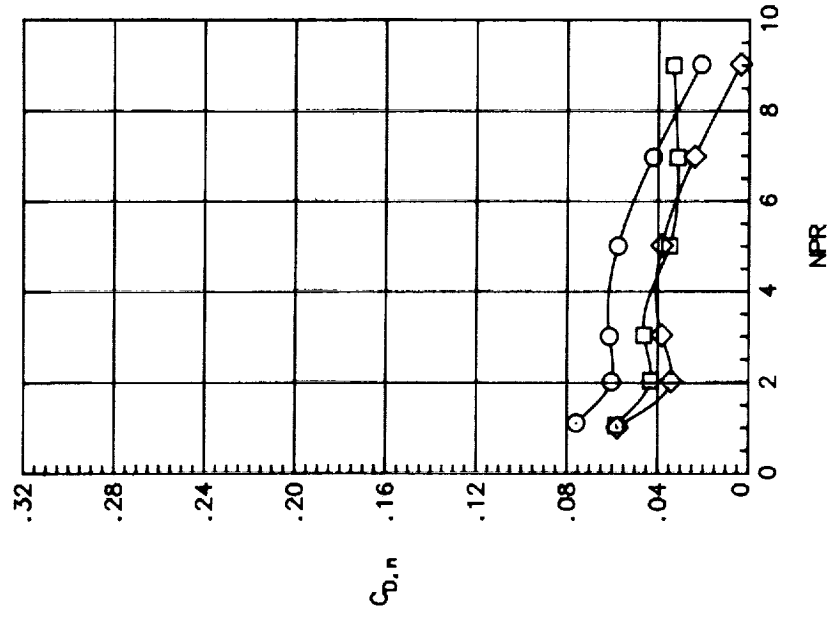
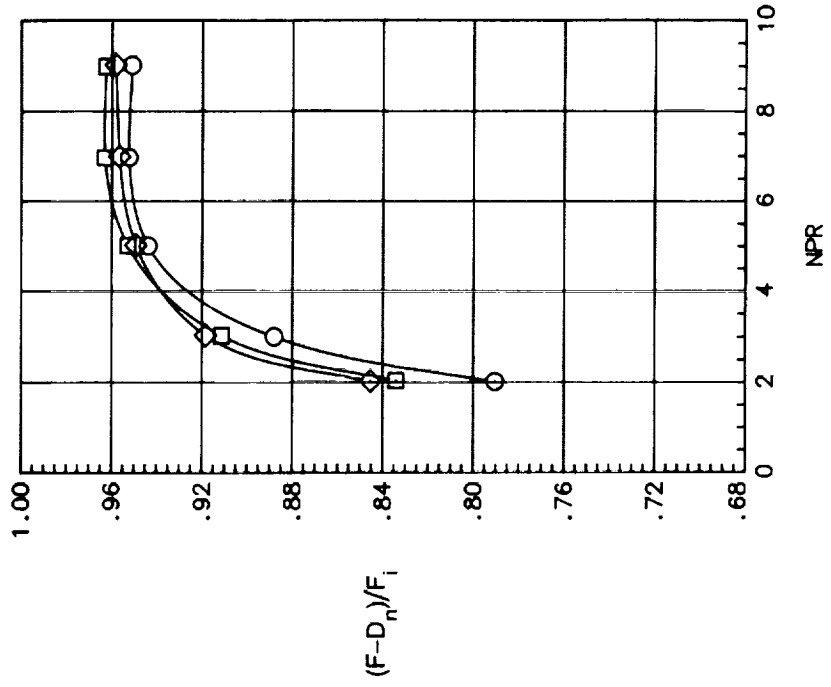
(g)  $M = 0.90; \alpha = 0^\circ$ .

Figure 5. Continued.

Nozzle	$t_r/h_{t,n}$	$\beta_r$ , deg	$(A_0/A_t)_1$	$(A_0/A_t)_e$
2	2.0	12.60	1.18	1.31
1	4.5	8.15	1.19	1.69
3	7.0	5.20	1.20	2.08



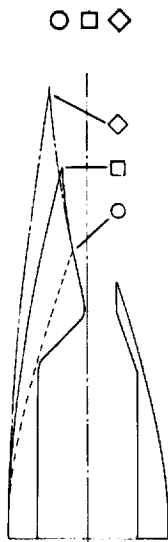
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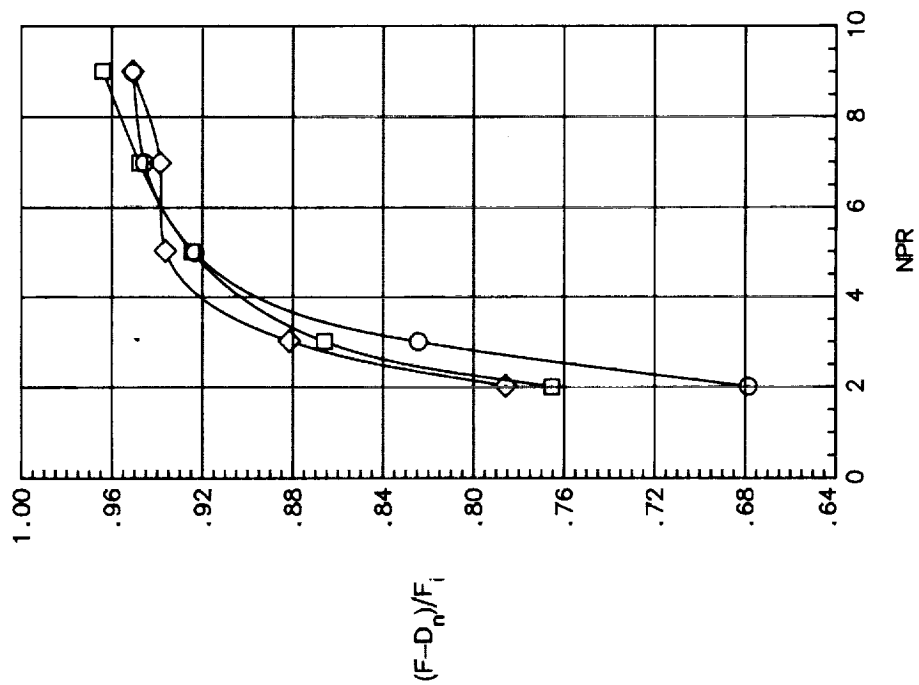
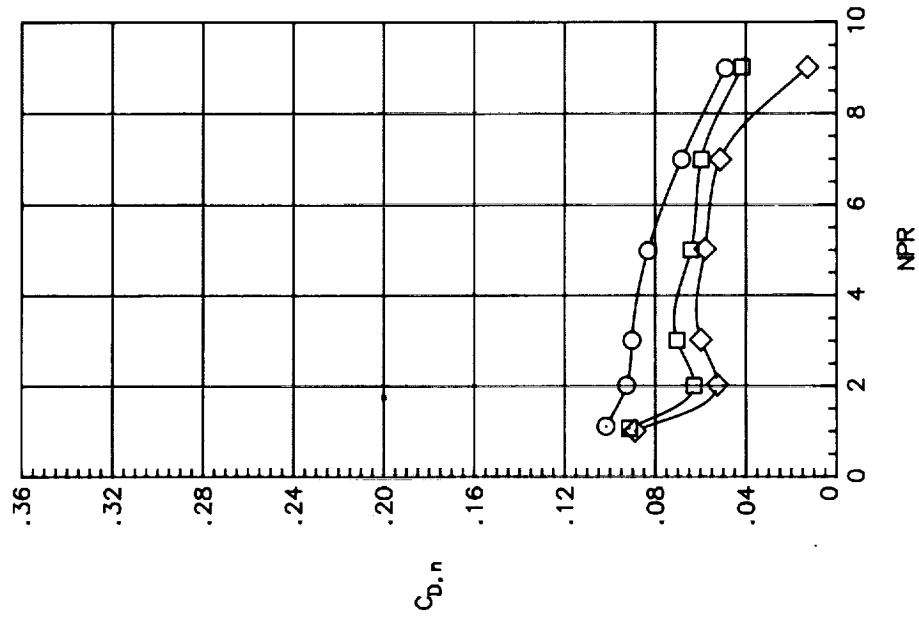
(h)  $M = 0.90; \alpha = 6^\circ$ .

Figure 5. Continued.

Nozzle	$l_r/h_{t,n}$	$\beta_r$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
2	2.0	12.60	1.18	1.31
1	4.5	8.15	1.19	1.69
3	7.0	5.20	1.20	2.08

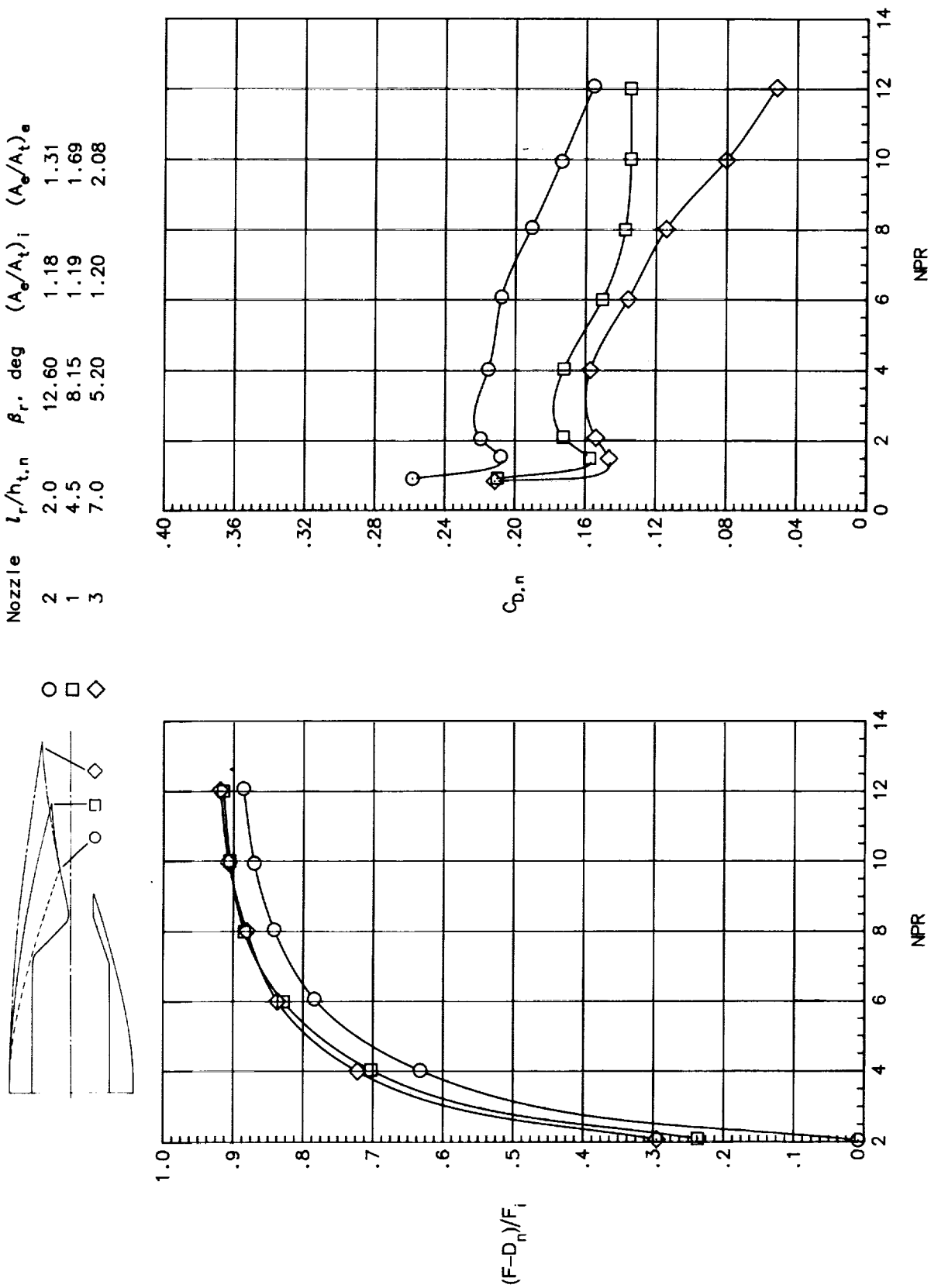


○ □ ◇



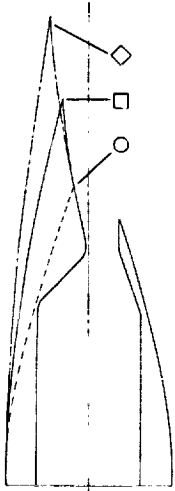
(i)  $M = 0.95; \alpha = 0^\circ$ .

Figure 5. Continued.



(j)  $M = 1.20; \alpha = 0^\circ$ .

Figure 5. Concluded.



Nozzle	$l_r/h_{t,n}$	$\beta_r$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
2	2.0	12.60	1.18	1.31
1	4.5	8.15	1.19	1.69
3	7.0	5.20	1.20	2.08

○ □ ◇

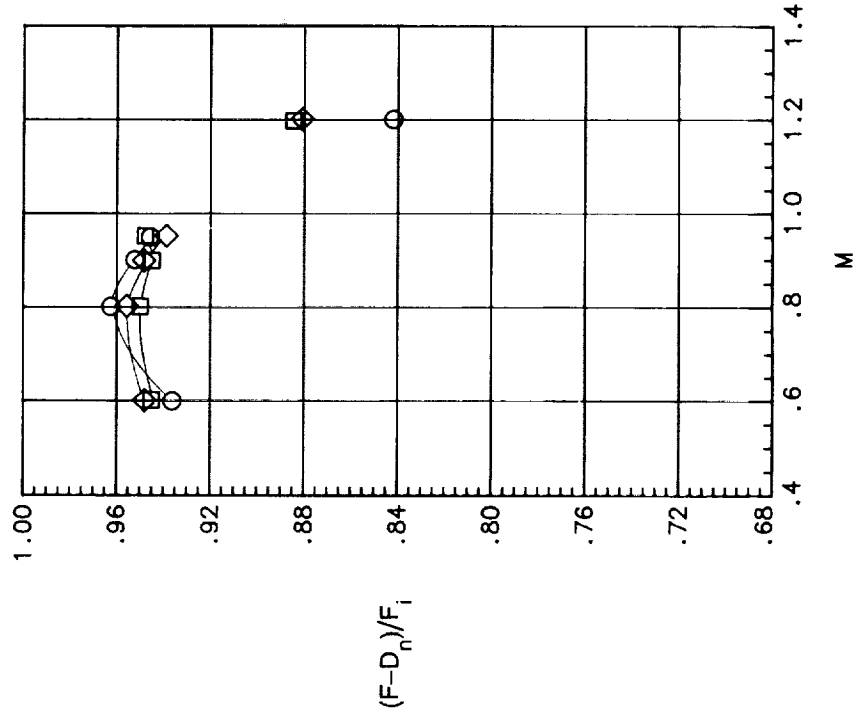
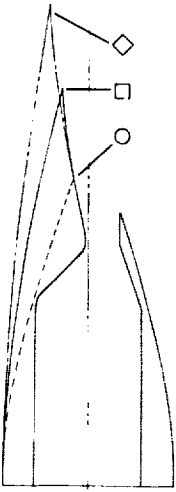


Figure 6. Effect of upper ramp length on aeropropulsive performance at scheduled NPR.  $\theta_r = 8.75^\circ$ ;  $l_f/h_{t,n} = 0.90$ ;  $\theta_f = 0^\circ$ ;  $\beta_f = 11.28^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .



Nozzle	$l_r/h_{t,n}$	$\beta_r$ , deg	$(A_e/\dot{A}_t)_i$	$(A_e/\dot{A}_t)_e$
○	2	12.60	1.18	1.31
□	1	8.15	1.19	1.69
◇	3	5.20	1.20	2.08

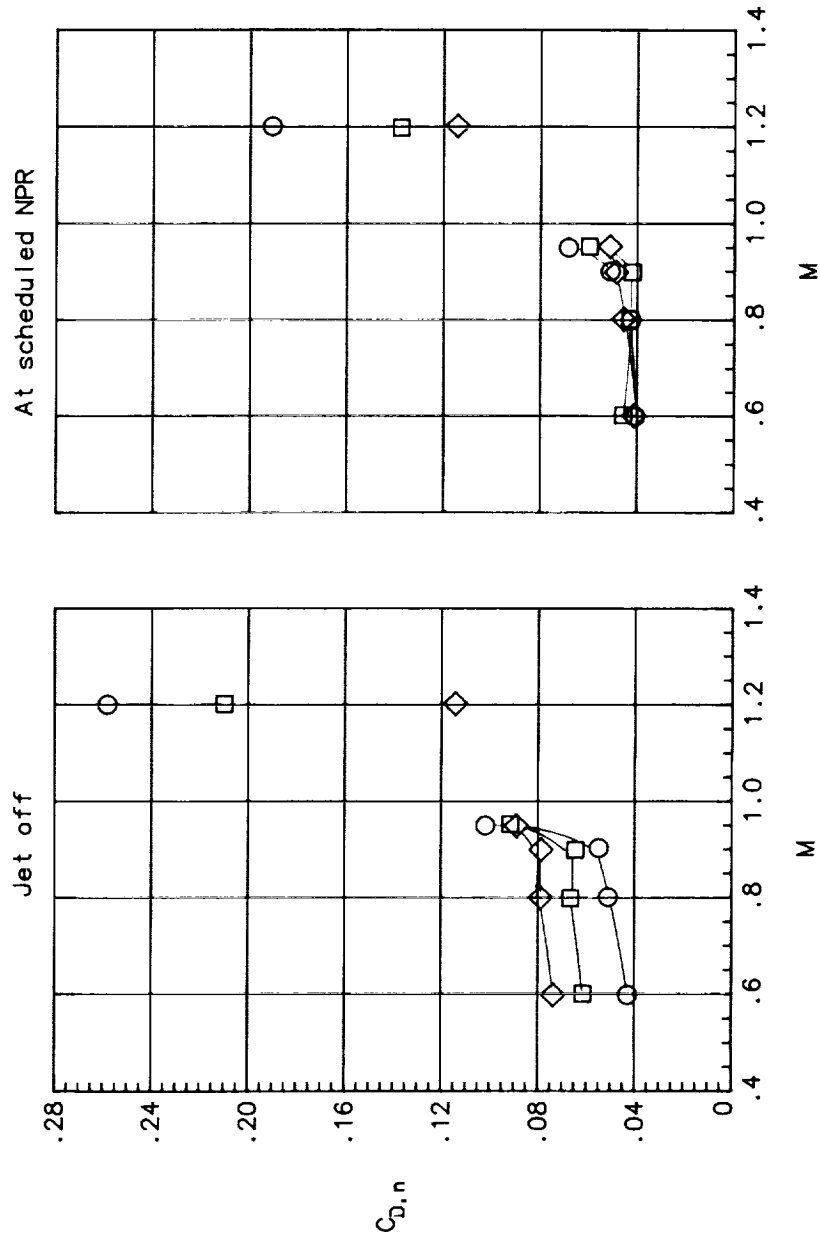
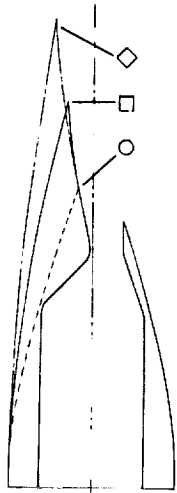


Figure 7. Effect of upper ramp length on nozzle drag.  $\theta_r = 8.75^\circ$ ;  $l_f/h_{t,n} = 0.90$ ;  $\theta_f = 0^\circ$ ;  $\beta_f = 11.28^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .





Nozzle	$l_r/h_{t,n}$	$\beta_r$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
○	2.0	12.60	1.18	1.31
□	4.5	8.15	1.19	1.69
◇	7.0	5.20	1.20	2.08

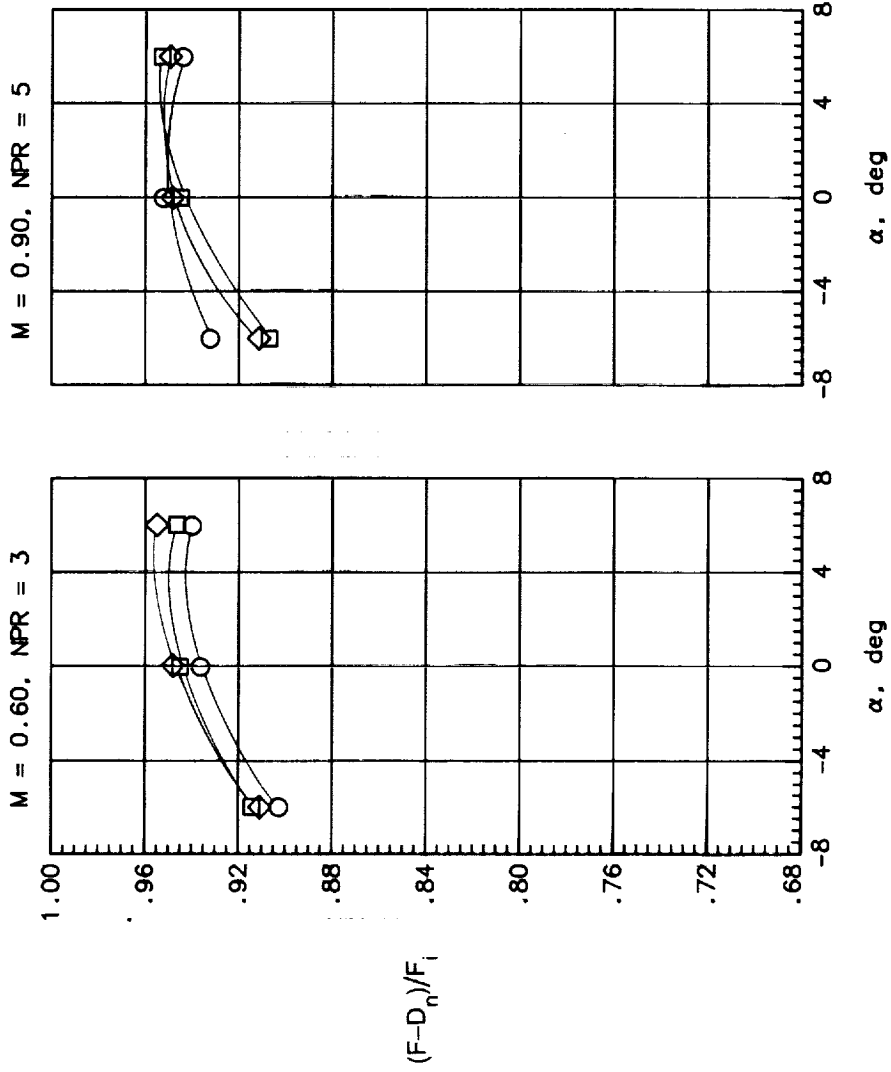
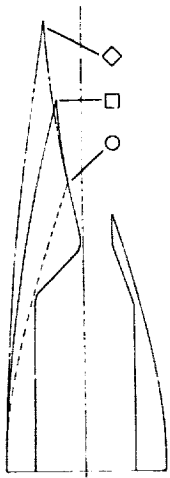
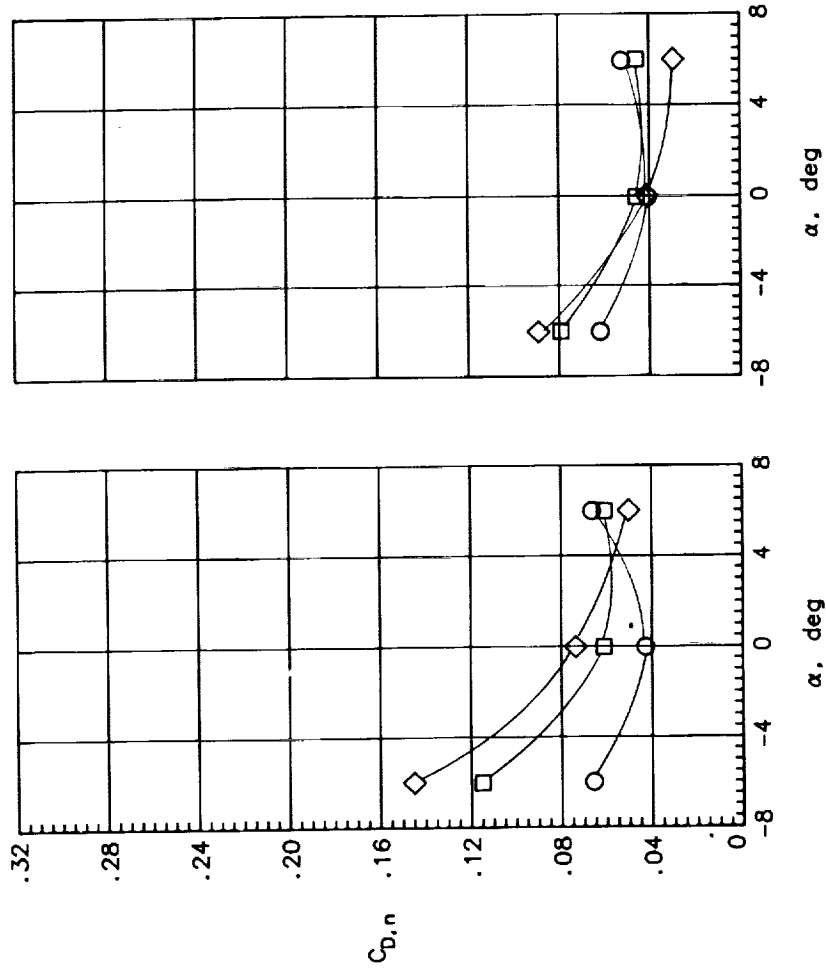


Figure 8. Effect of upper ramp length on aerodynamic performance at angle of attack at scheduled NPR.  
 $\theta_r = 8.75^\circ; l_f/h_{t,n} = 0.90; \theta_f = 0^\circ; \beta_f = 11.28^\circ; x_t/h_{t,n} = 7.25; y_t/h_{t,n} = 0.12.$



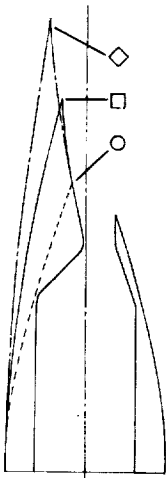
Symbol	Nozzle	$l_r/h_{t,n}$	$\beta_r$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
○	2	2.0	12.60	1.18	1.31
□	1	4.5	8.15	1.19	1.69
◇	3	7.0	5.20	1.20	2.08

Jet off  
NPR = 3



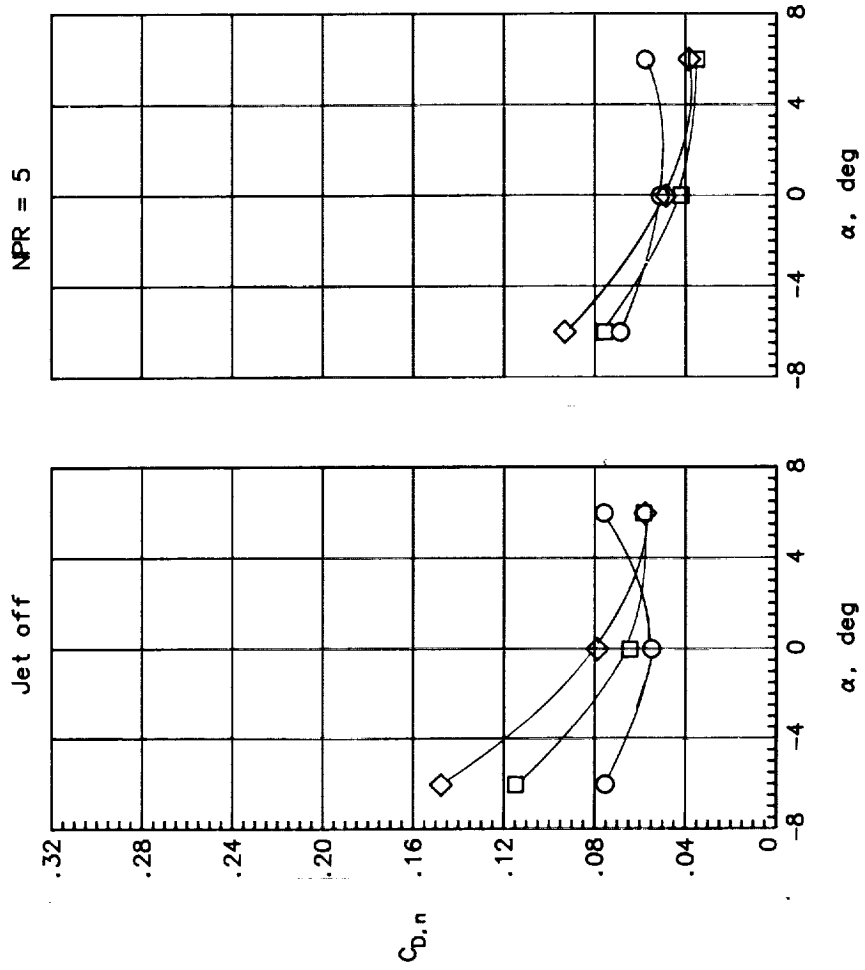
(a)  $M = 0.60$ .

Figure 9. Effect of upper ramp length on nozzle drag at angle of attack.  $\theta_r = 8.75^\circ$ ;  $l_f/h_{t,n} = 0.90$ ;  $\theta_f = 0^\circ$ ;  $\beta_f = 11.28^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ .



Nozzle	$l_r/h_{t,n}$	$\beta_r$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
○	2.0	12.60	1.18	1.31
□	4.5	8.15	1.19	1.69
◇	7.0	5.20	1.20	2.08

NPR = 5

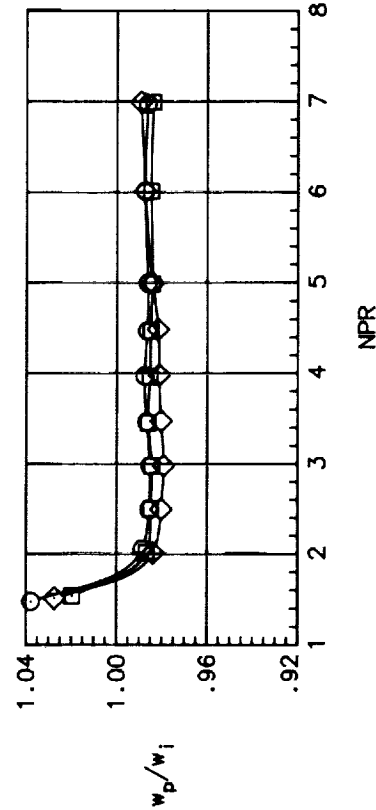
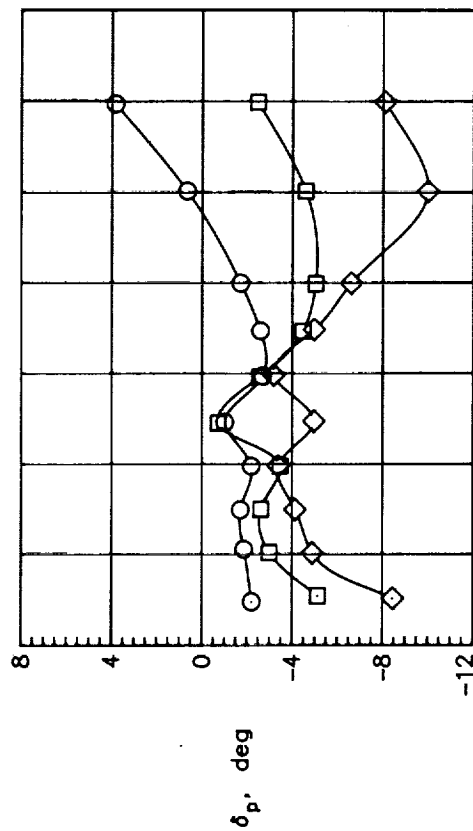
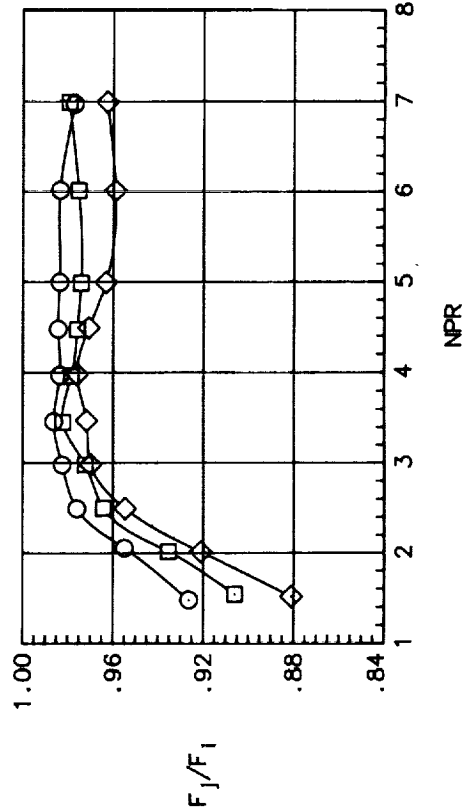
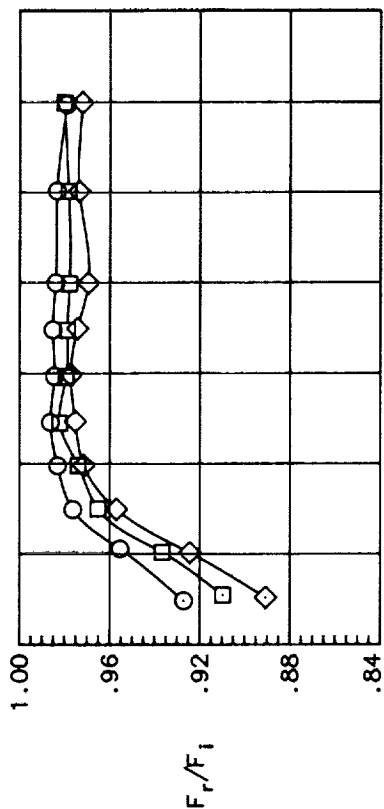
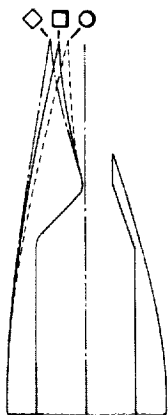


(b)  $M = 0.90$ .

Figure 9. Concluded.

Nozzle	$\theta_r$ , deg	$\beta_r$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
4	5.00	9.57	1.13	1.39
1	8.75	8.15	1.19	1.69
5	12.00	6.69	1.25	2.00

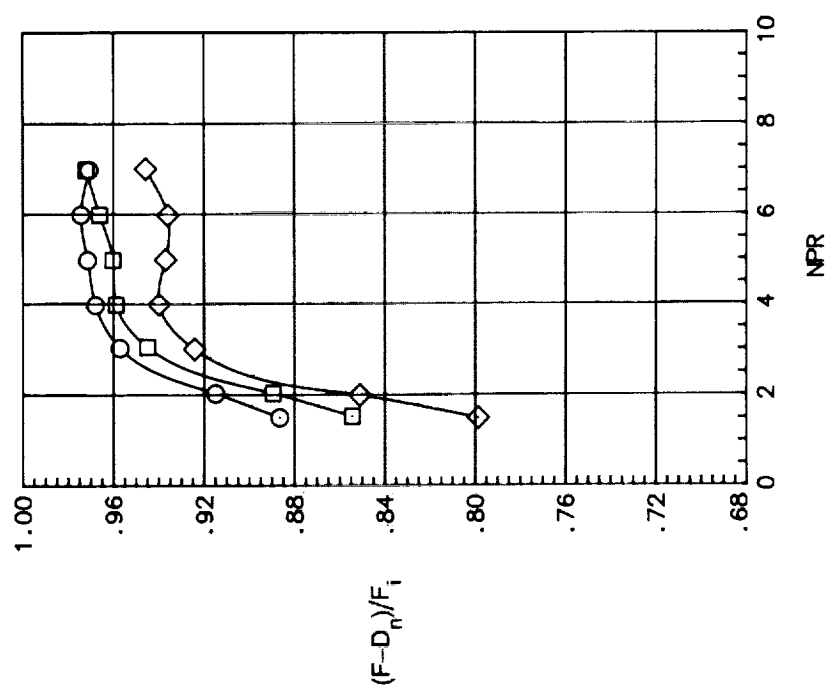
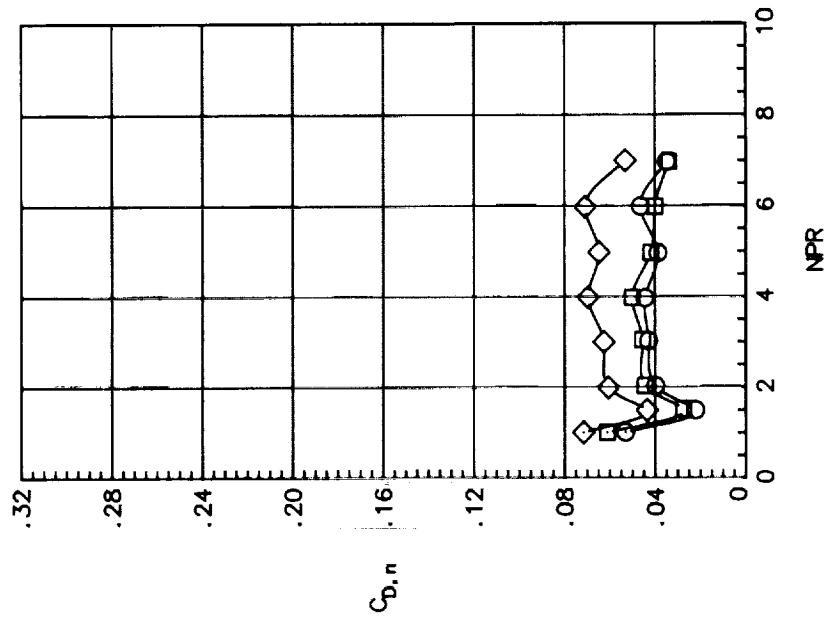
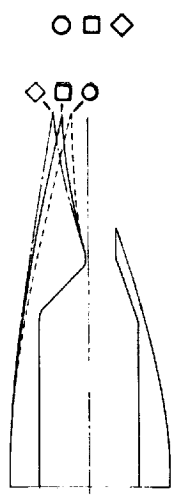
○ □ ◇



(a)  $M = 0$ .

Figure 10. Effect of upper ramp angle on aeropropulsive performance.  $l_r/h_{t,n} = 4.50$ ;  $l_f/h_{t,n} = 0.90$ ;  $\theta_f = 0^\circ$ ;  $\beta_f = 11.28^\circ$ ;  $x_t/h_t = 7.25$ ;  $y_t/h_t = 0.12$ ;  $\alpha = 0^\circ$ .

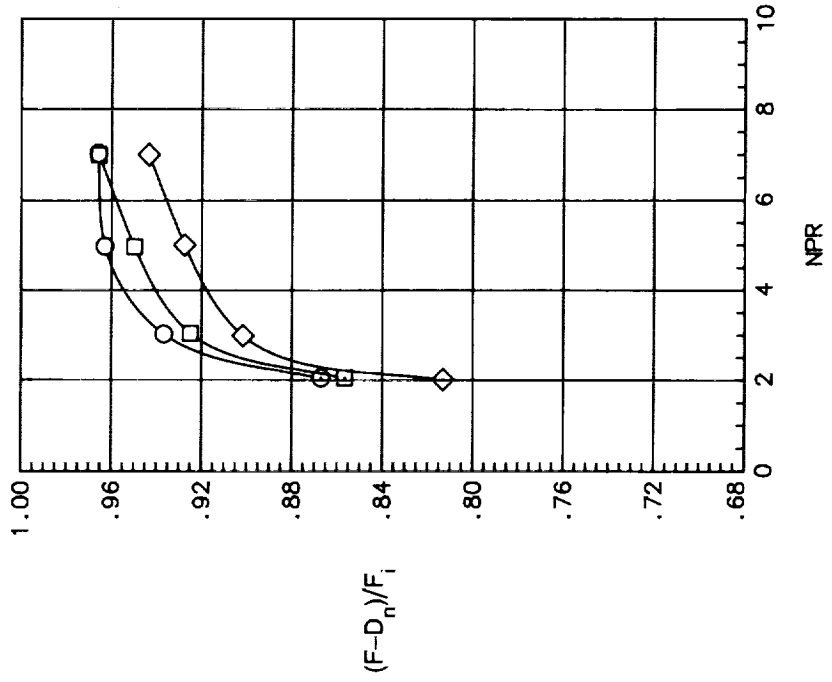
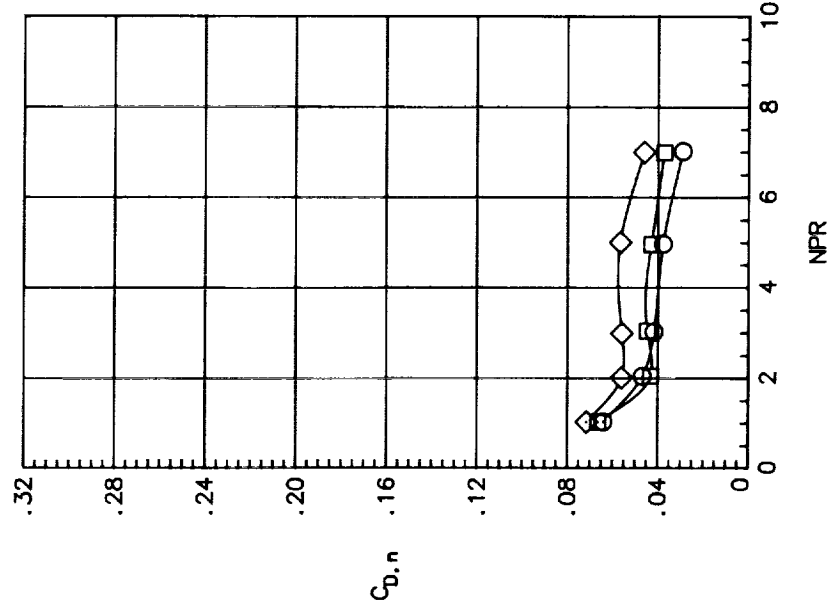
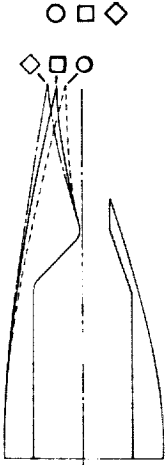
Nozzle	$\theta_r$ , deg	$\beta_r$ , deg	$(A_o/A_t)_i$	$(A_o/A_t)_e$
4	5.00	9.57	1.13	1.39
1	8.75	8.15	1.19	1.69
5	12.00	6.69	1.25	2.00



(b)  $M = 0.60$ .

Figure 10. Continued.

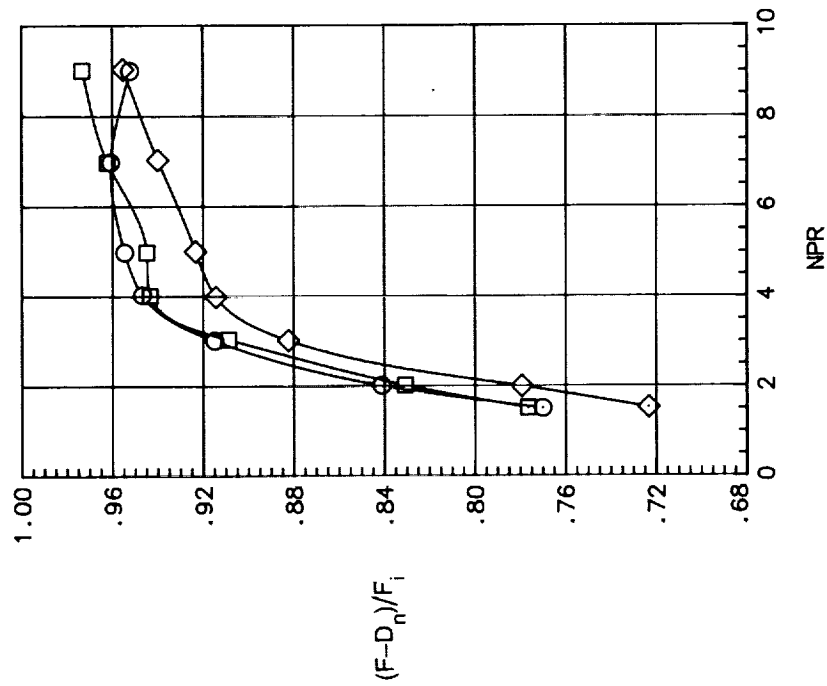
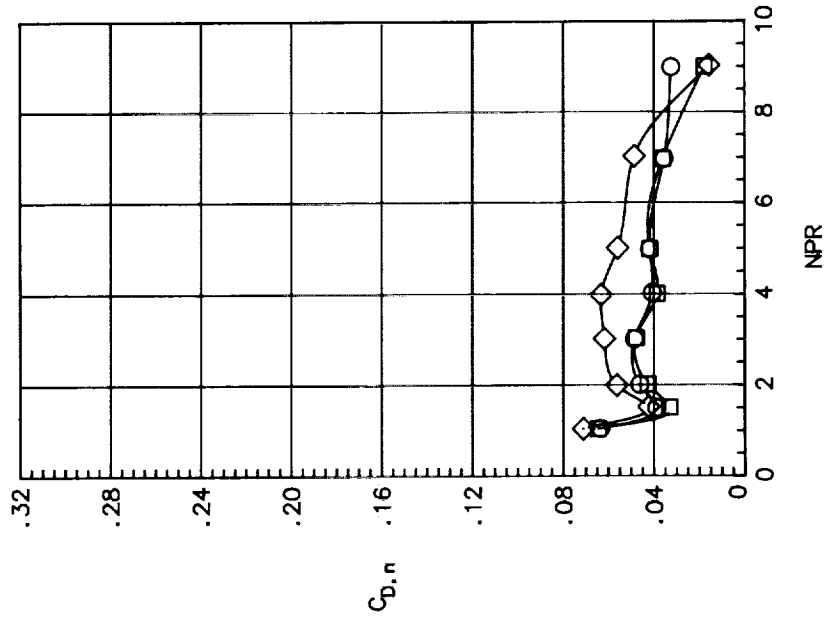
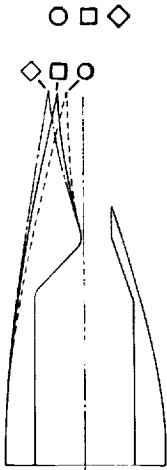
Nozzle	$\theta_r$ , deg	$\beta_r$ , deg	$(A_0/A_t)_i$	$(A_0/A_t)_e$
4	5.00	9.57	1.13	1.39
1	8.75	8.15	1.19	1.69
5	12.00	6.69	1.25	2.00



(c)  $M = 0.80$ .

Figure 10. Continued.

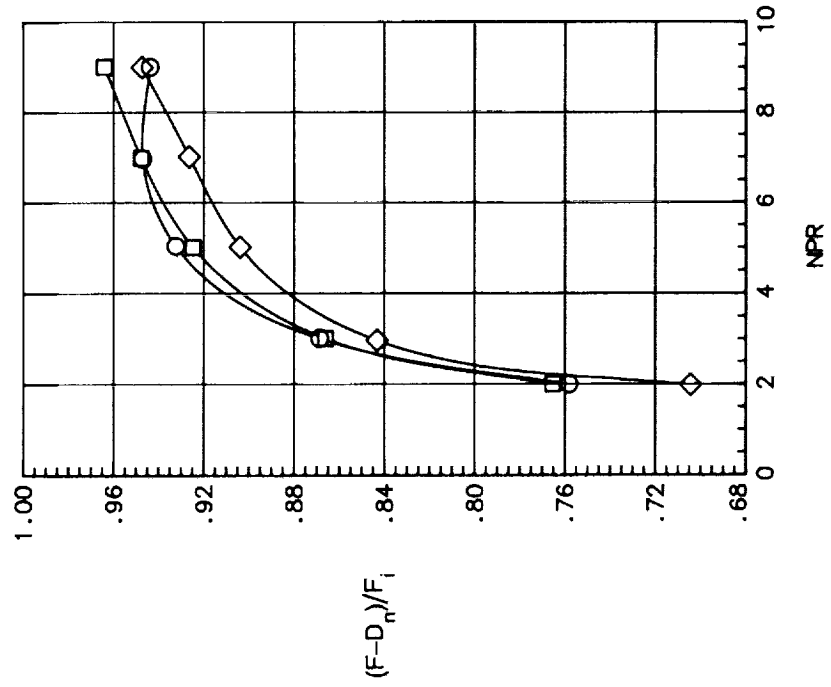
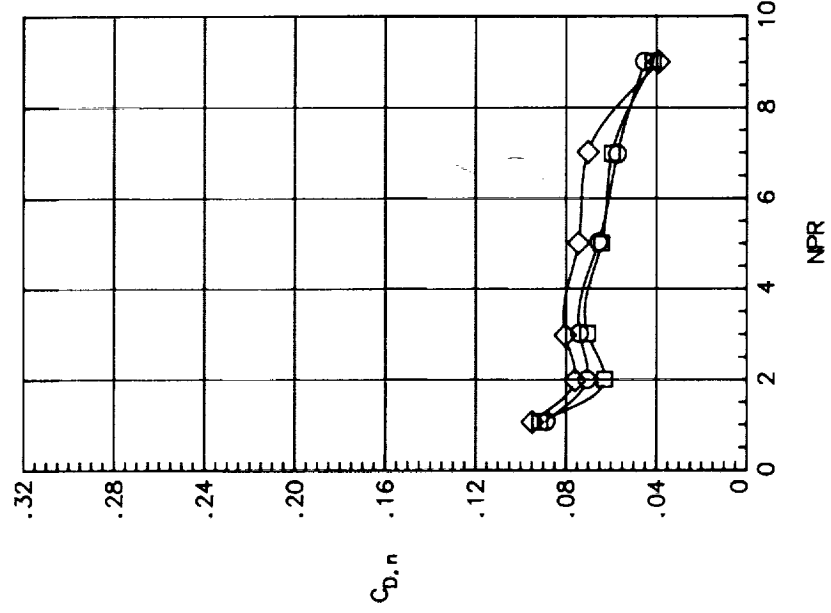
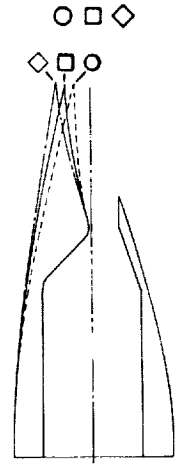
Nozzle	$\theta_r$ , deg	$\beta_r$ , deg	$(A_0/A_t)_1$	$(A_0/A_t)_e$
4	5.00	9.57	1.13	1.39
1	8.75	8.15	1.19	1.69
5	12.00	6.69	1.25	2.00



(d)  $M = 0.90$ .

Figure 10. Continued.

Nozzle	$\theta_r$ , deg	$\beta_r$ , deg	$(A_o/A_t)_i$	$(A_o/A_t)_e$
4	5.00	9.57	1.13	1.39
1	8.75	8.15	1.19	1.69
5	12.00	6.69	1.25	2.00

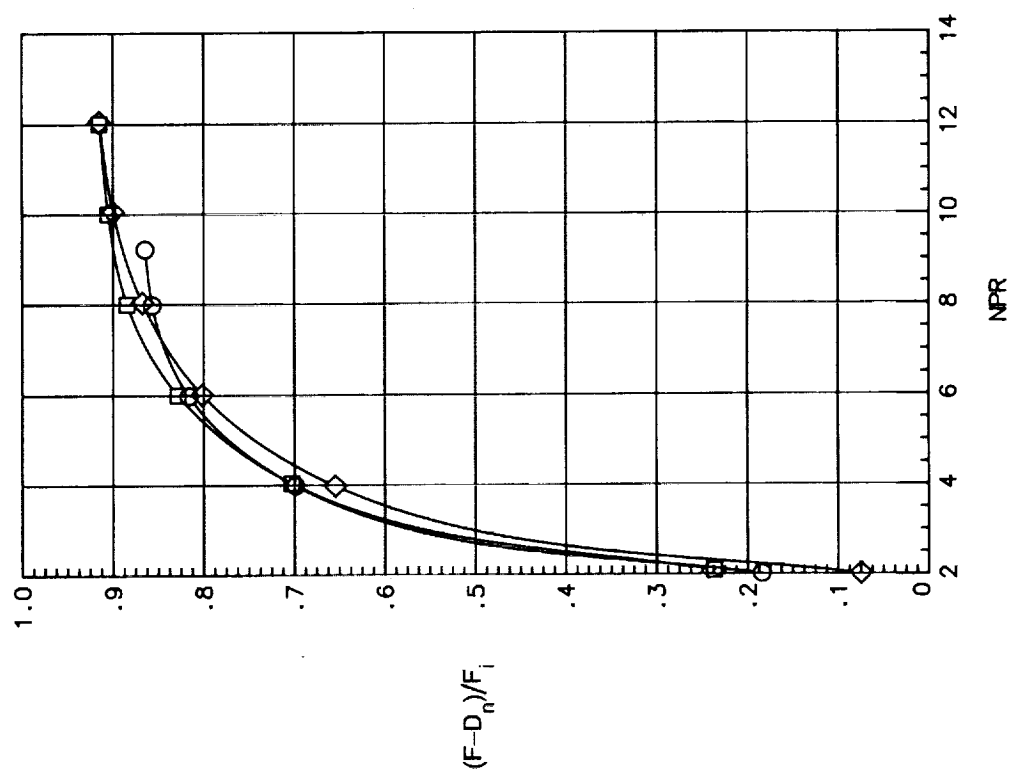
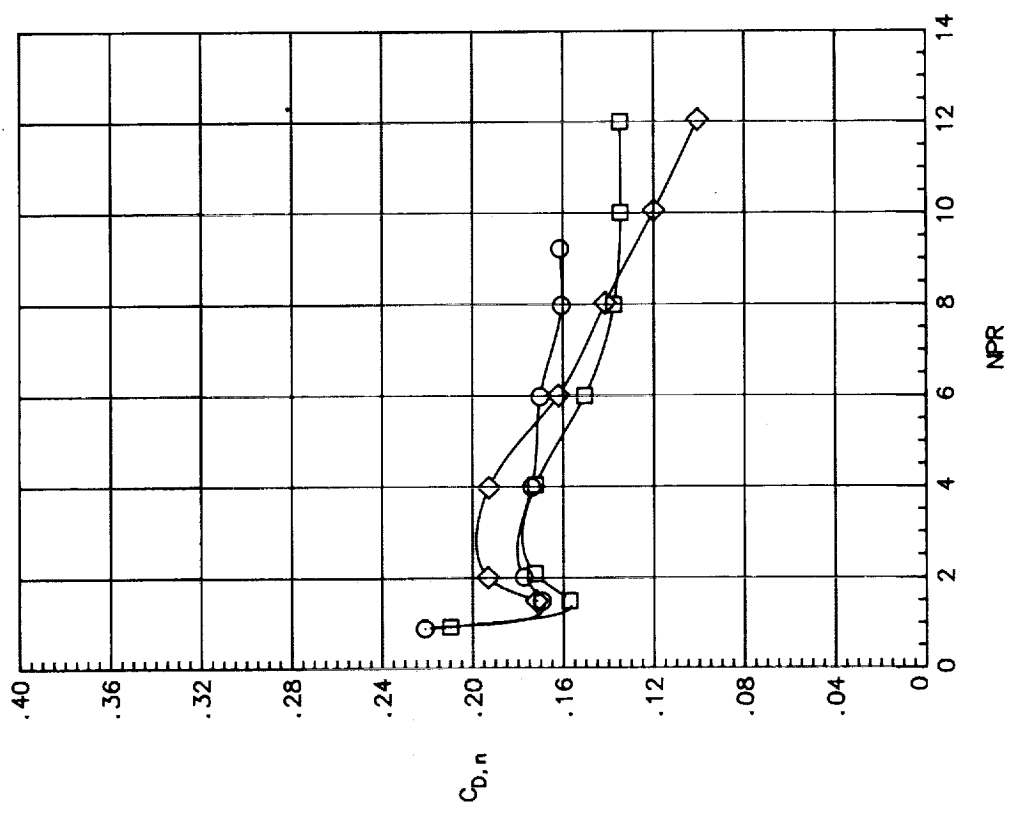
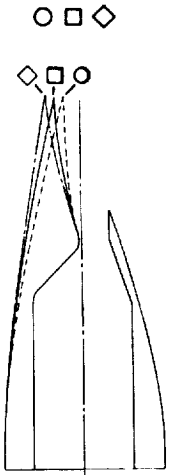


(e)  $M = 0.95$ .

Figure 10. Continued.

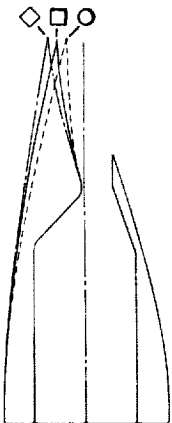


Nozzle	$\theta_r$ , deg	$\beta_r$ , deg	$(A_0/A_t)_i$	$(A_0/A_t)_e$
4	5.00	9.57	1.13	1.39
1	8.75	8.15	1.19	1.69
5	12.00	6.69	1.25	2.00



(f)  $M = 1.20$ .

Figure 10. Concluded.



Nozzle	$\theta_r$ , deg	$\beta_r$ , deg	$(A_0/A_t)_i$	$(A_0/A_t)_e$
○	5.00	9.57	1.13	1.39
□	8.75	8.15	1.19	1.69
◇	12.00	6.69	1.25	2.00

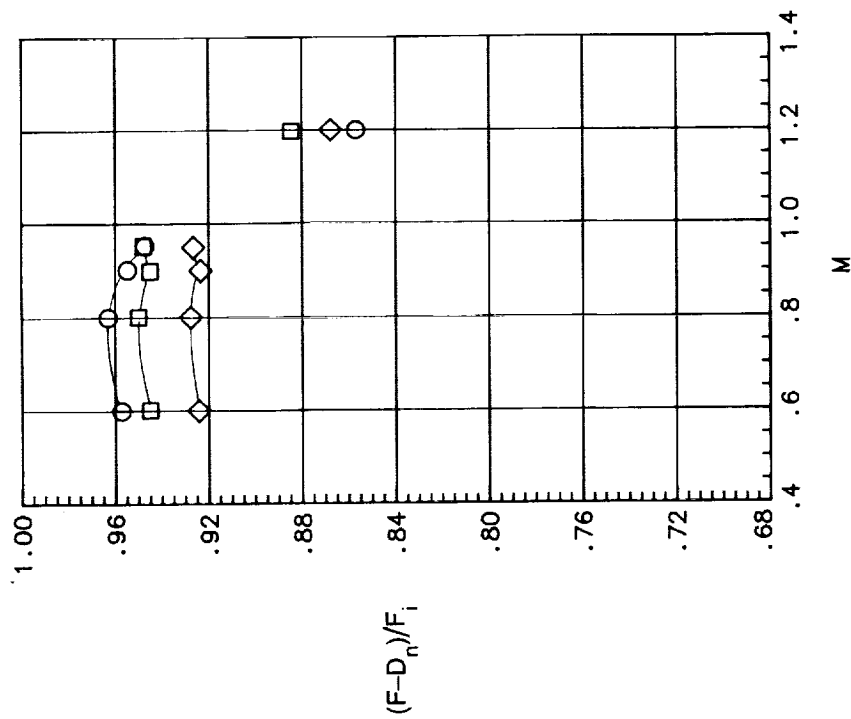
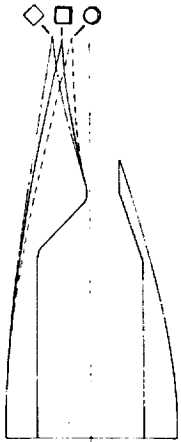


Figure 11. Effect of upper ramp angle on aerodynamic performance at scheduled NPR.  $t_r/h_{t,n} = 4.50$ ;  $t_f/h_{t,n} = 0.90$ ;  $\theta_f = 0^\circ$ ;  $\beta_f = 11.28^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .



Nozzle	$\theta_r$ , deg	$\beta_r$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
○	4	5.00	1.13	1.39
□	1	8.75	1.19	1.69
◇	5	12.00	1.25	2.00

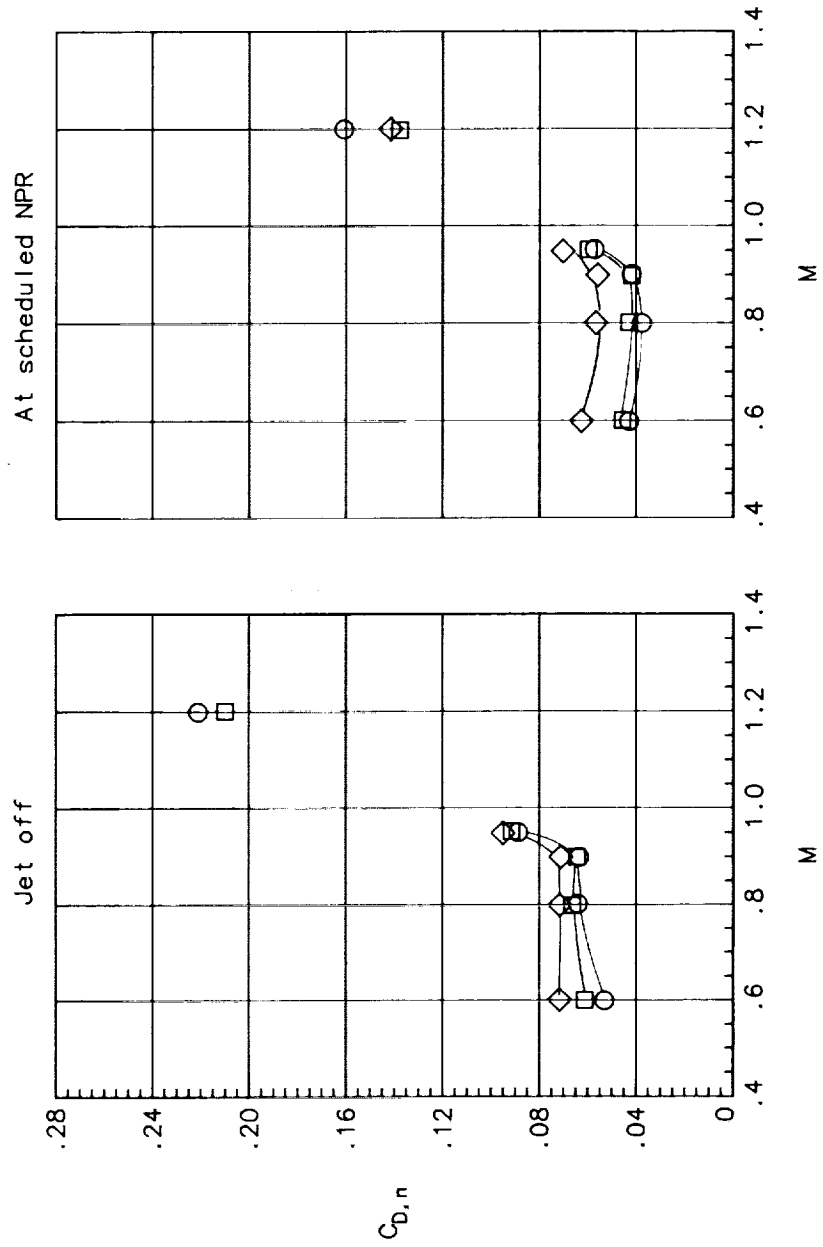
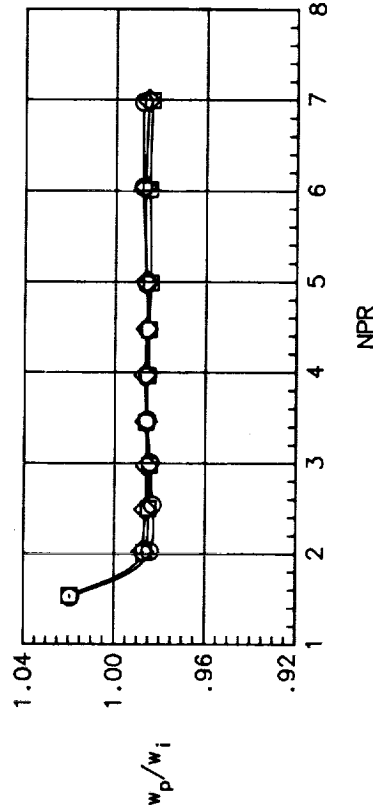
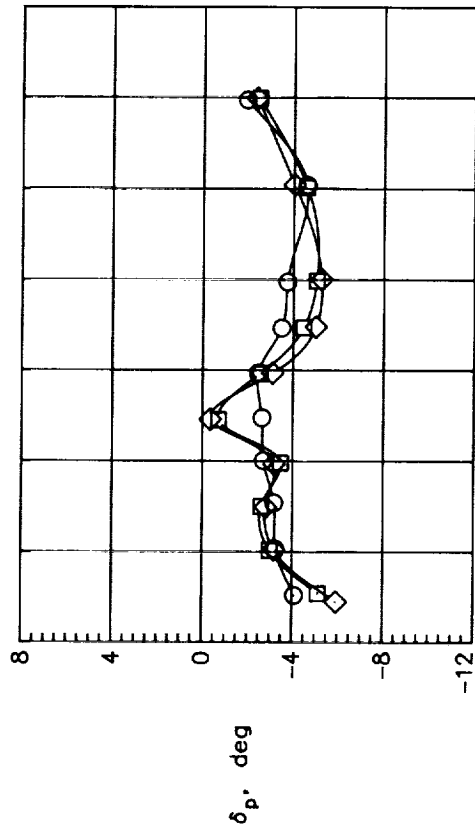
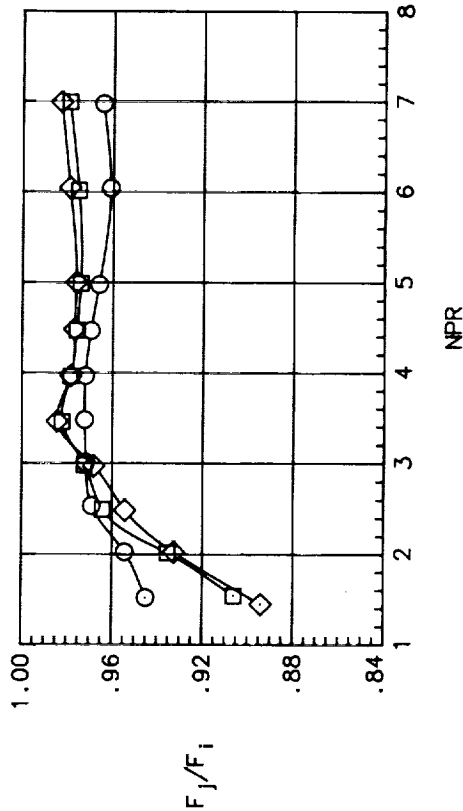
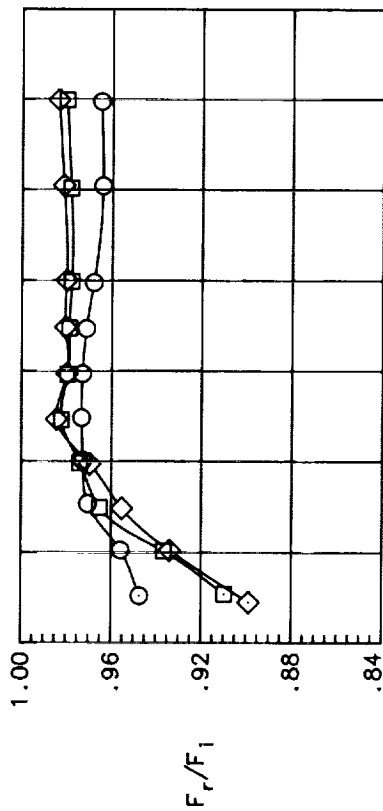
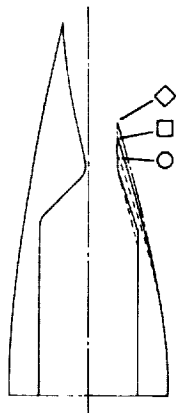


Figure 12. Effect of upper ramp angle on nozzle drag.  $l_r/h_{t,n} = 4.50$ ;  $l_f/h_{t,n} = 0.90$ ;  $\theta_f = 0^\circ$ ;  $\beta_f = 11.28^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .

Nozzle	$l_f/h_{t,n}$	$\beta_f$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
6	0.40	11.99	1.08	1.69
1	.90	11.28	1.19	1.69
7	1.40	10.64	1.30	1.69

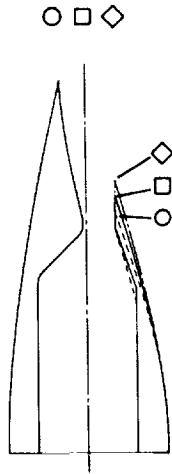
○ □ ◇



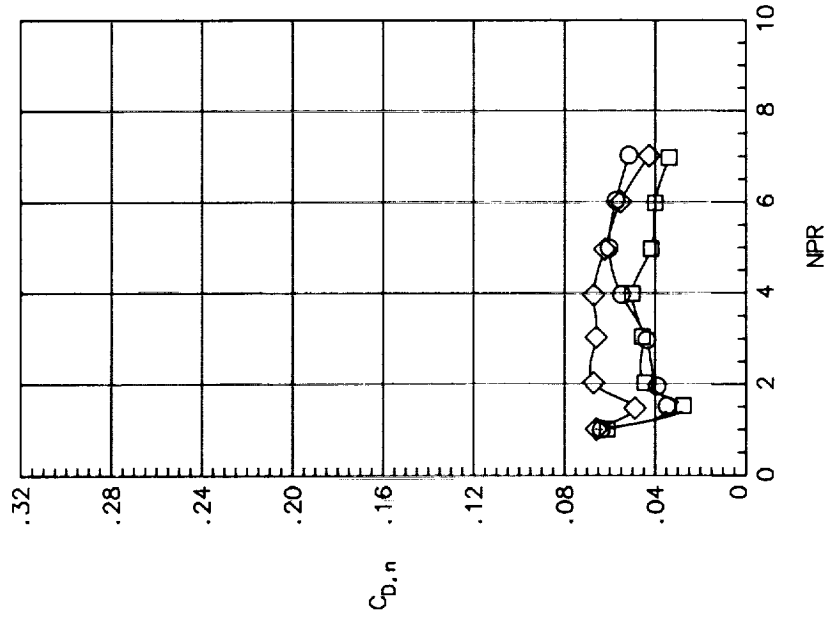
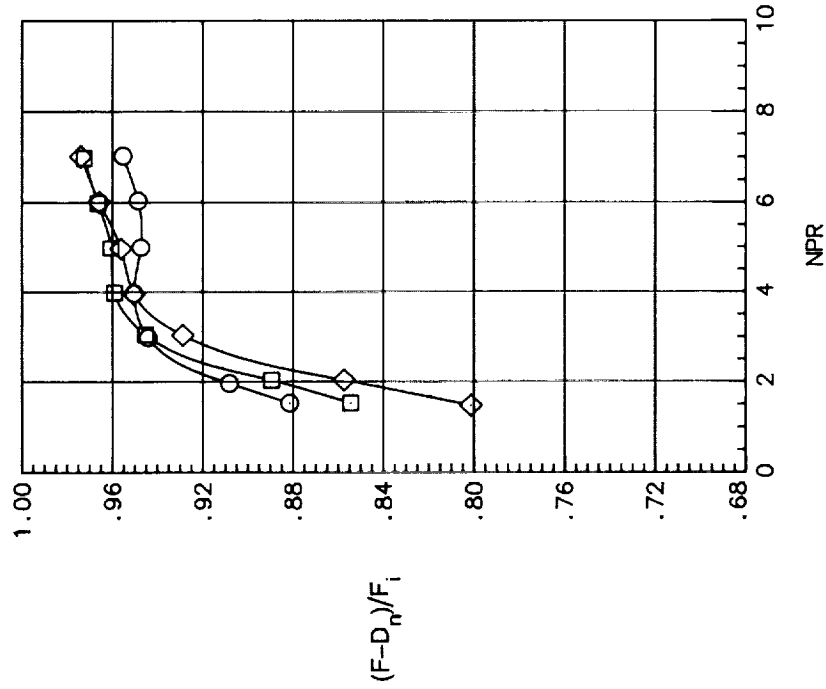
(a)  $M = 0$ .

Figure 13. Effect of lower flap length on aeropropulsive performance.  $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $\beta_r = 8.15^\circ$ ;  $\theta_f = 0^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .

Nozzle	$l_f/h_{t,n}$	$\beta_f$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
6	0.40	11.99	1.08	1.69
1	.90	11.28	1.19	1.69
7	1.40	10.64	1.30	1.69

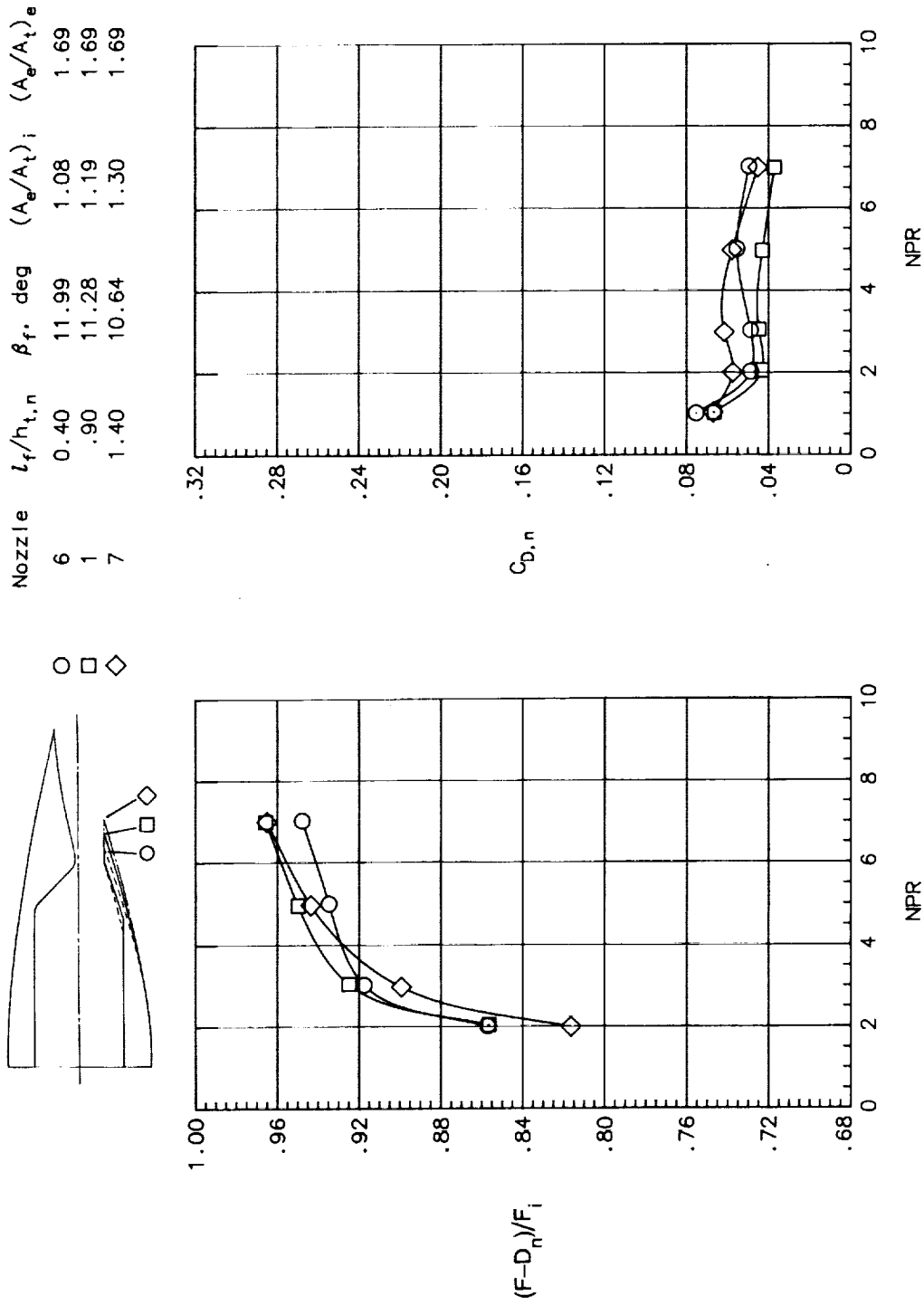


○ □ ◇



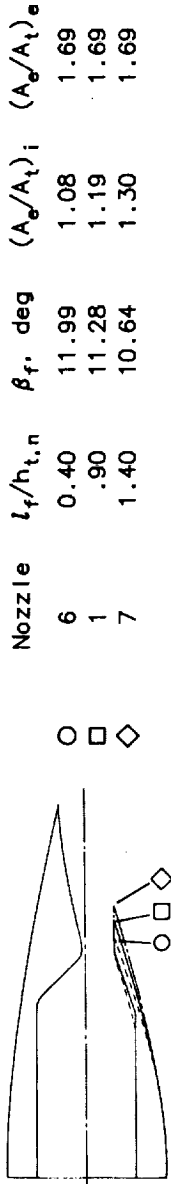
(b)  $M = 0.60$ .

Figure 13. Continued.



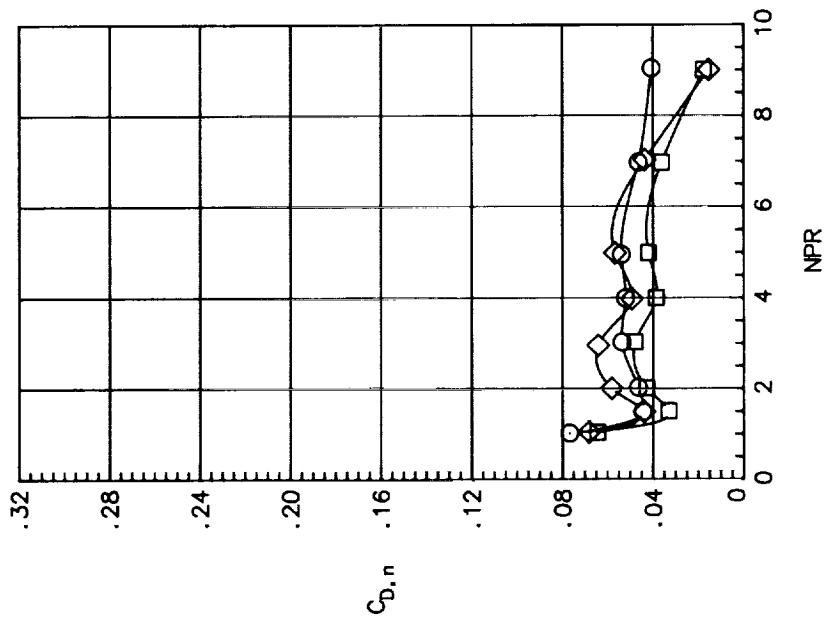
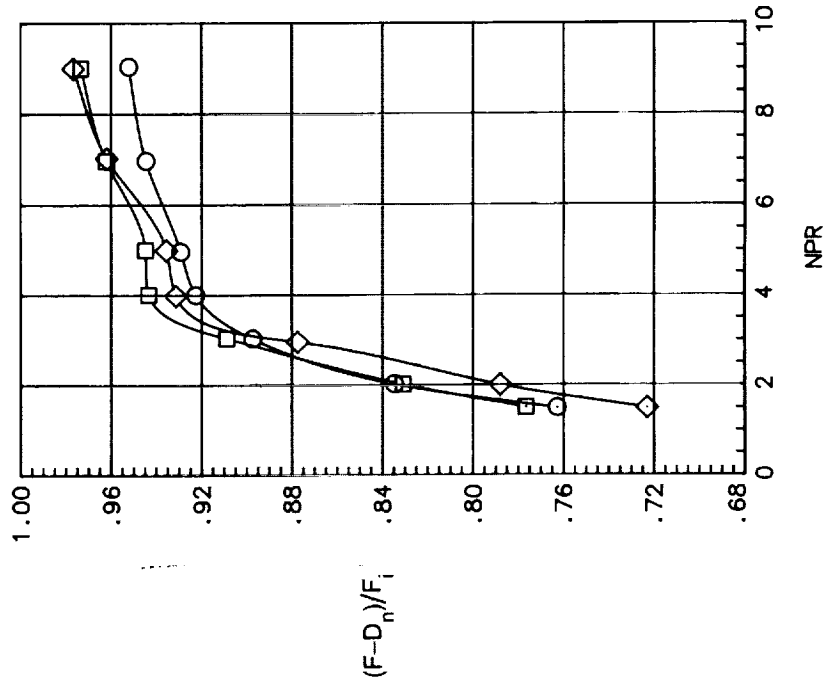
(c)  $M = 0.80$ .

Figure 13. Continued.



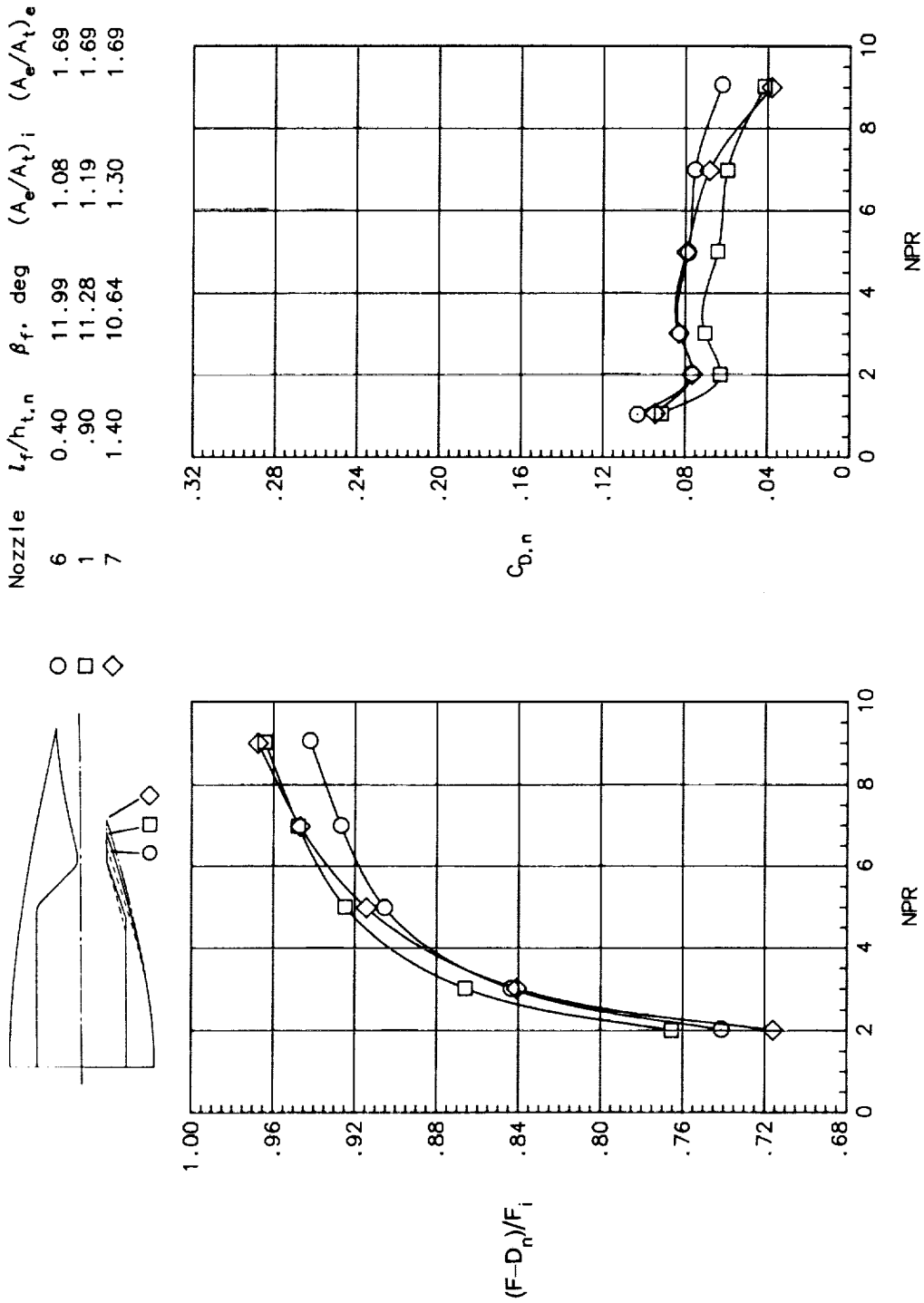
Nozzle	$l_f/h_{t,n}$	$\beta_f$ , deg	$(A_o/A_t)_i$	$(A_o/A_t)_e$
6	0.40	11.99	1.08	1.69
1	.90	11.28	1.19	1.69
7	1.40	10.64	1.30	1.69

○ □ ◇



(d)  $M = 0.90$ .

Figure 13. Continued.

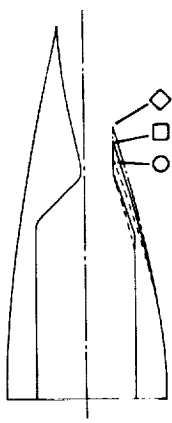


(e)  $M = 0.95$ .

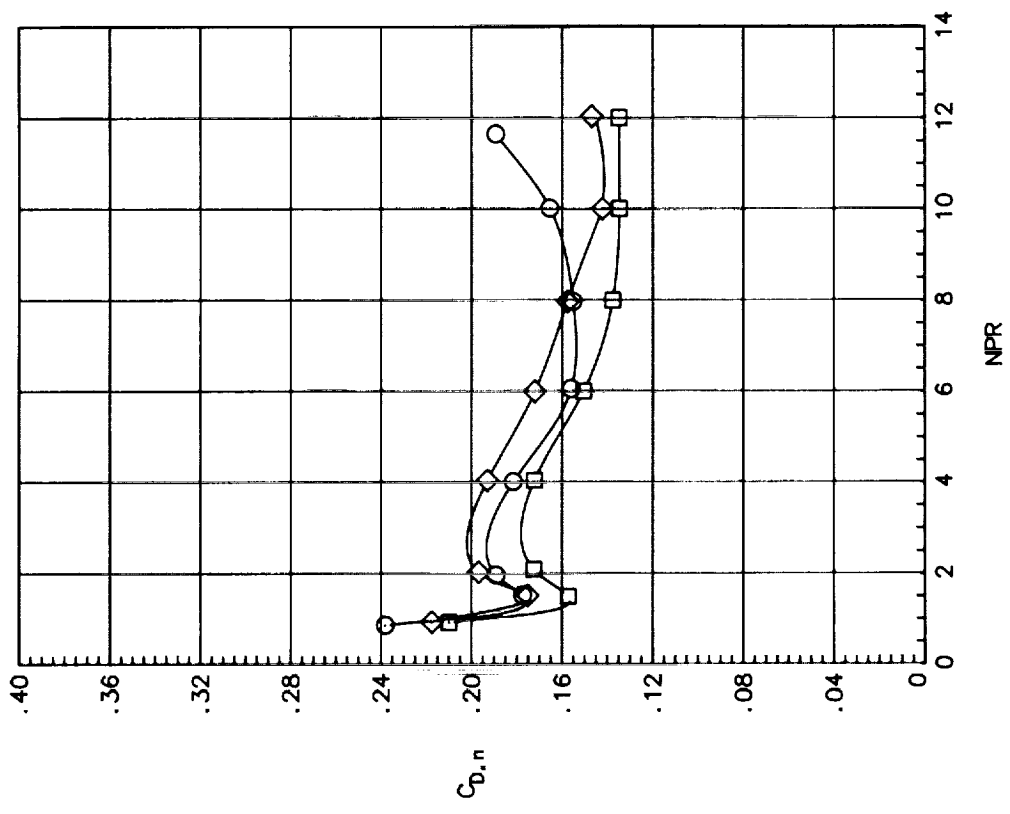
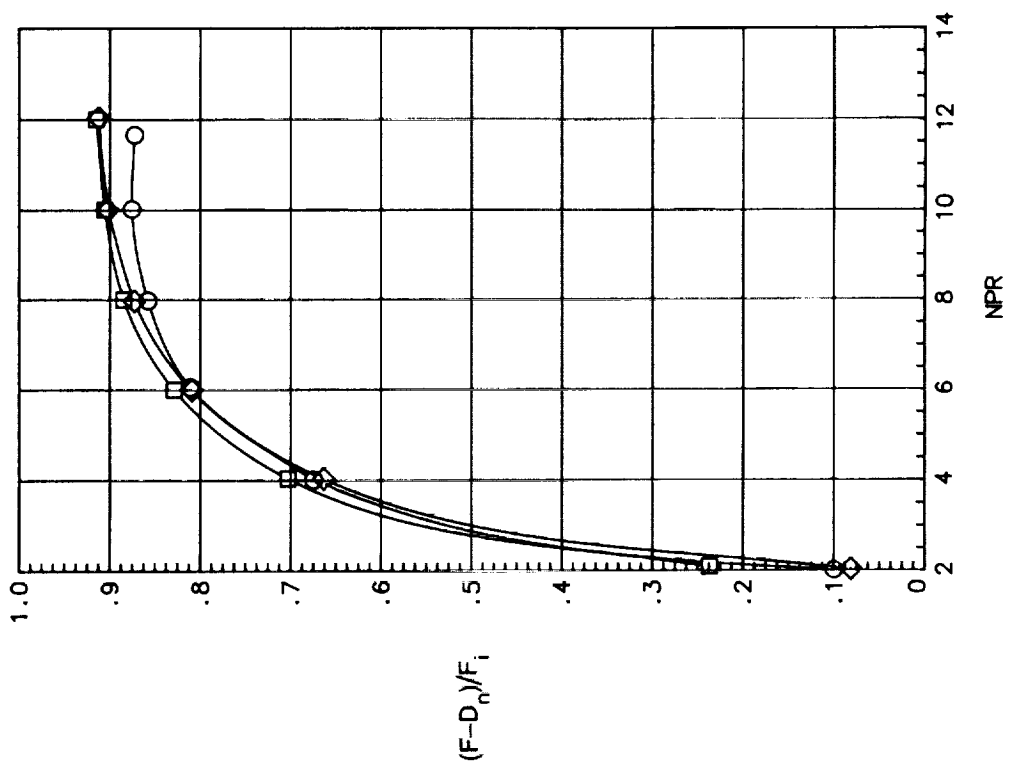
Figure 13. Continued.



Nozzle	$l_f/h_{t,n}$	$\beta_f$ , deg	$(A_o/A_t)_i$	$(A_o/A_t)_e$
6	0.40	11.99	1.08	1.69
1	.90	11.28	1.19	1.69
7	1.40	10.64	1.30	1.69



○ □ ◇



(f)  $M = 1.20$ .

Figure 13. Concluded.

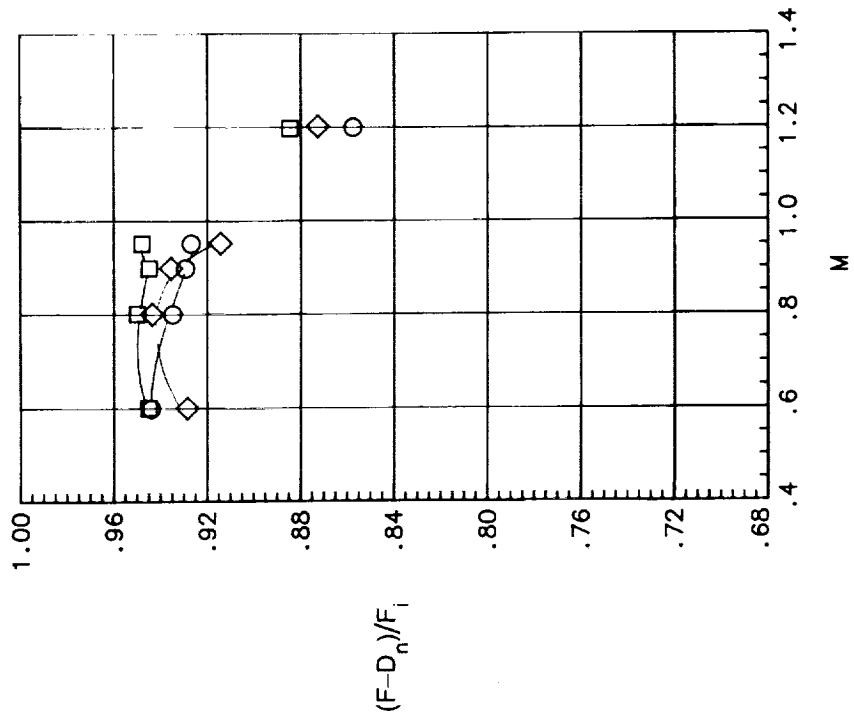
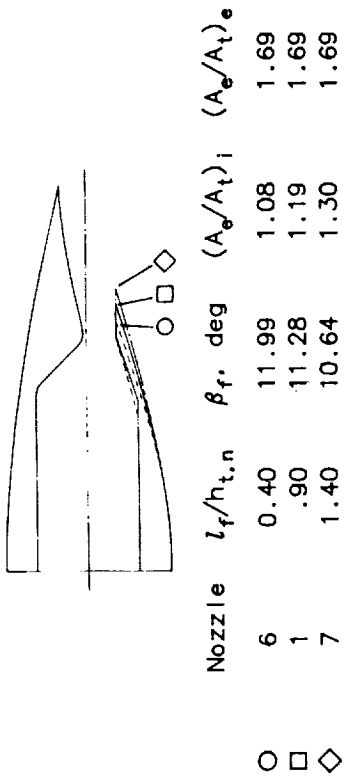
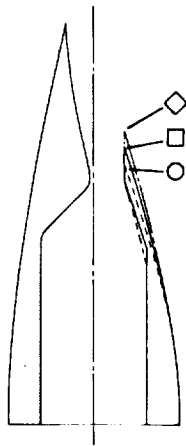


Figure 14. Effect of lower flap length on aeropropulsive performance at scheduled NPR.  $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $\beta_r = 8.15^\circ$ ;  $\theta_f = 0^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .



Nozzle	$l_f/h_{t,n}$	$\beta_f$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
○	0.40	11.99	1.08	1.69
□	.90	11.28	1.19	1.69
◇	1.40	10.64	1.30	1.69

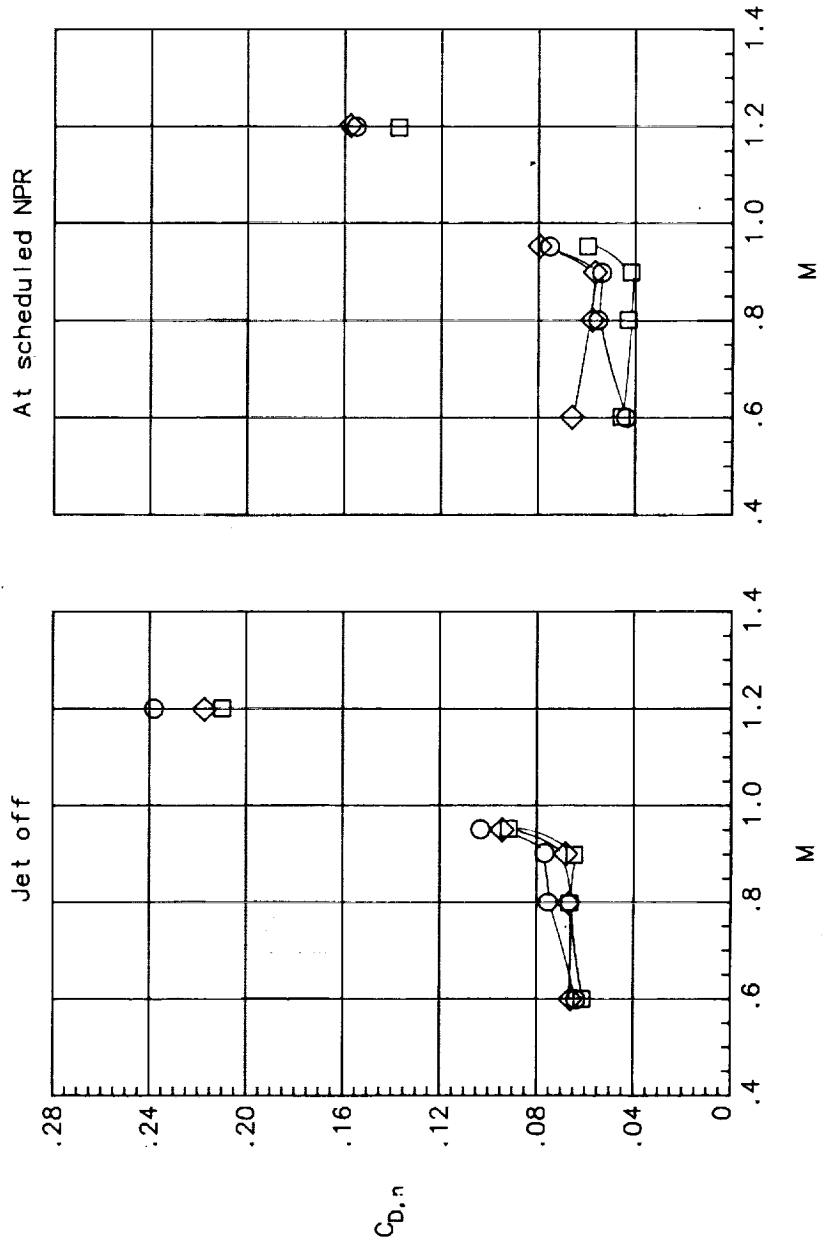
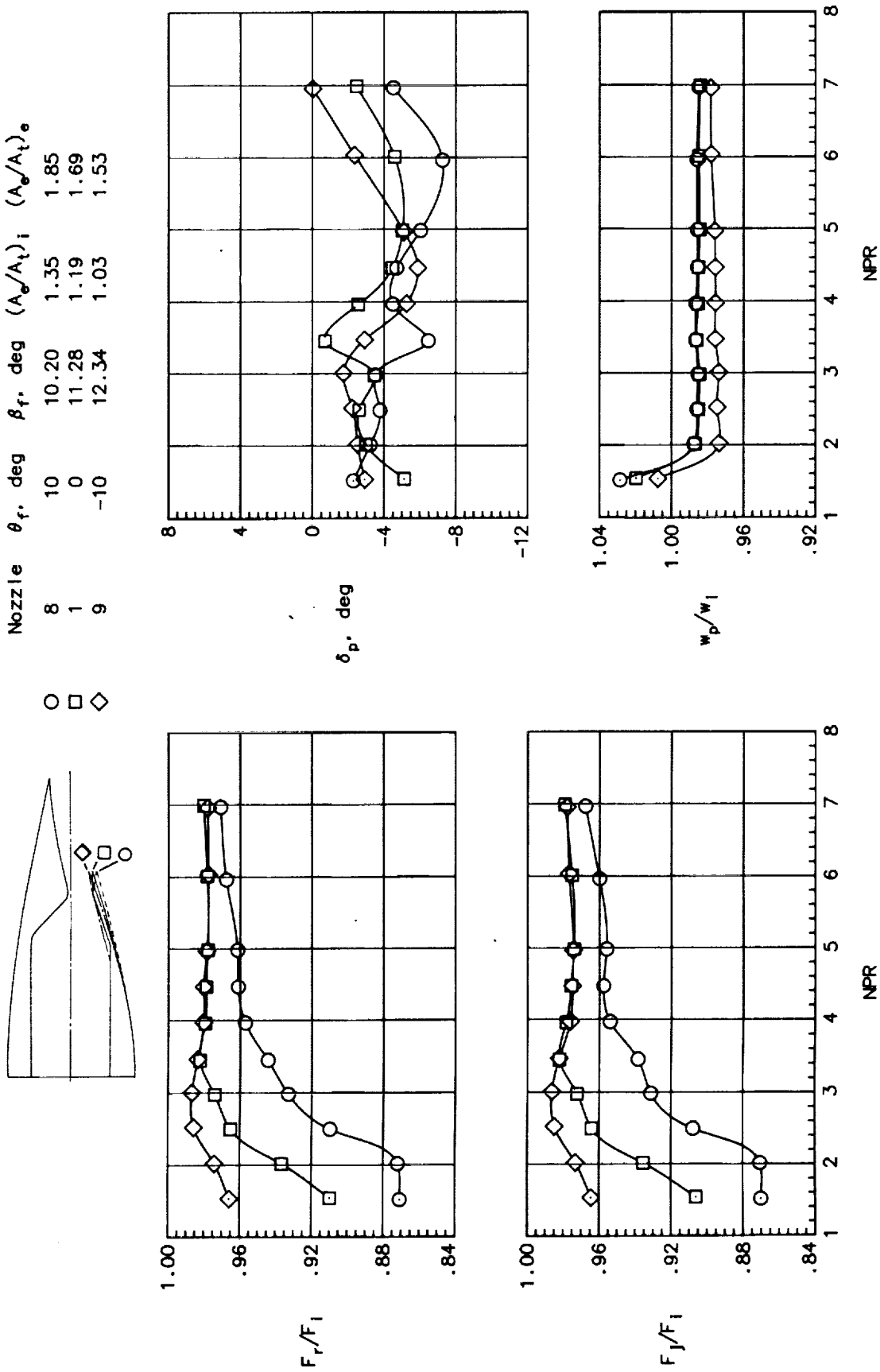


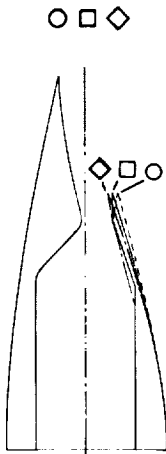
Figure 15. Effect of lower flap length on nozzle drag.  $l_f/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $\beta_r = 8.15^\circ$ ;  $\theta_f = 0^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .



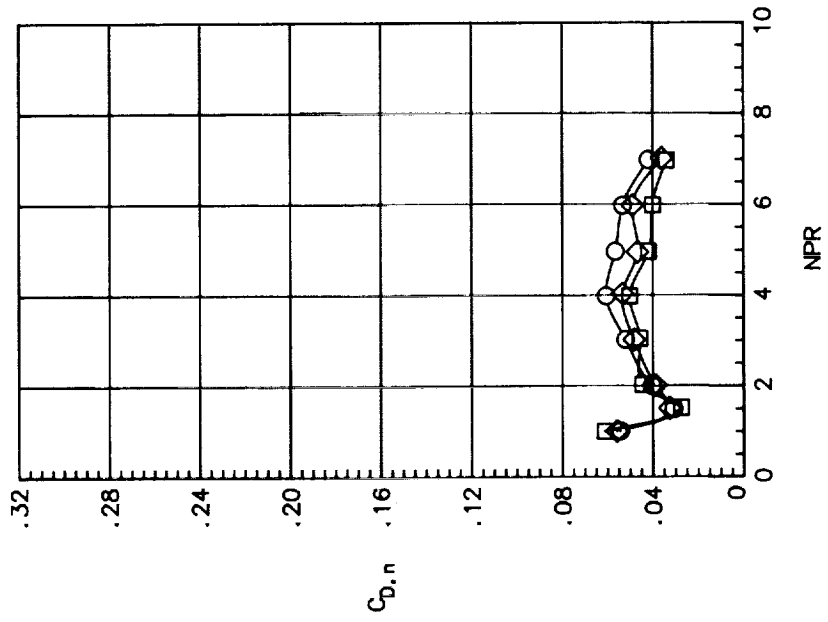
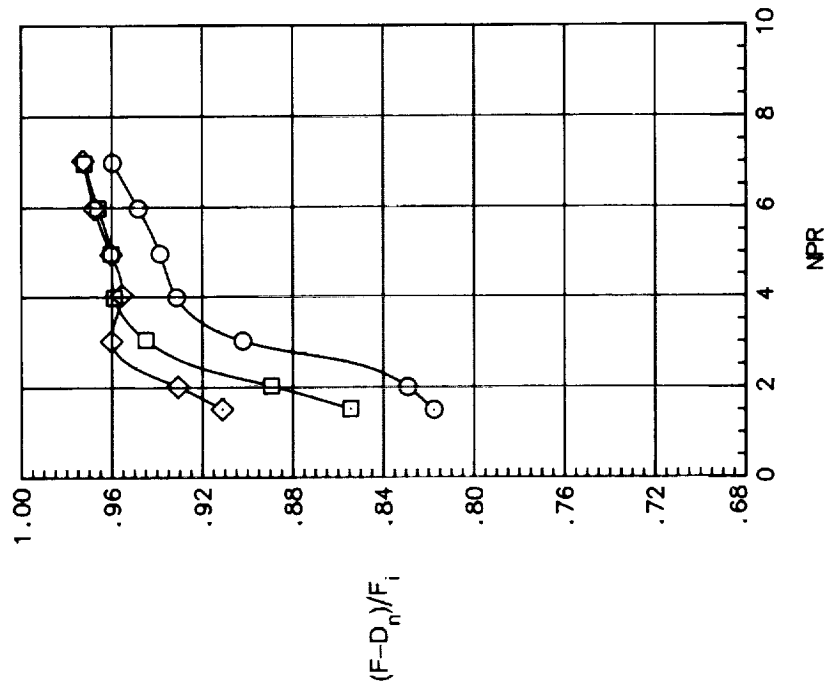
(a)  $M = 0$ .

Figure 16. Effect of lower flap angle on aerodynamic performance.  $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $\beta_r = 8.15^\circ$ ;  $l_f/h_{t,n} = 0.90$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .

Nozzle	$\theta_f$ , deg	$\beta_f$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
8	10	10.20	1.35	1.85
1	0	11.28	1.19	1.69
9	-10	12.34	1.03	1.53

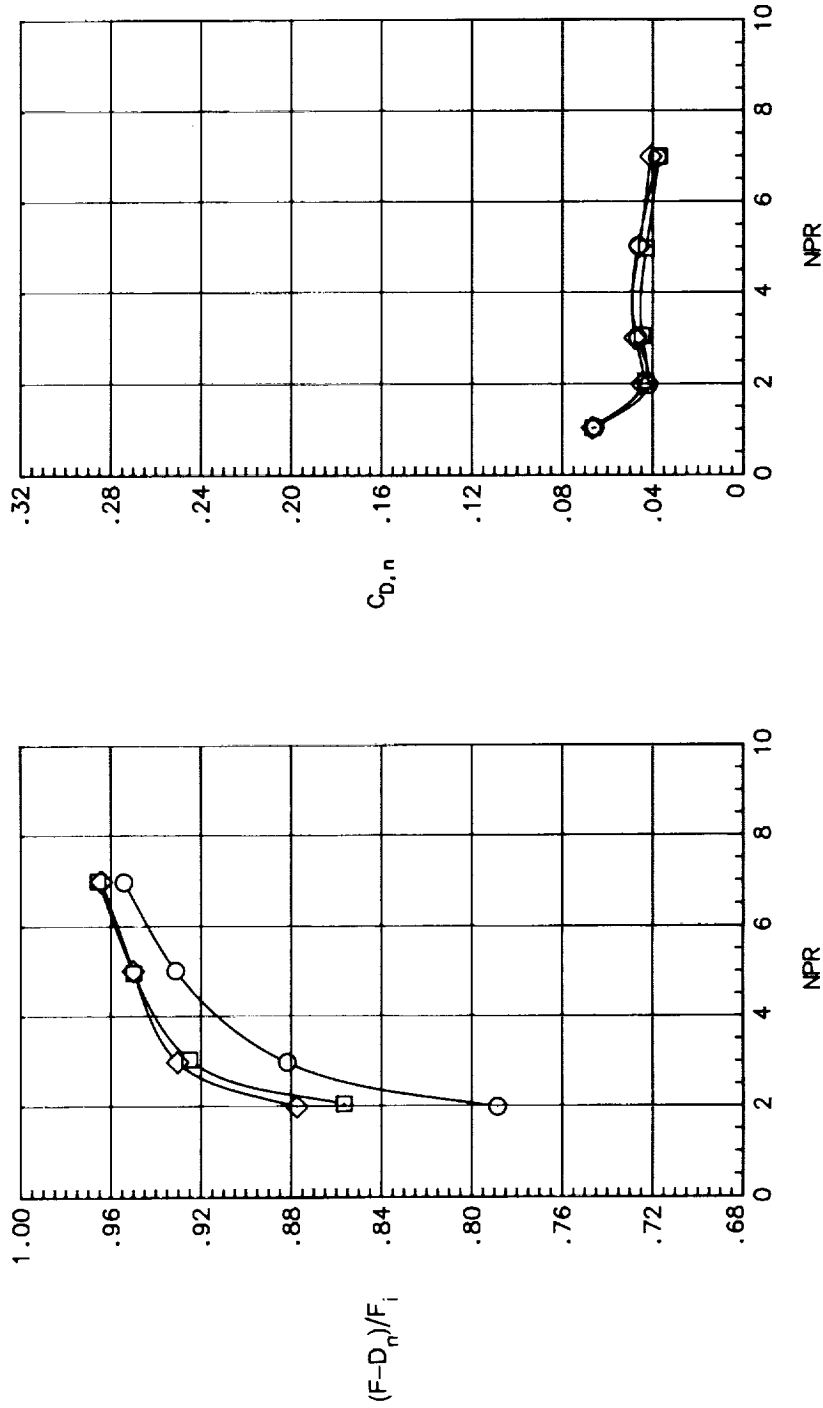
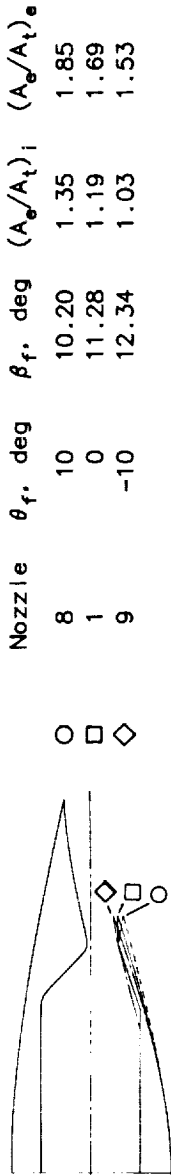


○ □ ◇



(b)  $M = 0.60$ .

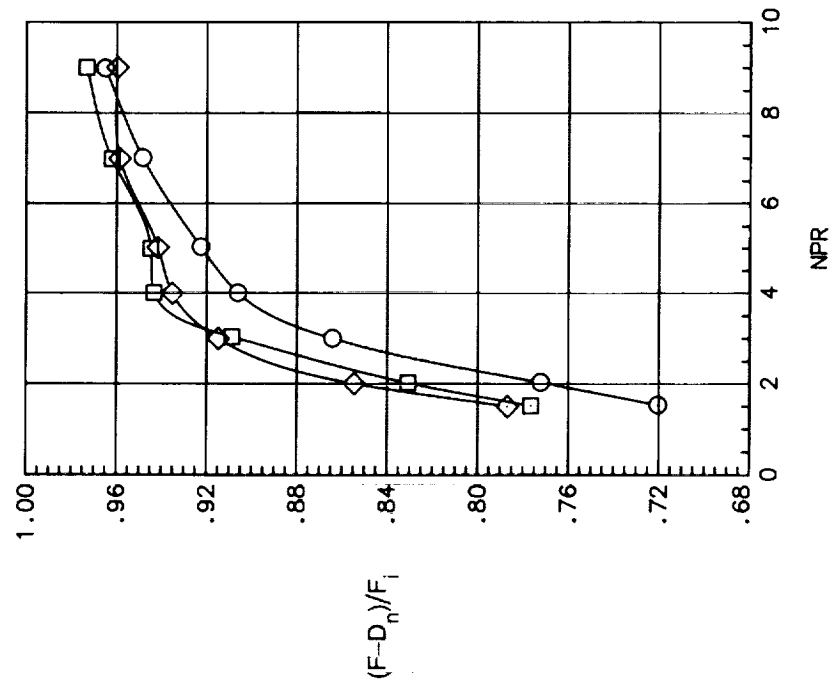
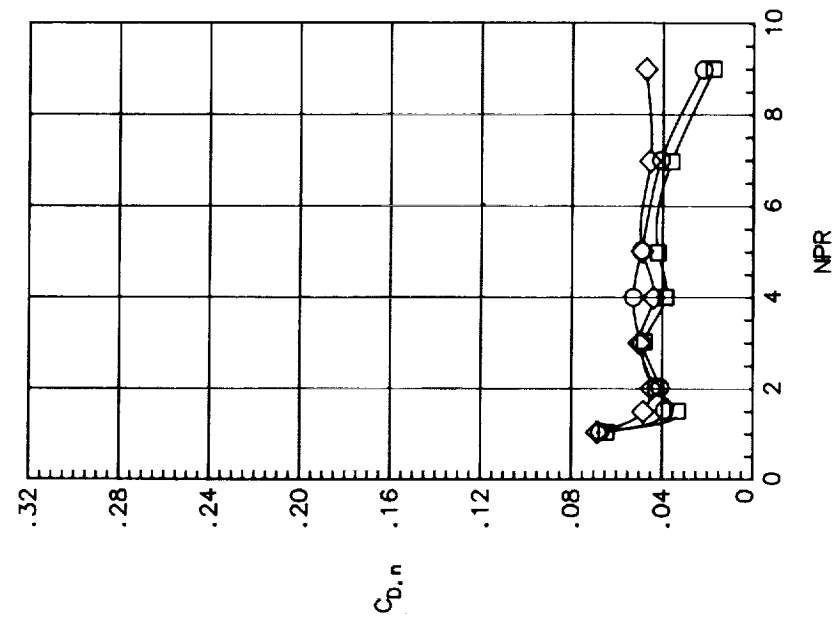
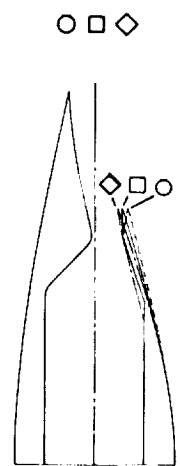
Figure 16. Continued.



(c)  $M = 0.80$ .

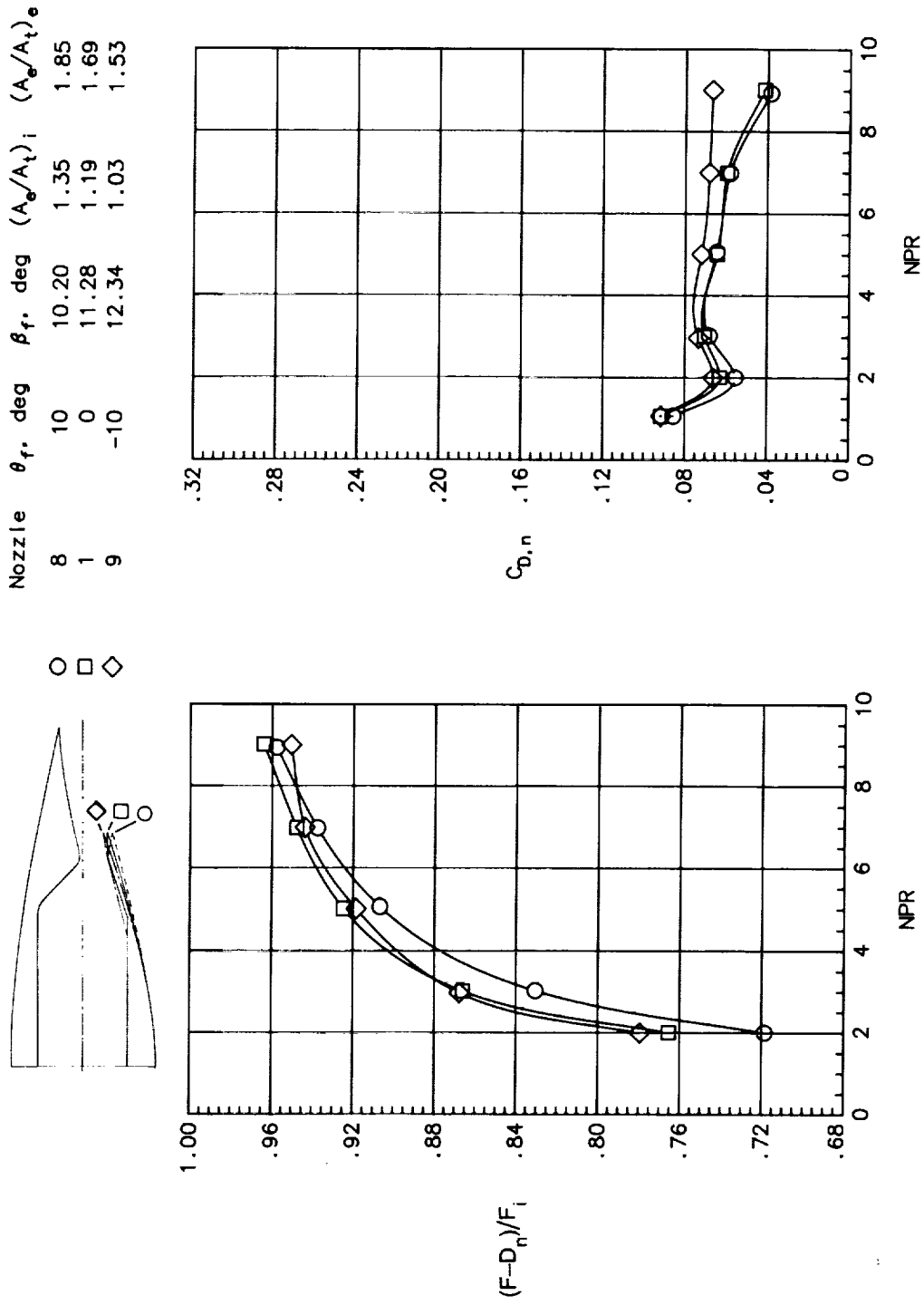
Figure 16. Continued.

Nozzle	$\theta_f$ , deg	$\beta_f$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
8	10	10.20	1.35	1.85
1	0	11.28	1.19	1.69
9	-10	12.34	1.03	1.53



(d)  $M = 0.90$ .

Figure 16. Continued.



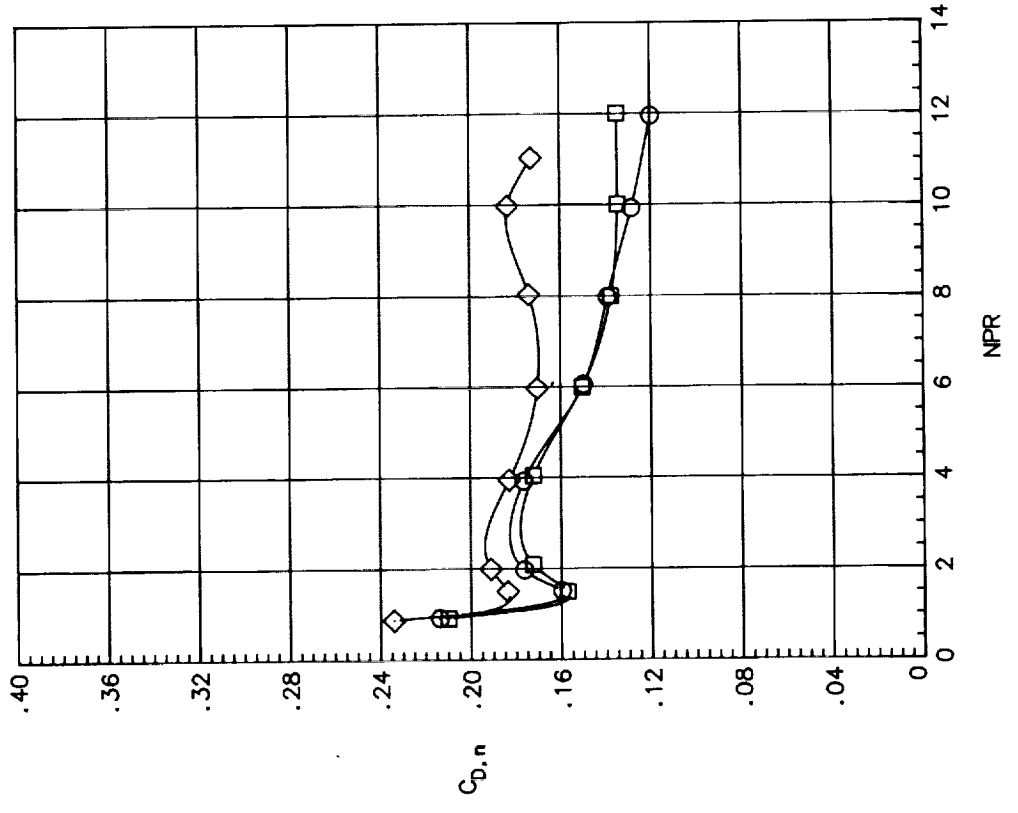
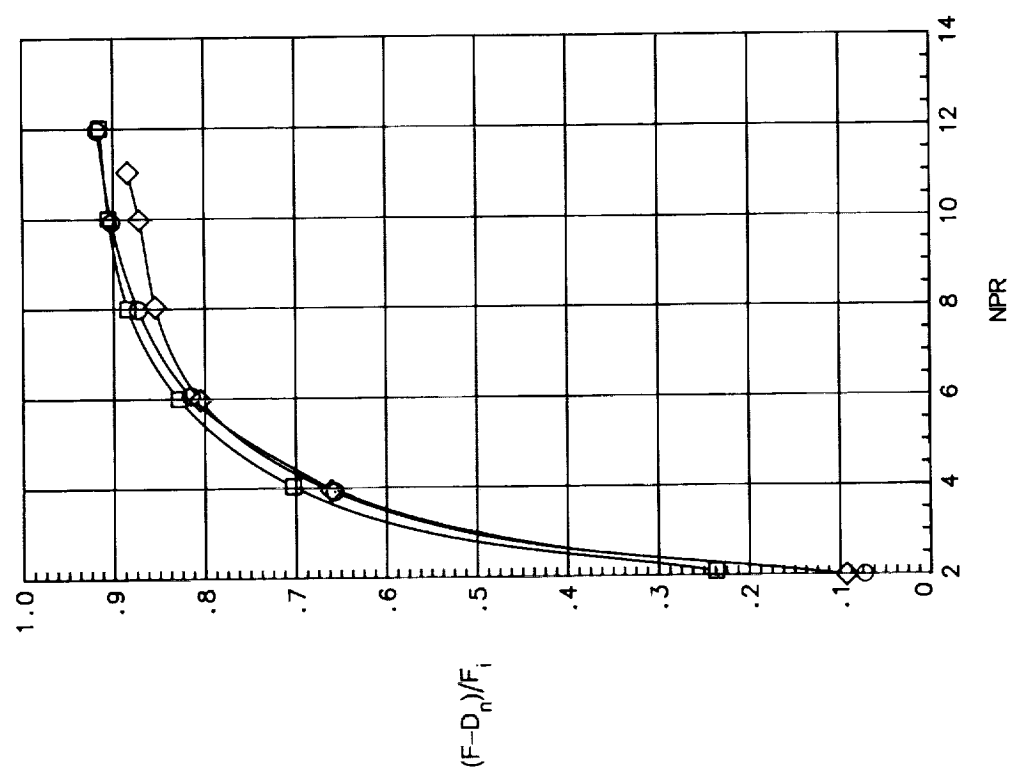
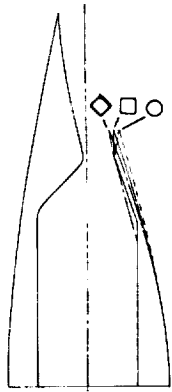
(e)  $M = 0.95$ .

Figure 16. Continued.



Nozzle	$\theta_f$ , deg	$\beta_f$ , deg	$(A_o/A_t)_i$	$(A_o/A_t)_e$
8	10	10.20	1.35	1.85
1	0	11.28	1.19	1.69
9	-10	12.34	1.03	1.53

○ □ ◇



(f)  $M = 1.20$ .

Figure 16. Concluded.

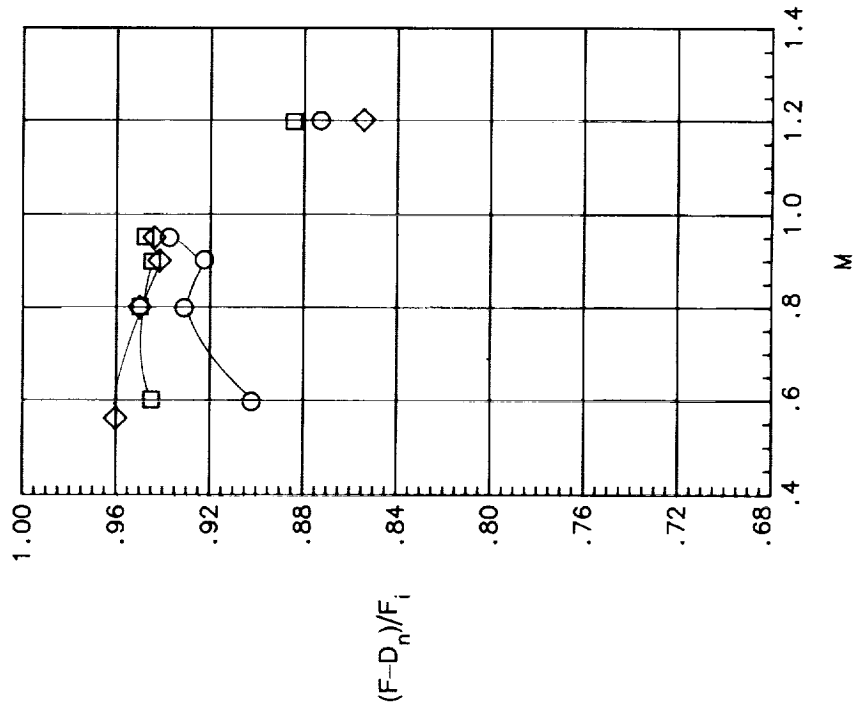
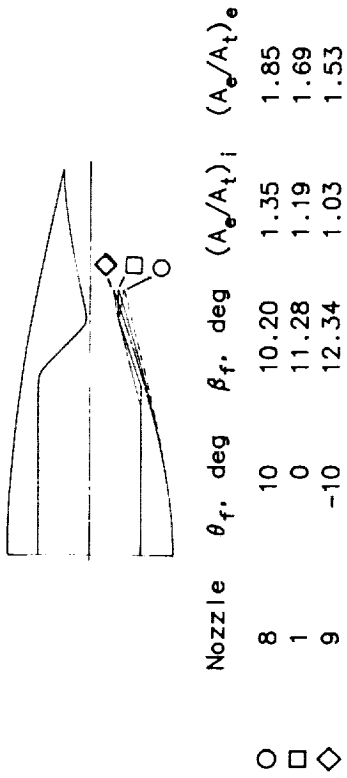
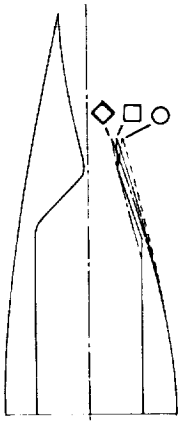


Figure 17. Effect of lower flap angle on acropulsive performance at scheduled NPR.  $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $\beta_r = 8.15^\circ$ ;  $l_f/h_{t,n} = 0.90$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .



Nozzle	$\theta_f$ , deg	$\beta_f$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
○	8	10	1.35	1.85
□	1	0	1.19	1.69
◇	9	-10	1.03	1.53

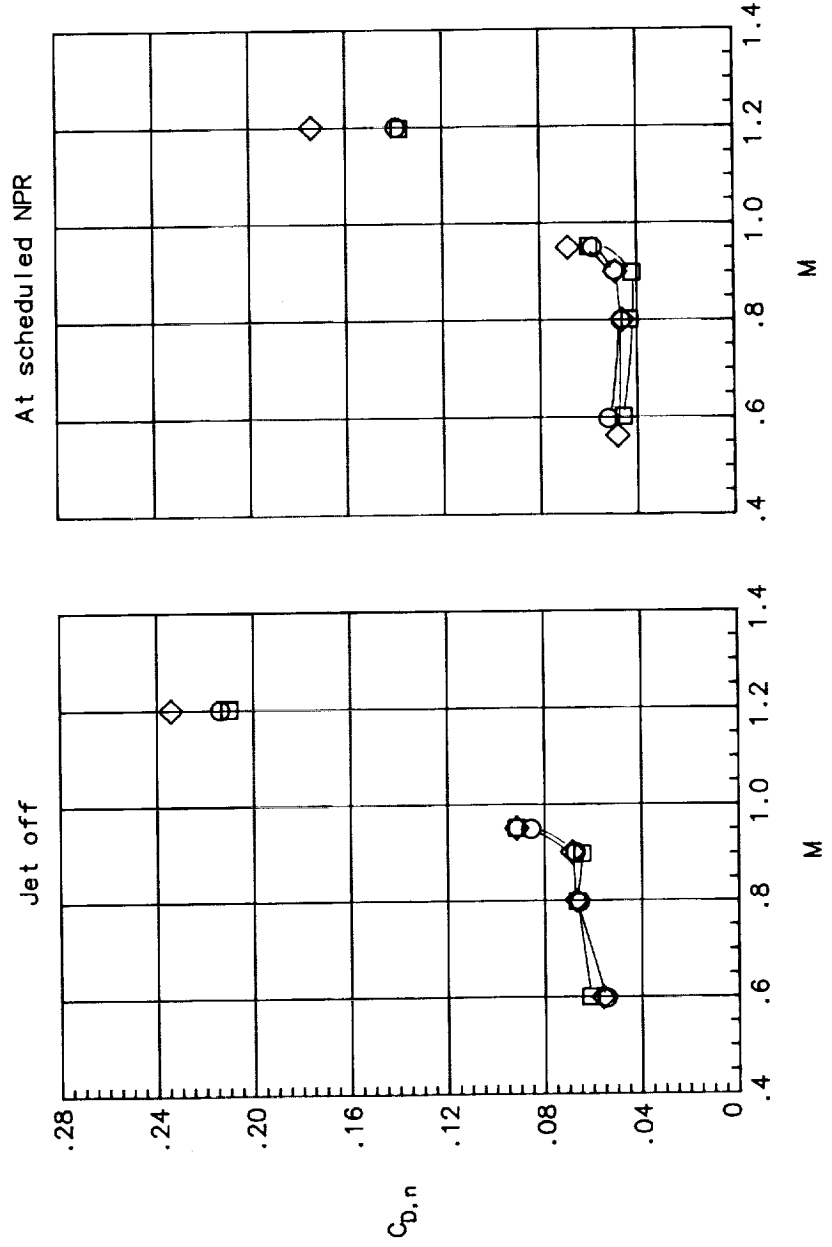
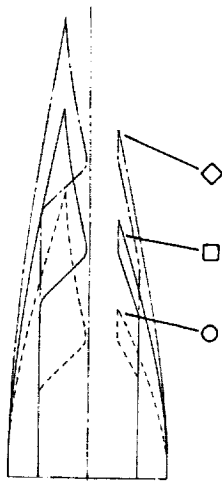
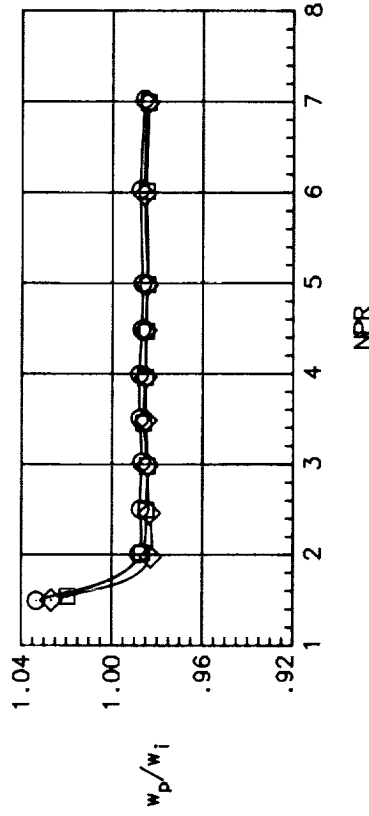
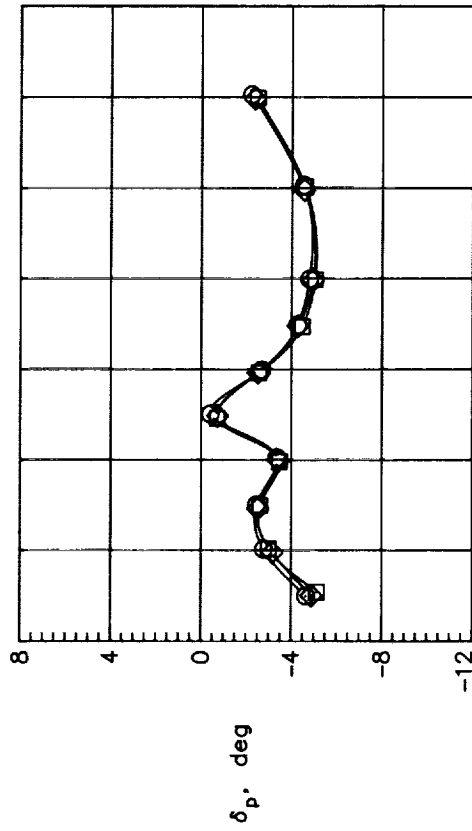
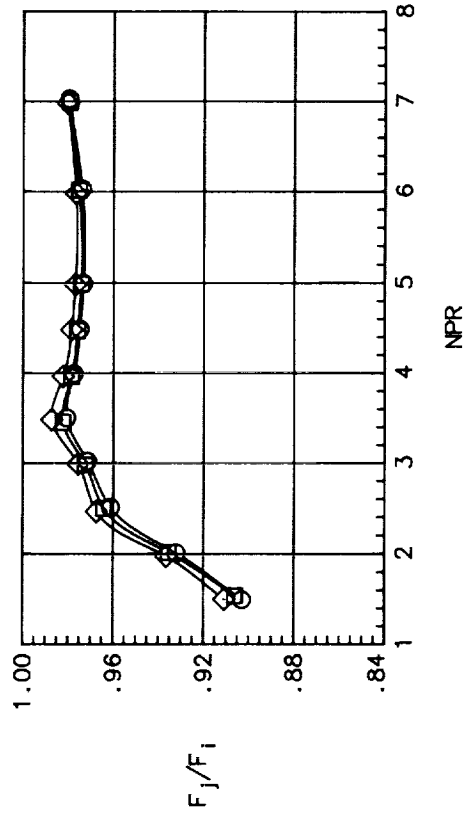
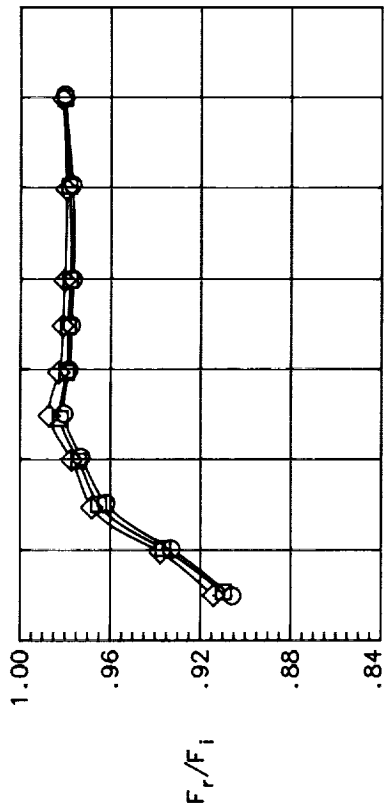


Figure 18. Effect of lower flap angle on nozzle drag.  $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $\beta_r = 8.15^\circ$ ;  $l_f/h_{t,n} = 0.90$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .



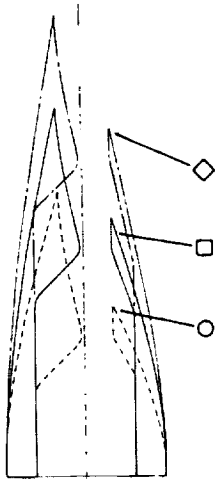
Nozzle	$x_t/h_{t,n}$	$\beta_r$ , deg	$\beta_f$ , deg
10	4.50	10.59	16.75
1	7.25	8.15	11.28
11	10.00	6.62	8.47

○ □ ◇



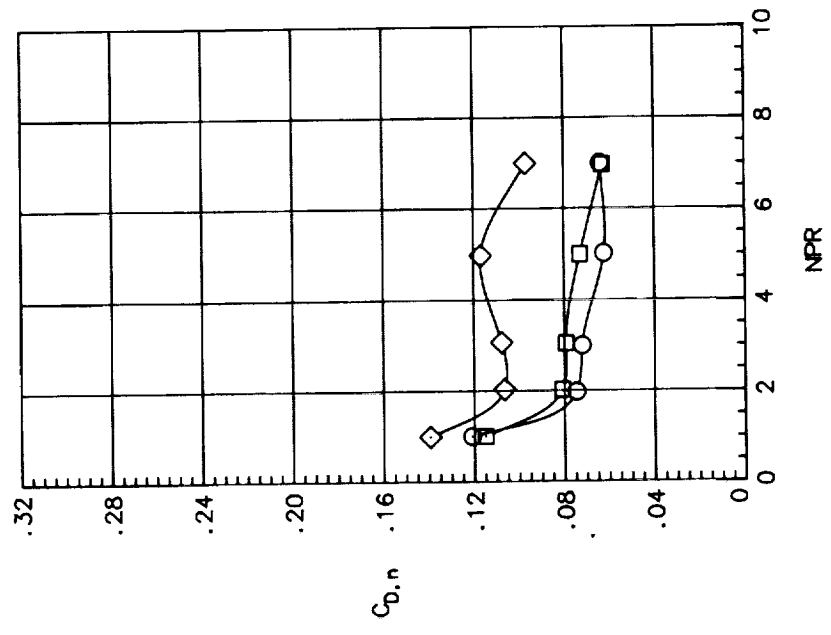
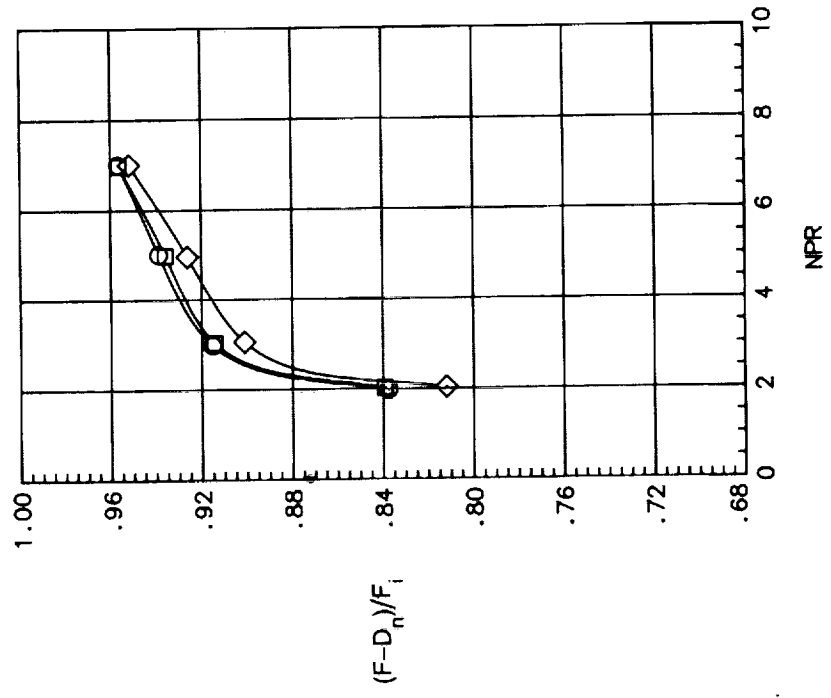
(a)  $M = 0; \alpha = 0^\circ$ .

Figure 19. Effect of axial location of nozzle throat on aeropropulsive performance.  $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $l_f/h_{t,n} = 0.90$ ;  $\theta_f = 0^\circ$ ;  $y_t/h_{t,n} = 0.12$ ;  $(A_e/A_t)_i = 1.19$ ;  $(A_e/A_t)_e = 1.69$ .



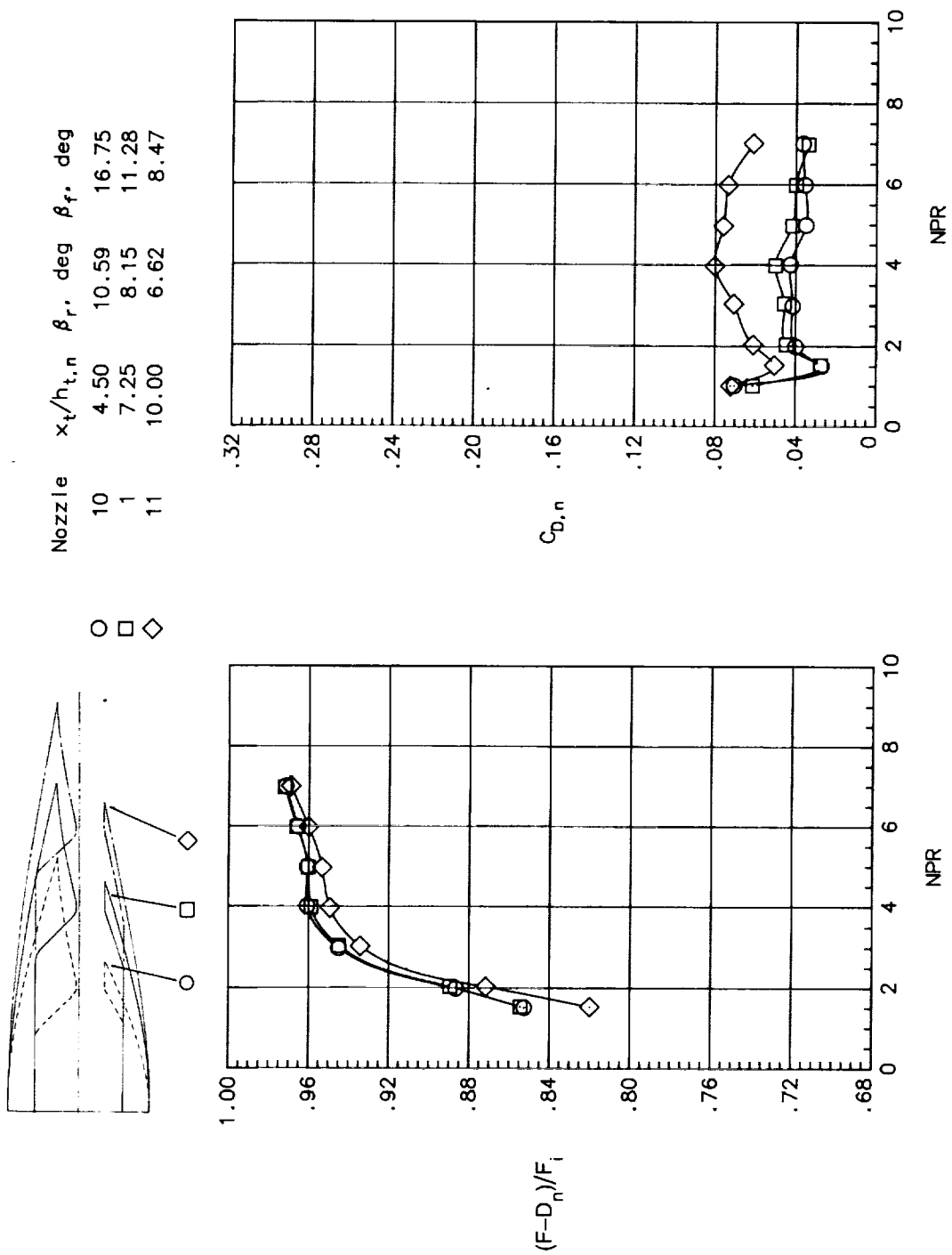
Nozzle	$x_t/h_{t,n}$	$\beta_r$ , deg	$\beta_f$ , deg
10	4.50	10.59	16.75
1	7.25	8.15	11.28
11	10.00	6.62	8.47

○ □ ◇



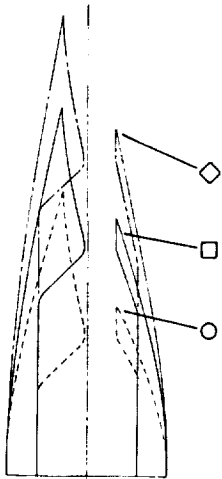
(b)  $M = 0.60; \alpha = -6^\circ$ .

Figure 19. Continued.



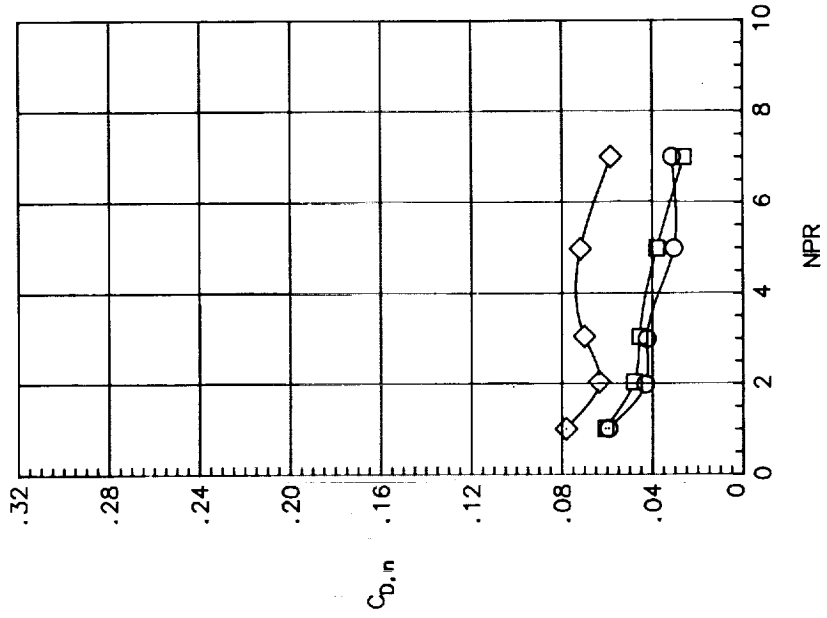
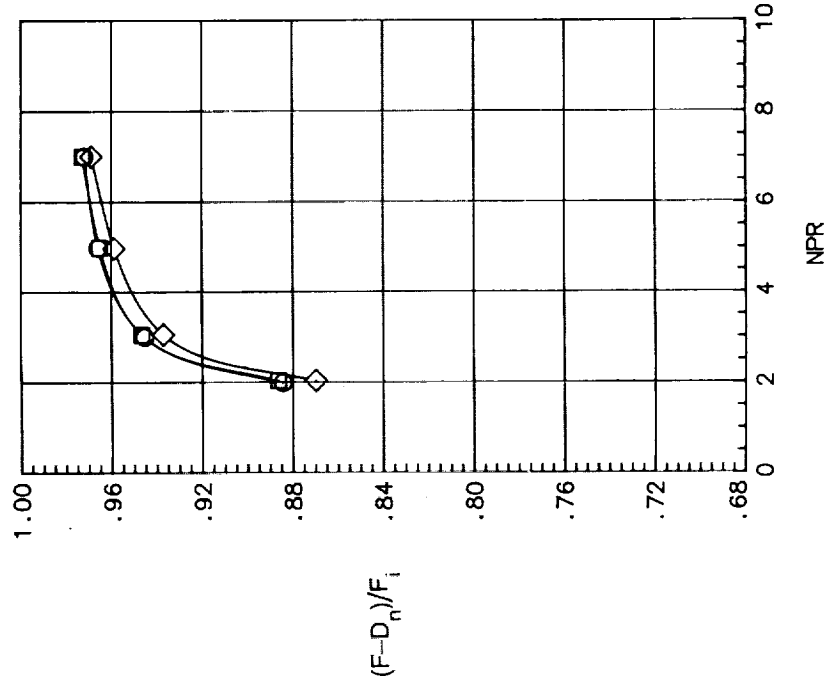
(c)  $M = 0.60; \alpha = 0^\circ$ .

Figure 19. Continued.



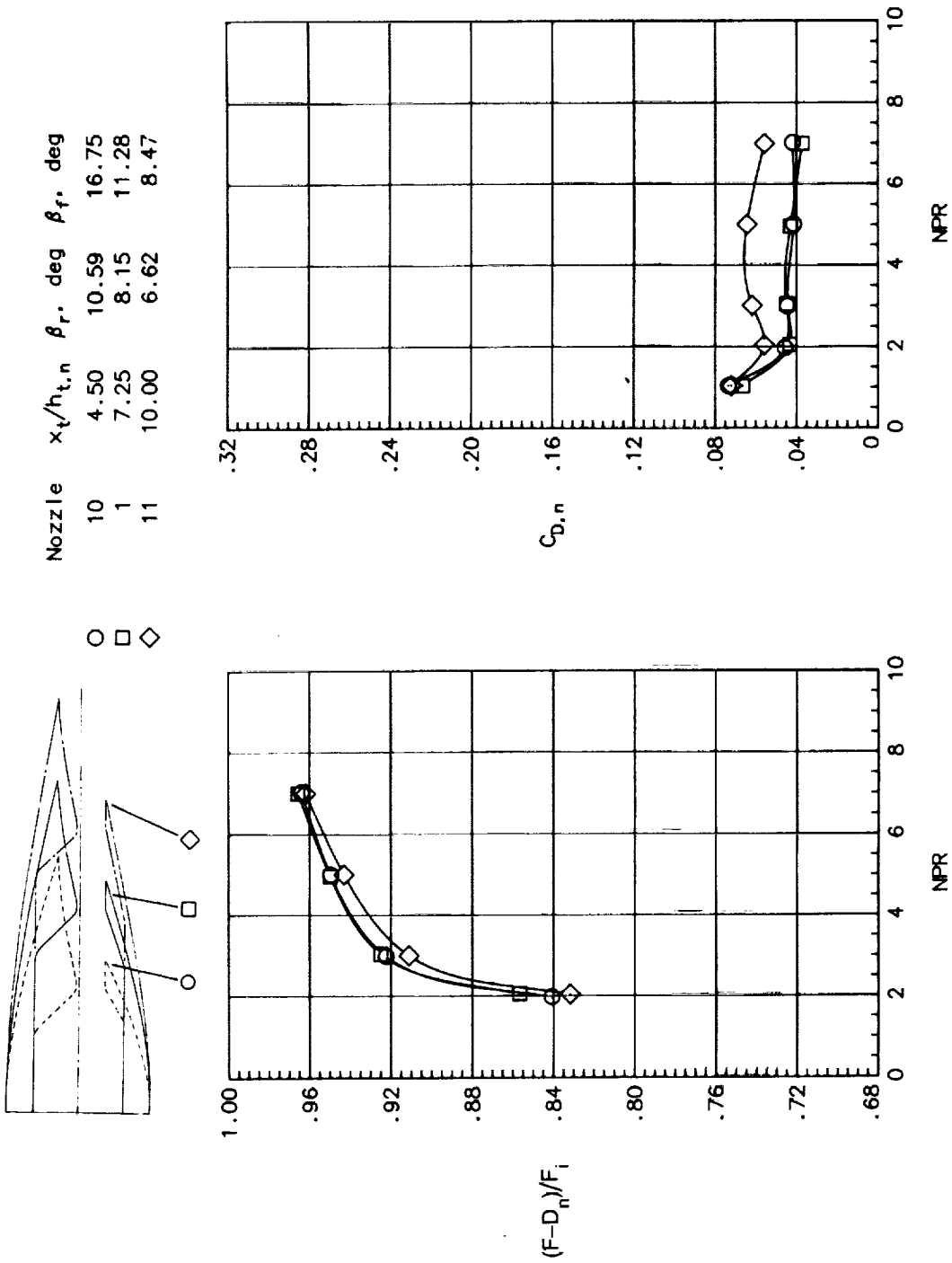
Nozzle	$x_t/h_{t,n}$	$\beta_r$ , deg	$\beta_f$ , deg
10	4.50	10.59	16.75
1	7.25	8.15	11.28
11	10.00	6.62	8.47

○ □ ◇



(d)  $M = 0.60; \alpha = 6^\circ$ .

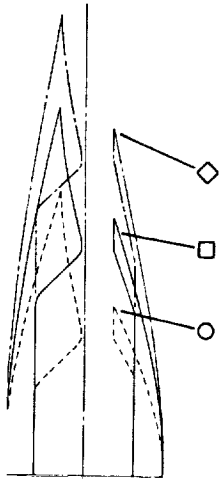
Figure 19. Continued.



(c)  $M = 0.80; \alpha = 0^\circ$ .

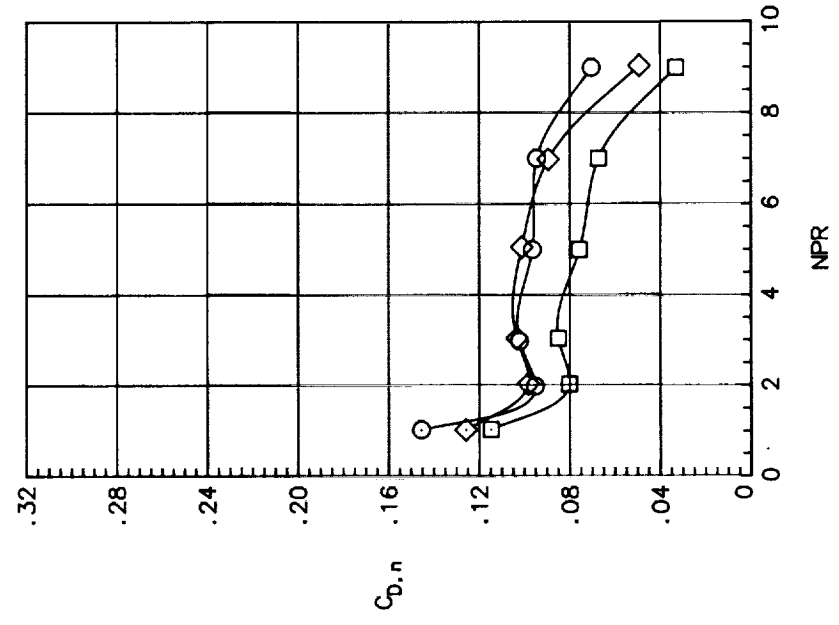
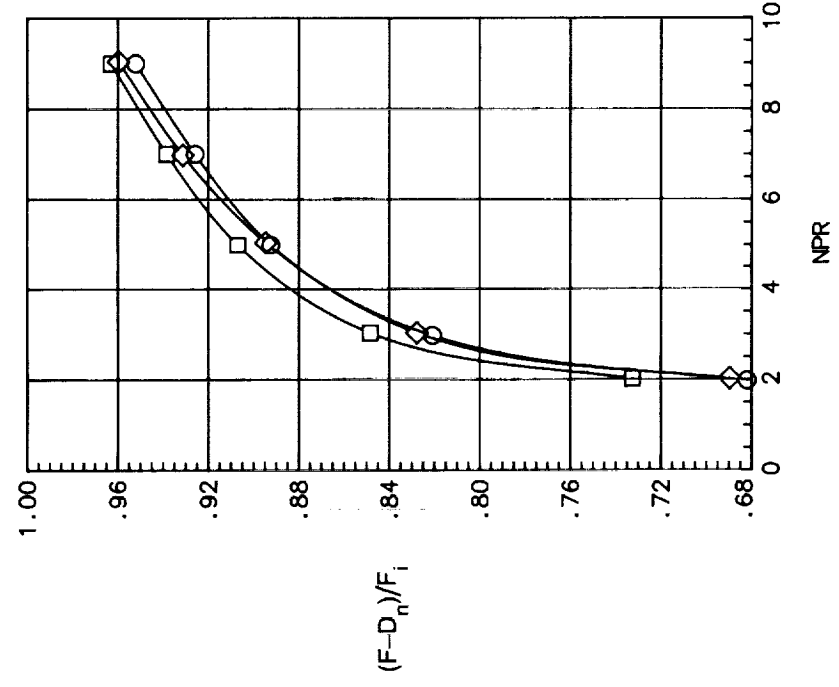
Figure 19. Continued.





Nozzle	$x_t/h_{t,n}$	$\beta_r$ , deg	$\beta_f$ , deg
10	4.50	10.59	16.75
1	7.25	8.15	11.28
11	10.00	6.62	8.47

○ □ ◇



(f)  $M = 0.90; \alpha = -6^\circ$ .

Figure 19. Continued.

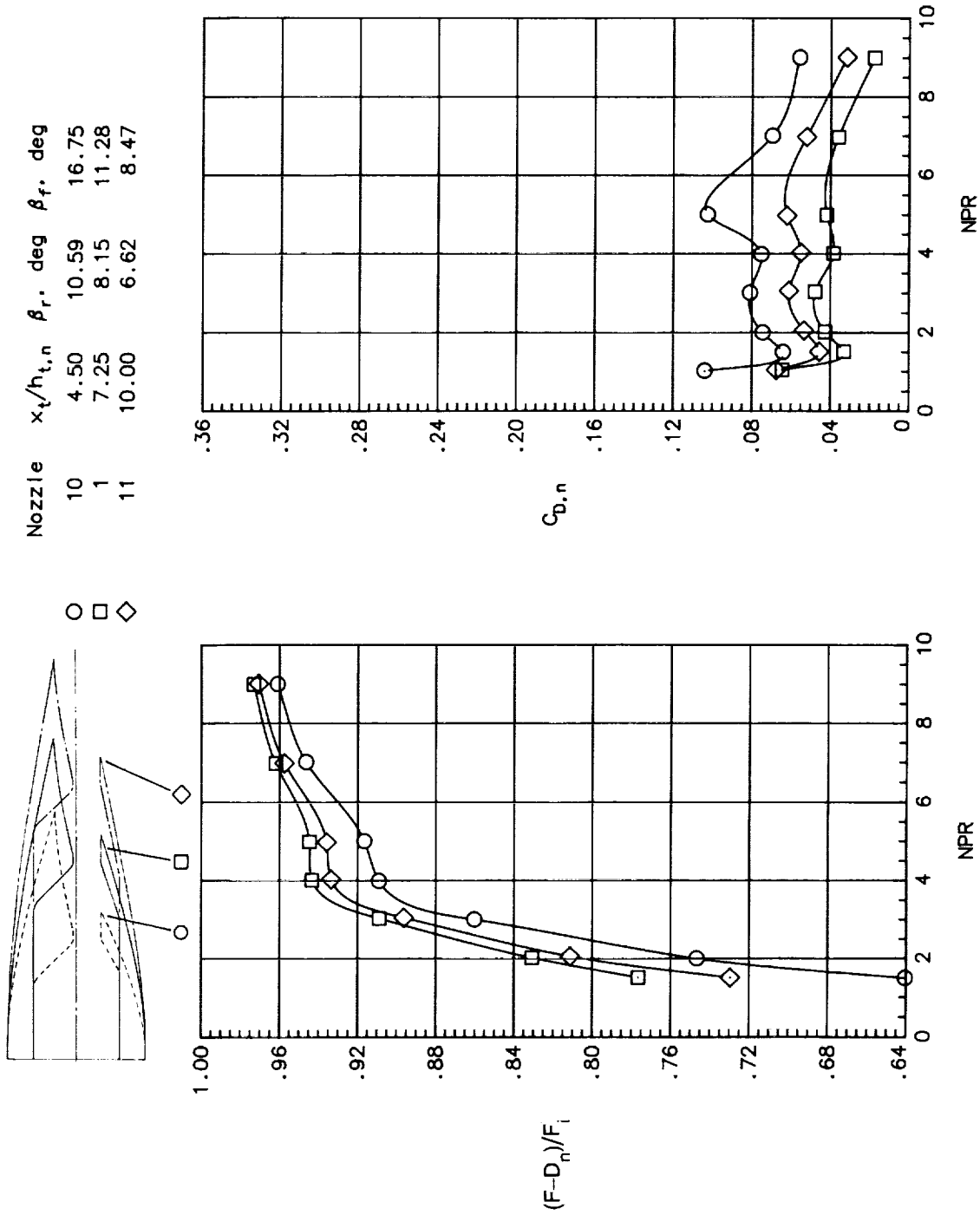
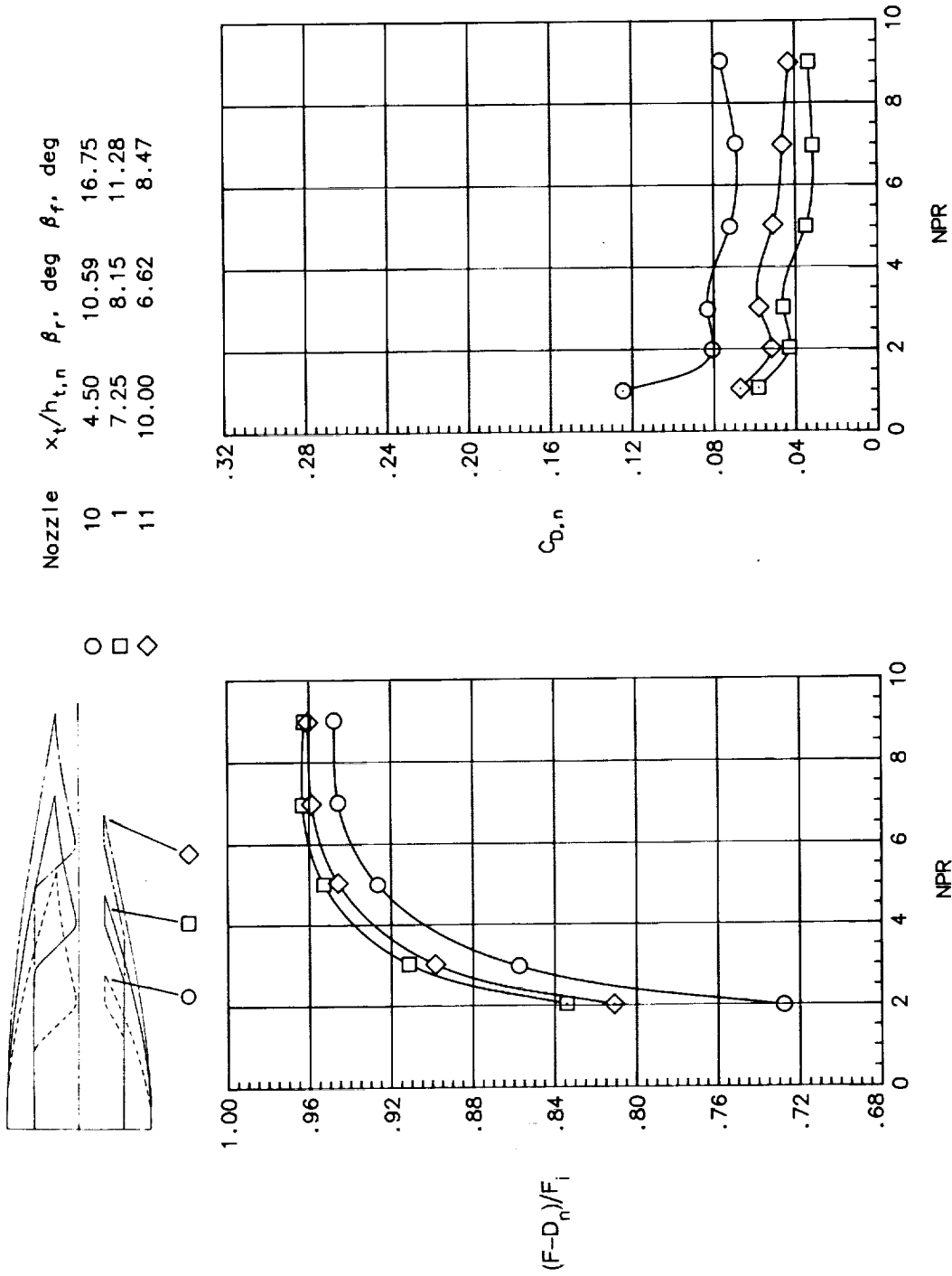
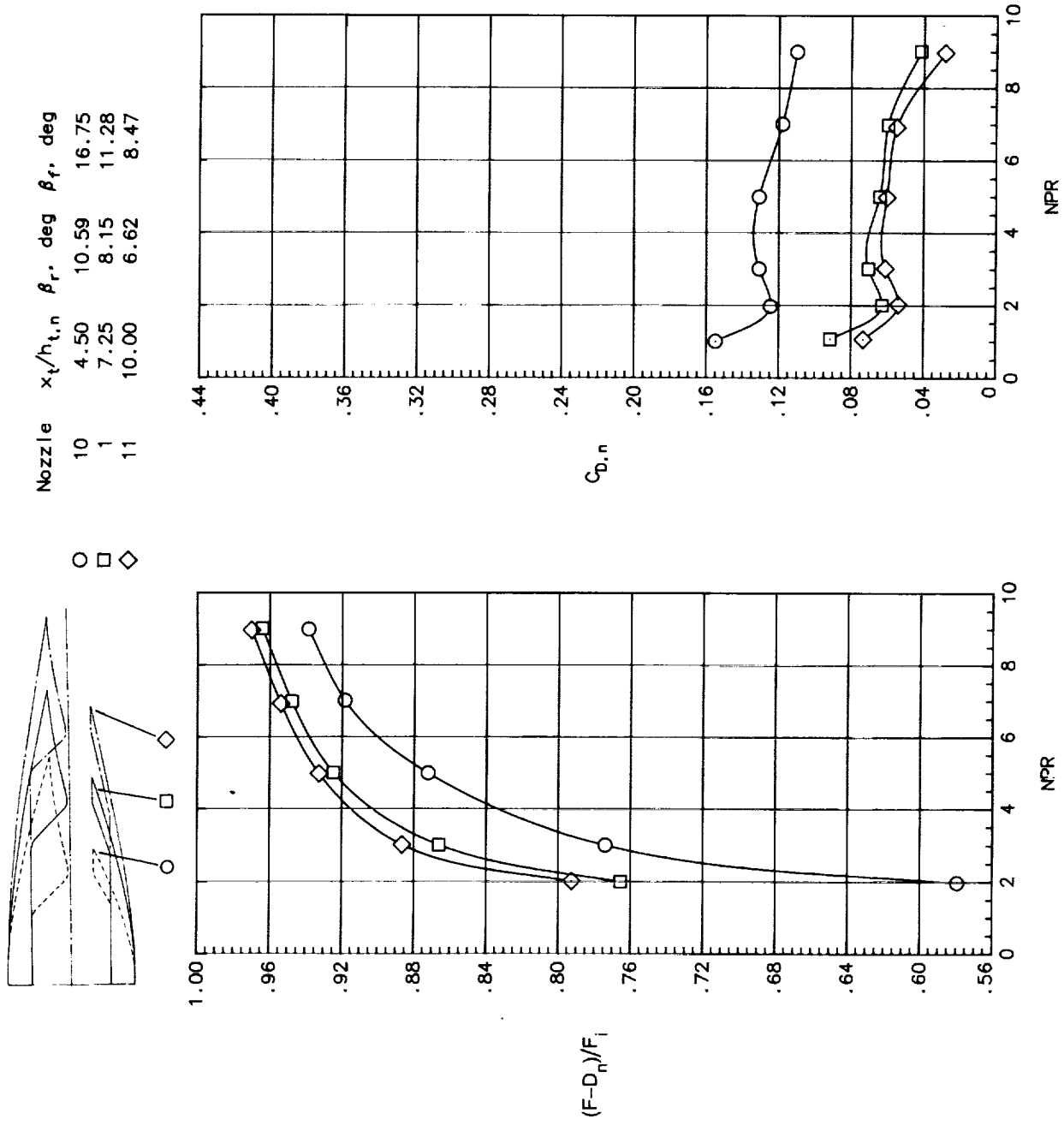


Figure 19. Continued.



(h)  $M = 0.90; \alpha = 6^\circ$ .

Figure 19. Continued.

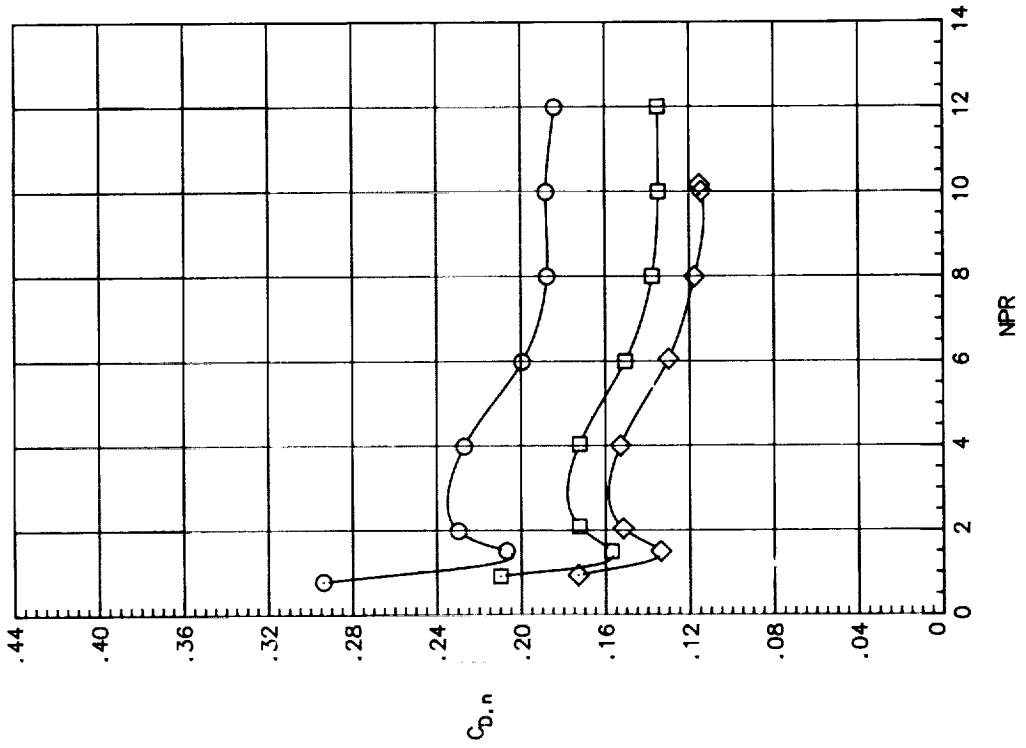
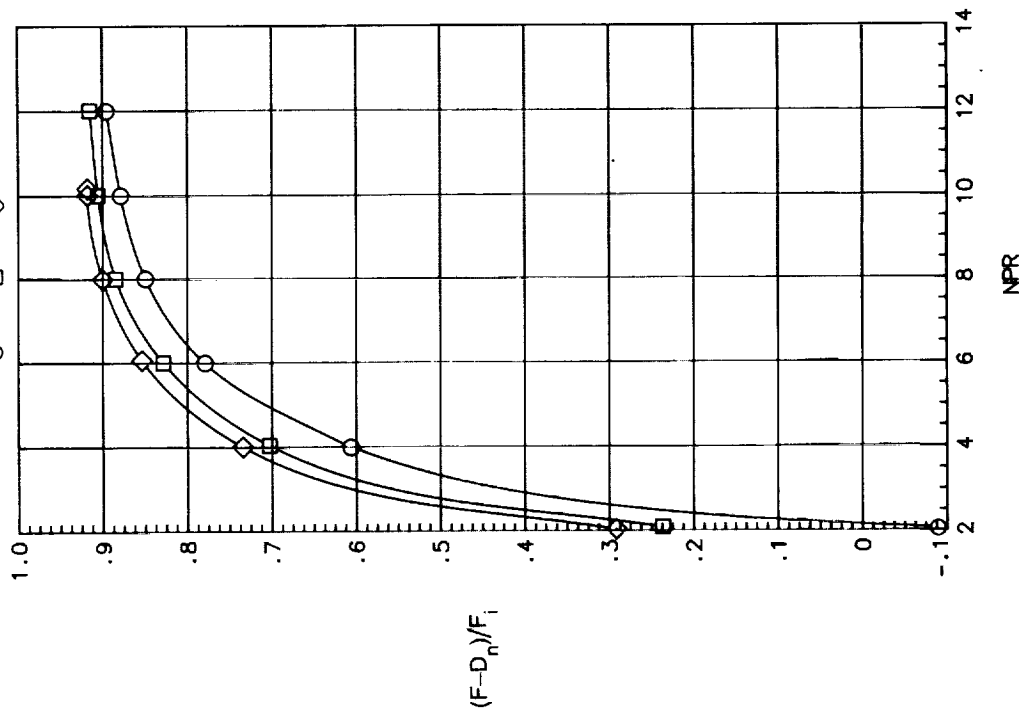


(i)  $M = 0.95; \alpha = 0^\circ$ .  
 Figure 19. Continued.



Nozzle	$x_t/h_{t,n}$	$\beta_r$ , deg	$\beta_f$ , deg
10	4.50	10.59	16.75
1	7.25	8.15	11.28
11	10.00	6.62	8.47

○ □ ◇



(j)  $M = 1.20; \alpha = 0^\circ$ .

Figure 19. Concluded.

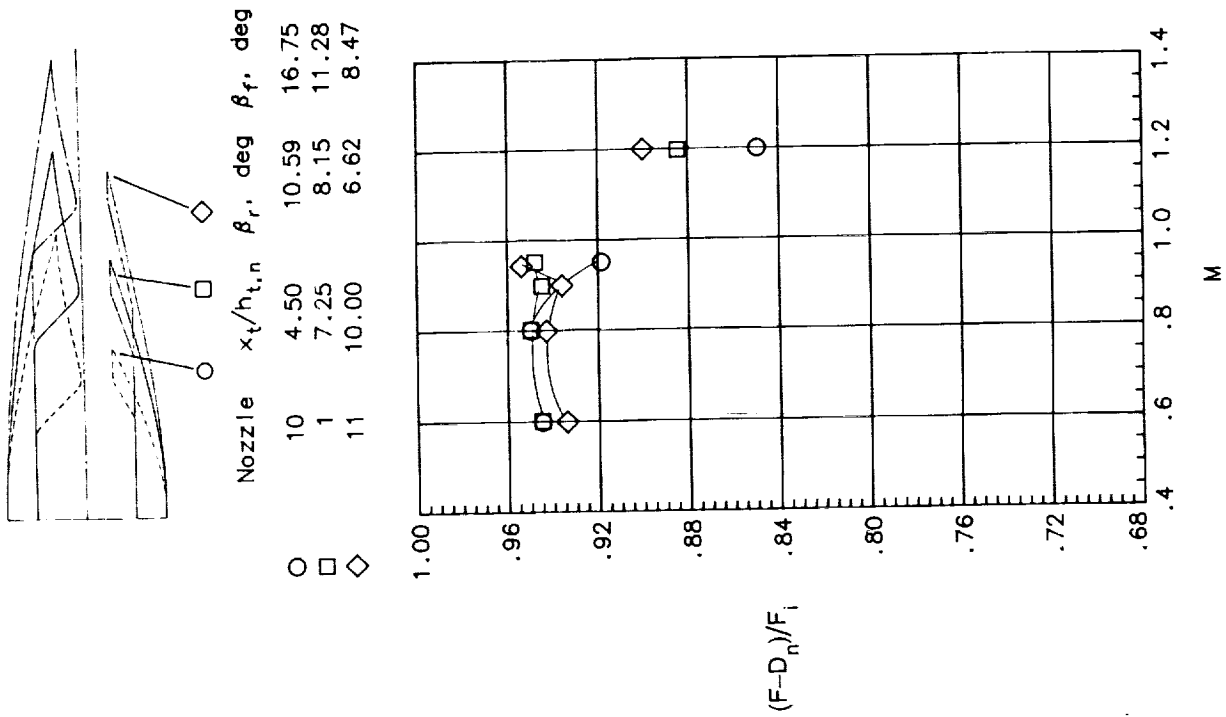


Figure 20. Effect of axial location of nozzle throat on aeropropulsive performance at scheduled NPR.  
 $l_r/h_{t,n} = 4.50; \theta_r = 8.75^\circ; l_f/h_{t,n} = 0.90; \theta_f = 0^\circ; y_f/h_{t,n} = 0.12; (A_e/A_t)_e = 1.19; (A_e/A_t)_i = 1.69; \alpha = 0^\circ$ .

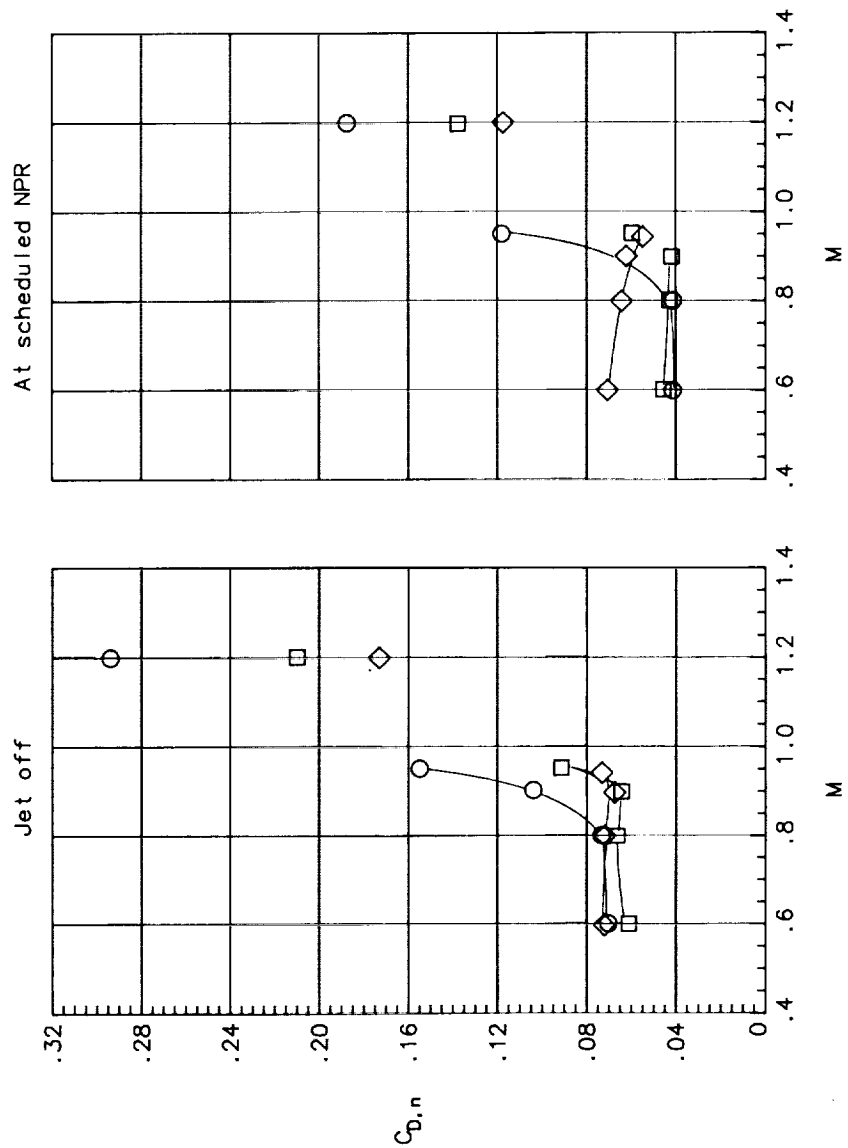
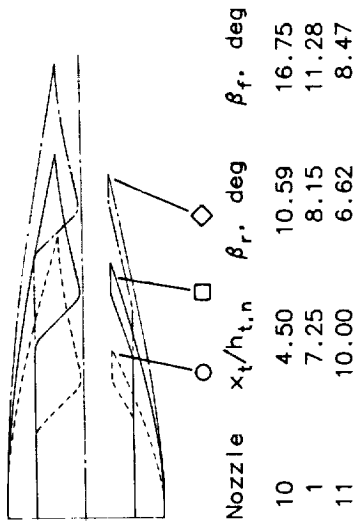


Figure 21. Effect of axial location of nozzle throat on nozzle drag.  $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $l_f/h_{t,n} = 0.90$ ;  $\theta_f = 0^\circ$ ;  $y_t/h_{t,n} = 0.12$ ;  $(A_e/A_t)_i = 1.19$ ;  $(A_e/A_t)_e = 1.69$ ;  $\alpha = 0^\circ$ .

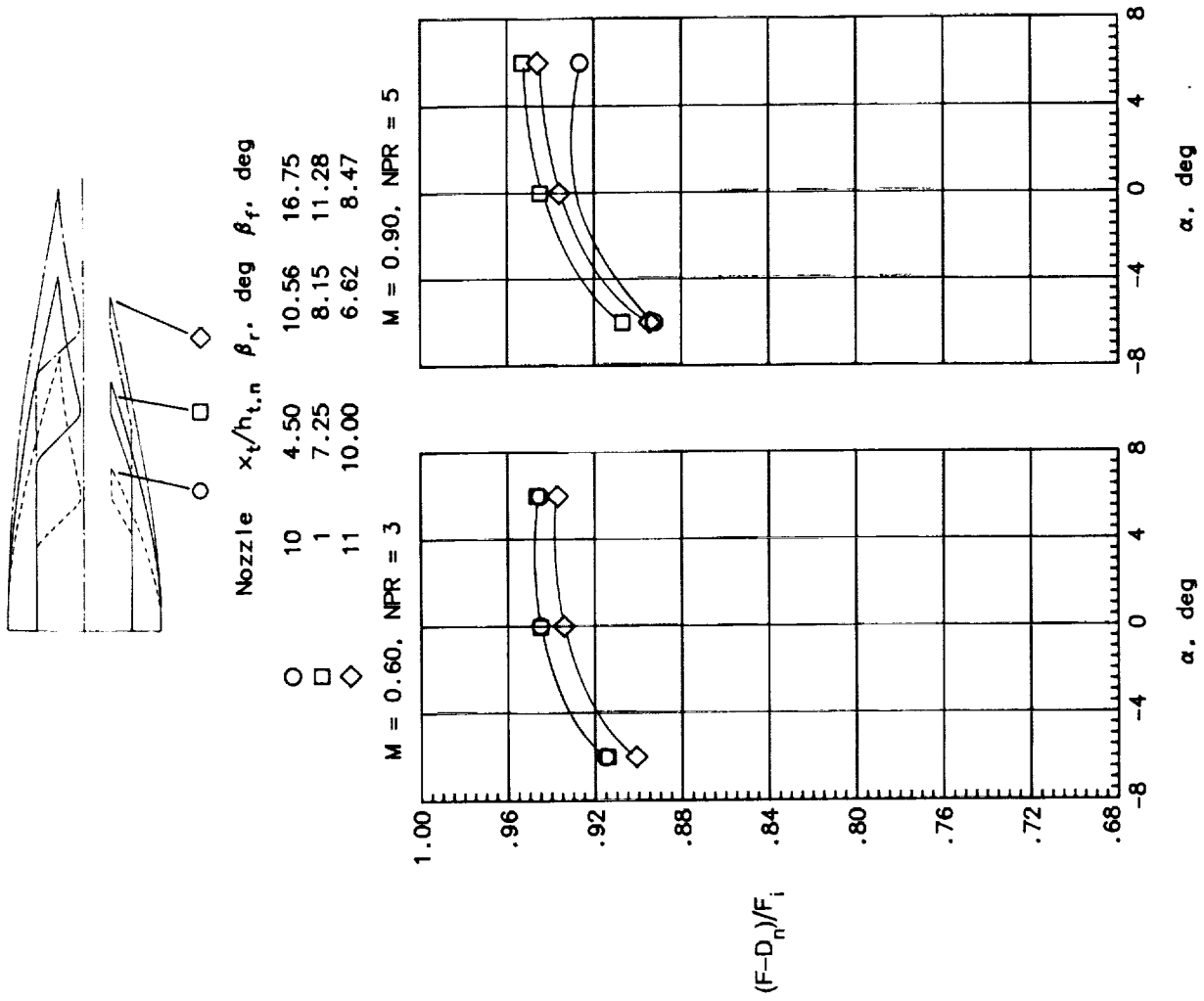
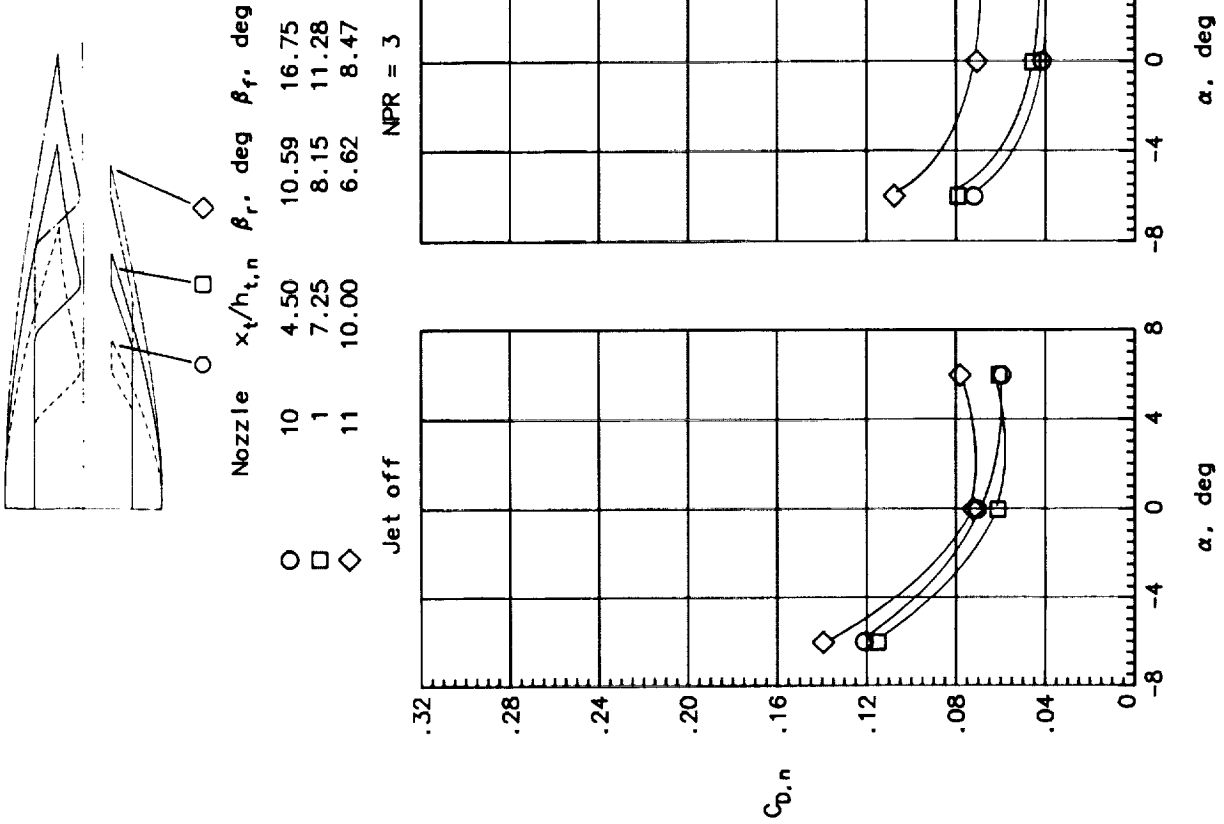


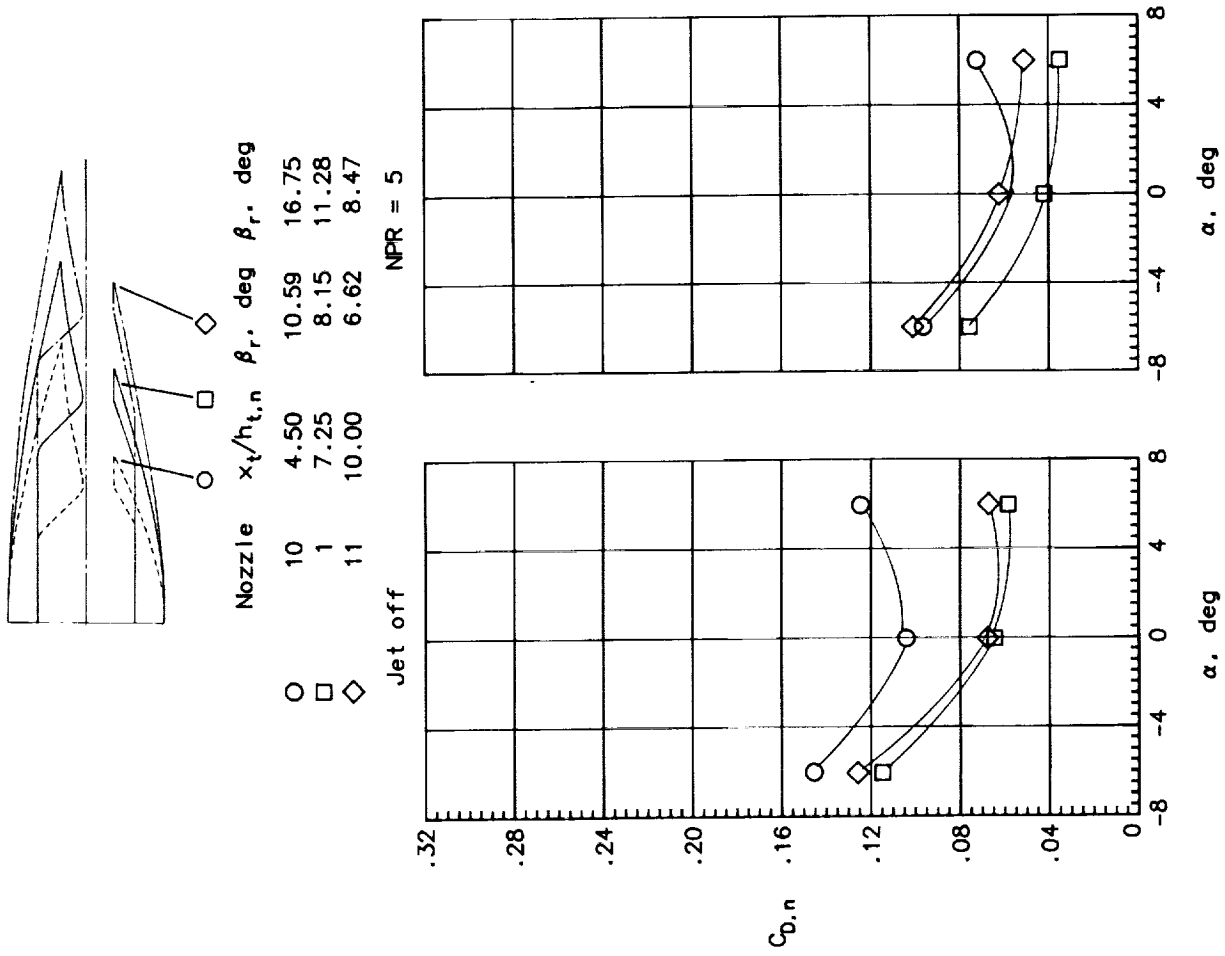
Figure 22. Effect of axial location of nozzle throat on aerodynamic performance at angle of attack at scheduled NPR.  $t_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $l_f/h_{t,n} = 0.90$ ;  $\theta_f = 0^\circ$ ;  $y_H/h_{t,n} = 0.12$ ;  $(A_e/A_t)_i = 1.19$ ;  $(A_e/A_t)_e = 1.69$ .





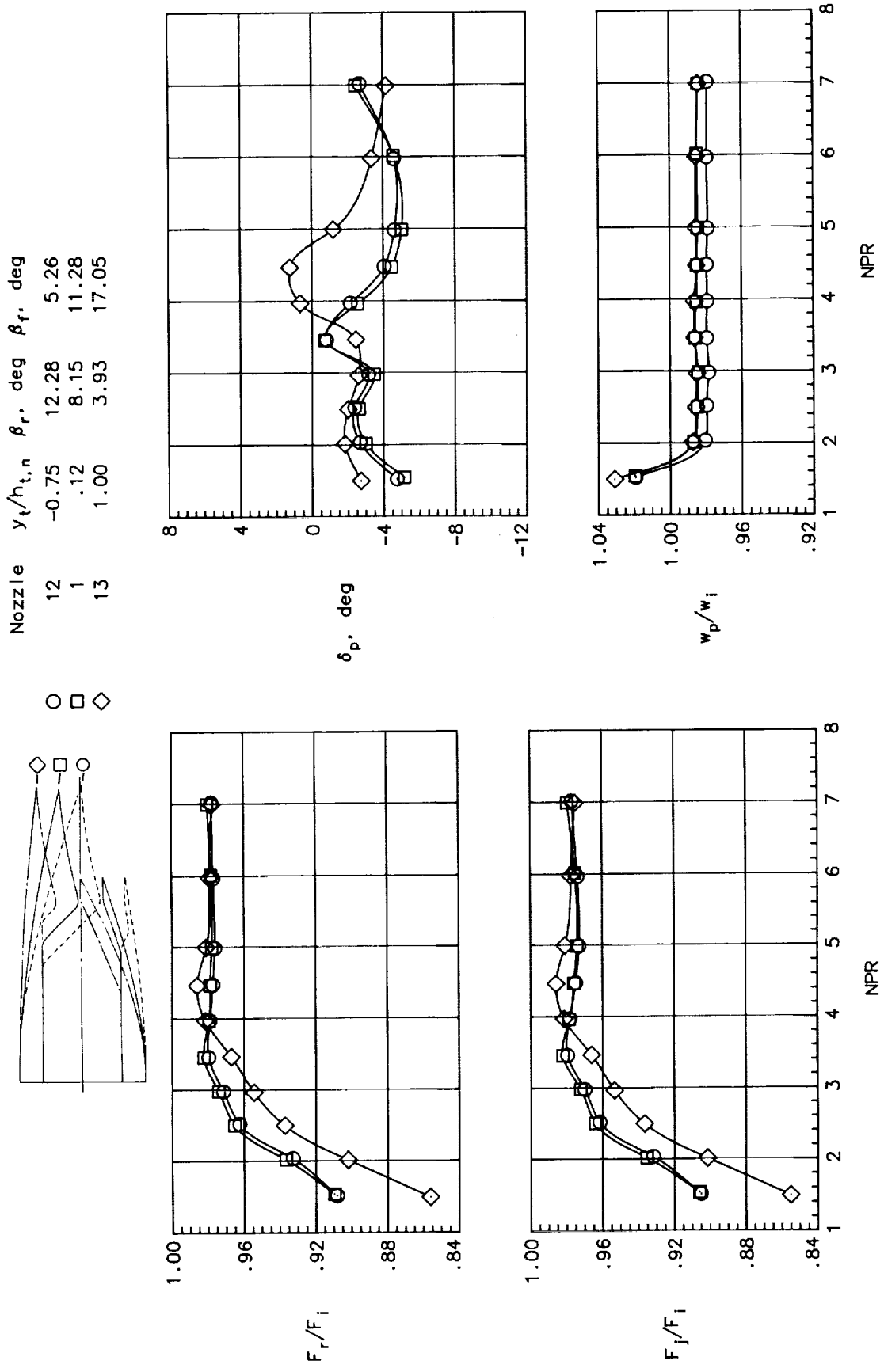
(a)  $M = 0.60$ .

Figure 23. Effect of axial location of nozzle throat on nozzle drag at angle of attack.  $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $l_f/h_{t,n} = 0.90$ ;  $\theta_f = 0^\circ$ ;  $y_t/h_{t,n} = 0.12$ ;  $(A_e/A_t)_i = 1.19$ ;  $(A_e/A_t)_e = 1.69$ .



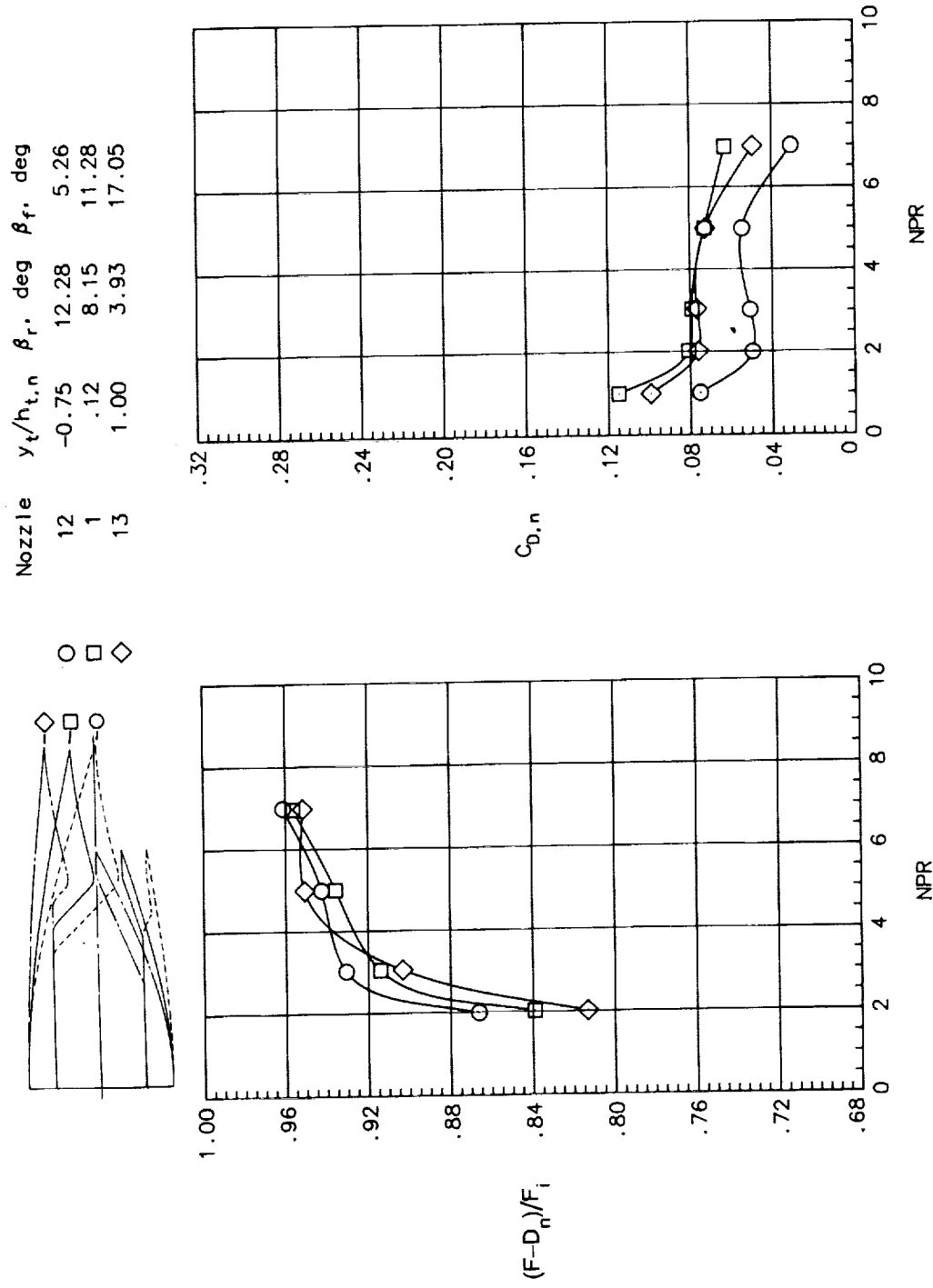
(b)  $M = 0.90$ .

Figure 23. Concluded.



(a)  $M = 0; \alpha = 0^\circ$ .

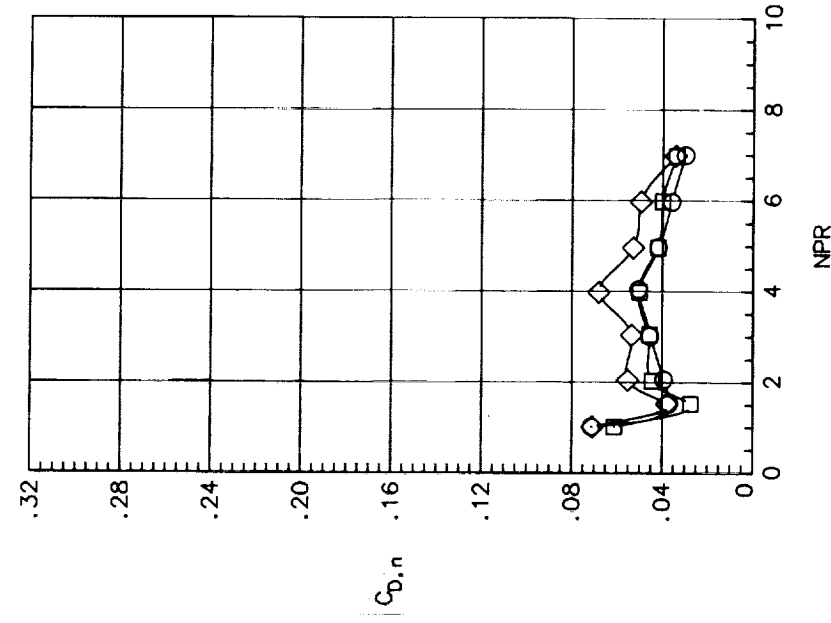
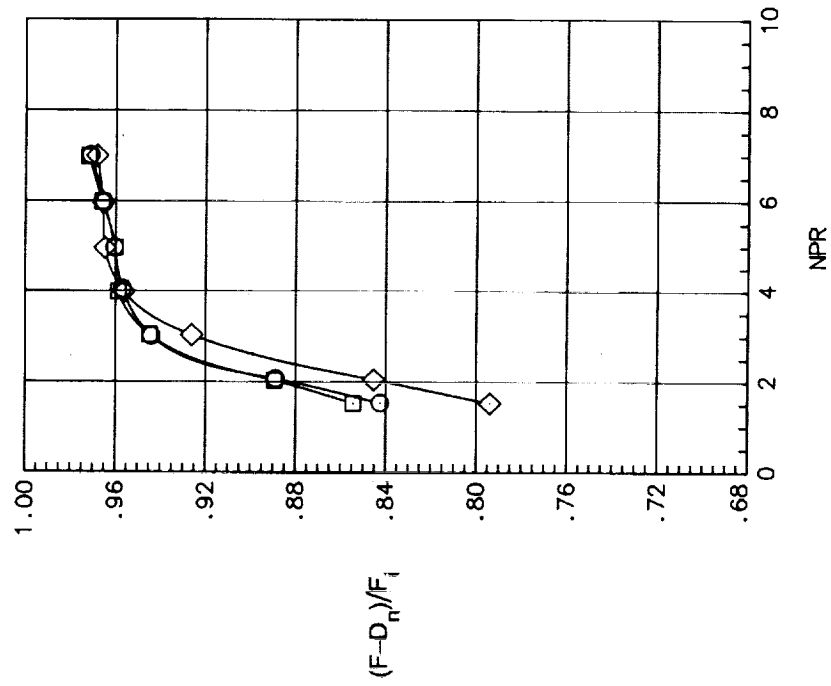
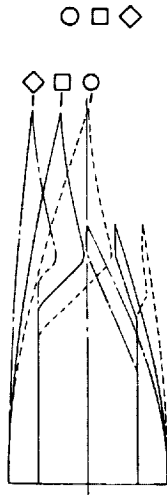
Figure 24. Effect of vertical location of nozzle throat on aerodynamic performance.  $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $l_f/h_{t,n} = 0.90$ ;  $\theta_f = 0^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $(A_e/A_t)_i = 1.19$ ;  $(A_e/A_t)_e = 1.69$ .



(b)  $M = 0.60; \alpha = -6^\circ$ .

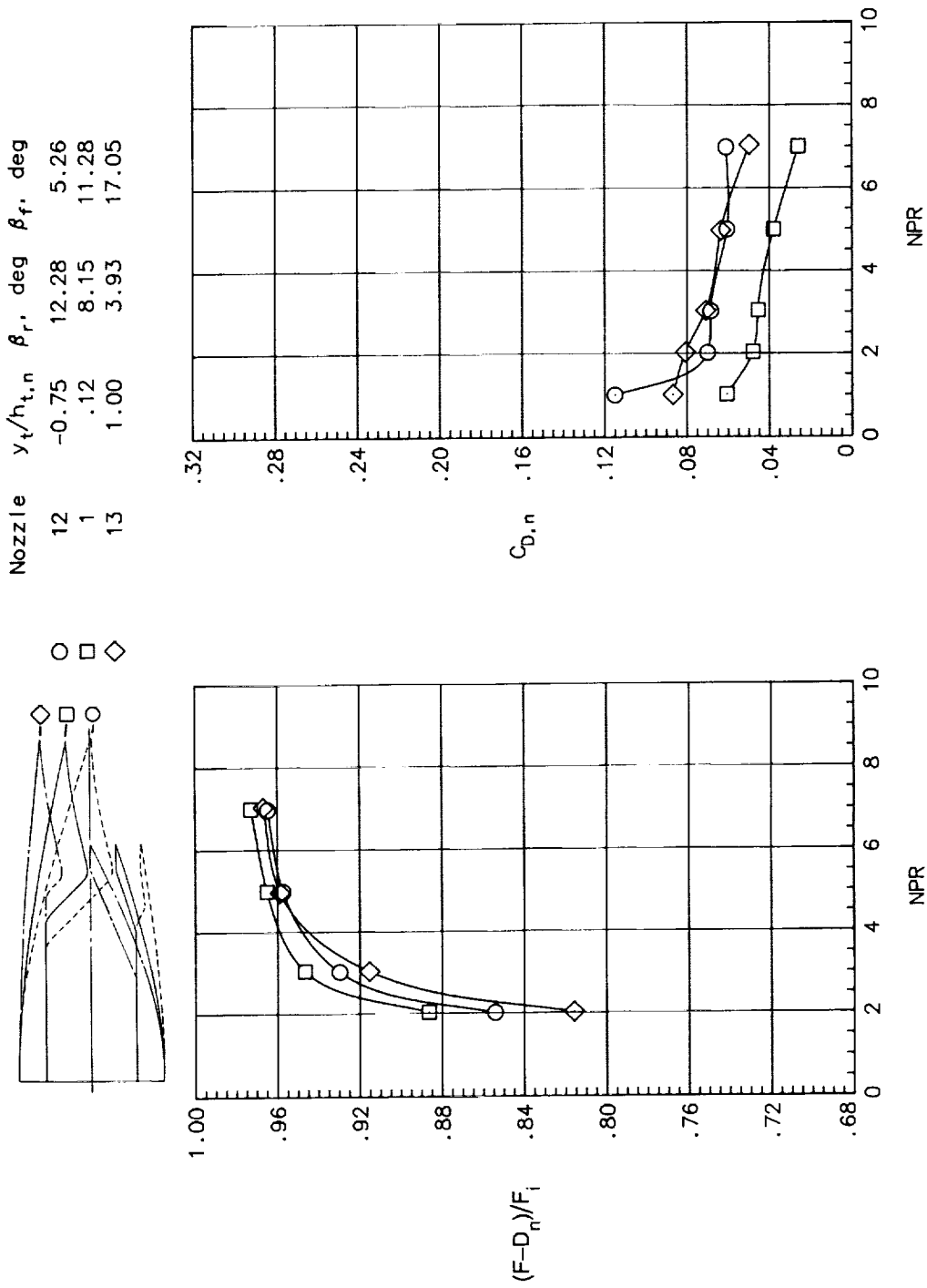
Figure 24. Continued.

Nozzle	$y_t/h_{t,n}$	$\beta_r$ , deg	$\beta_f$ , deg
12	-0.75	12.28	5.26
1	.12	8.15	11.28
13	1.00	3.93	17.05



(c)  $M = 0.60; \alpha = 0^\circ$ .

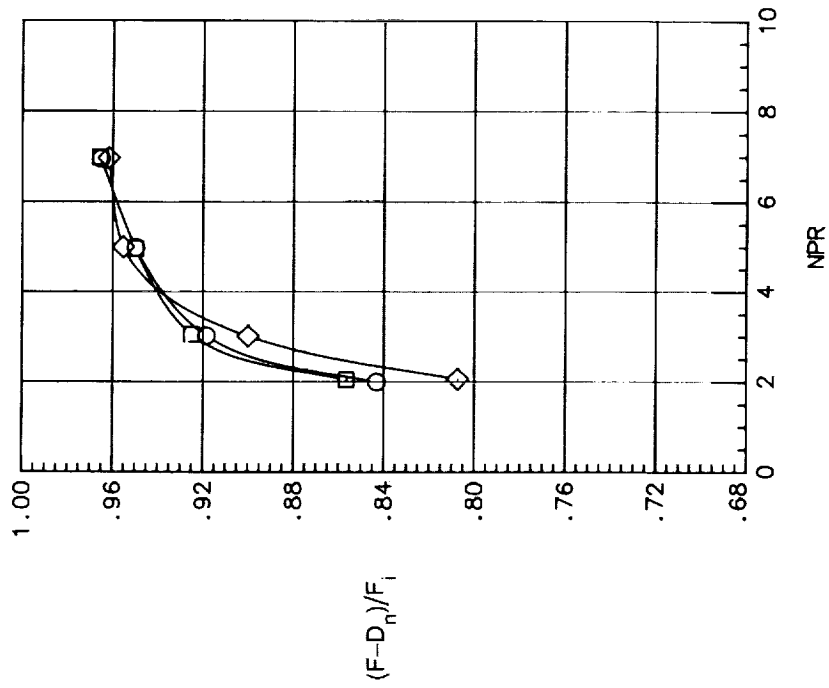
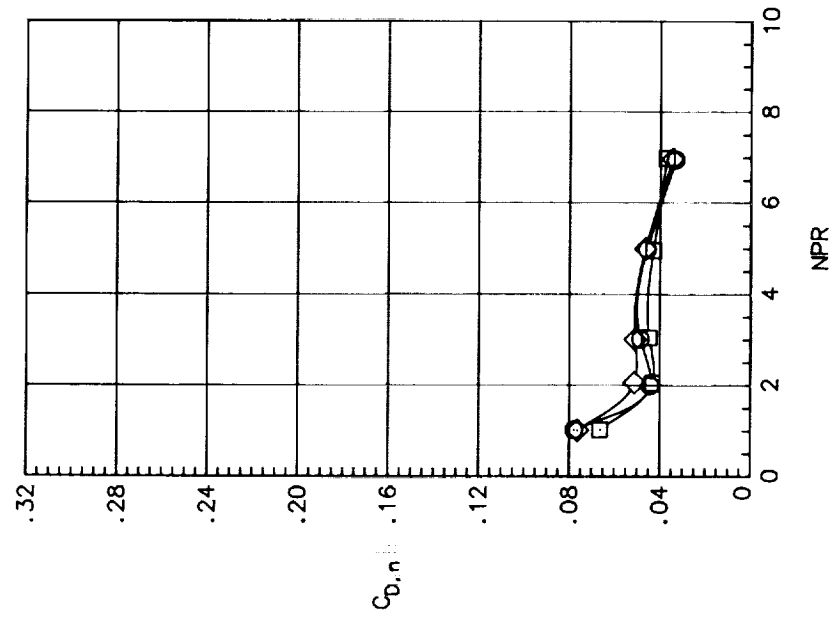
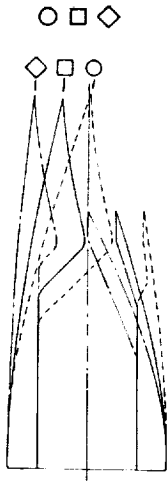
Figure 24. Continued.



(d)  $M = 0.60; \alpha = 6^\circ$ .

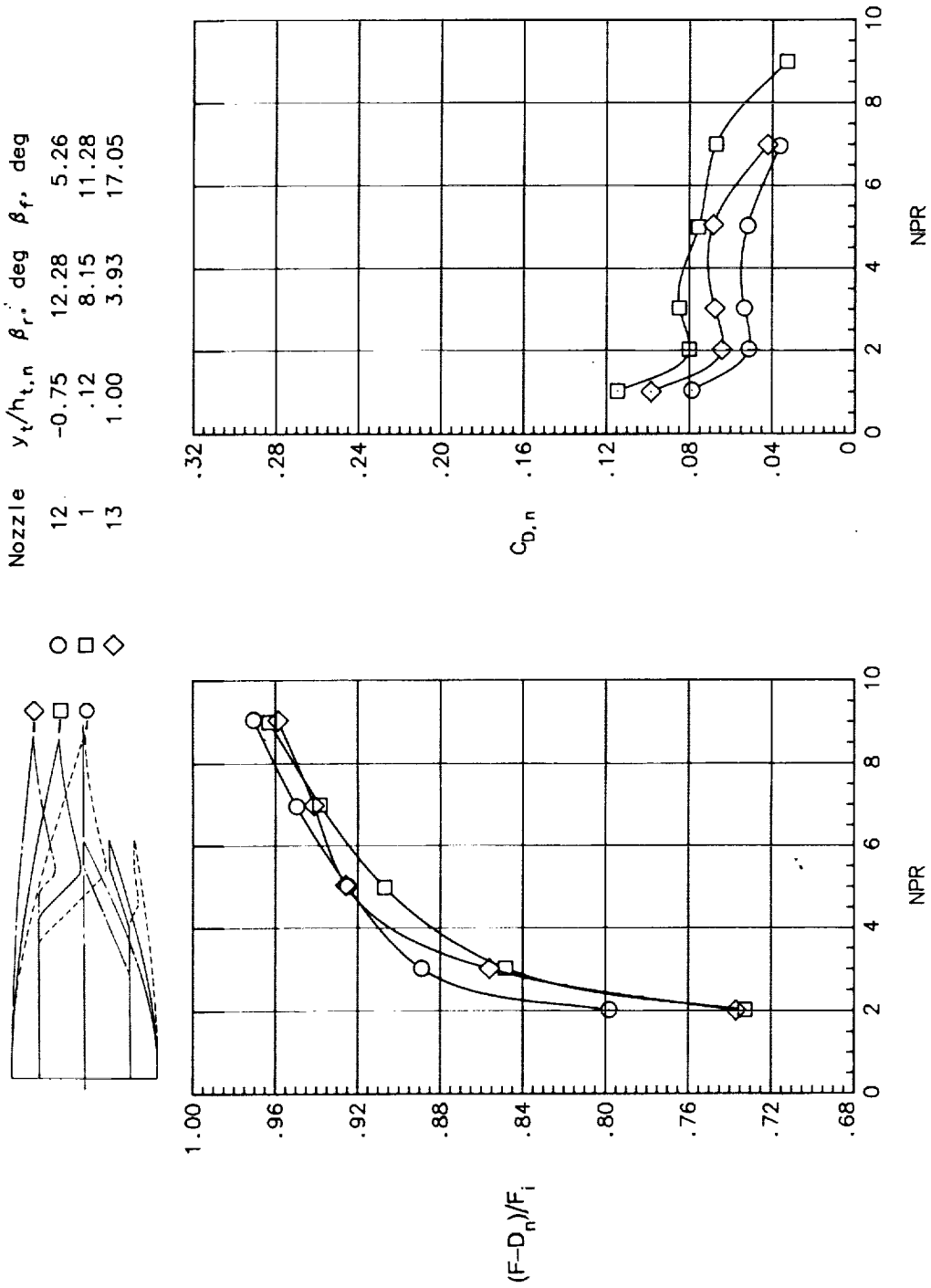
Figure 24. Continued.

Nozzle	$y_t/h_{t,n}$	$\beta_r$ , deg	$\beta_f$ , deg
12	-0.75	12.28	5.26
1	.12	8.15	11.28
13	1.00	3.93	17.05



(e)  $M = 0.80$ ;  $\alpha = 0^\circ$ .

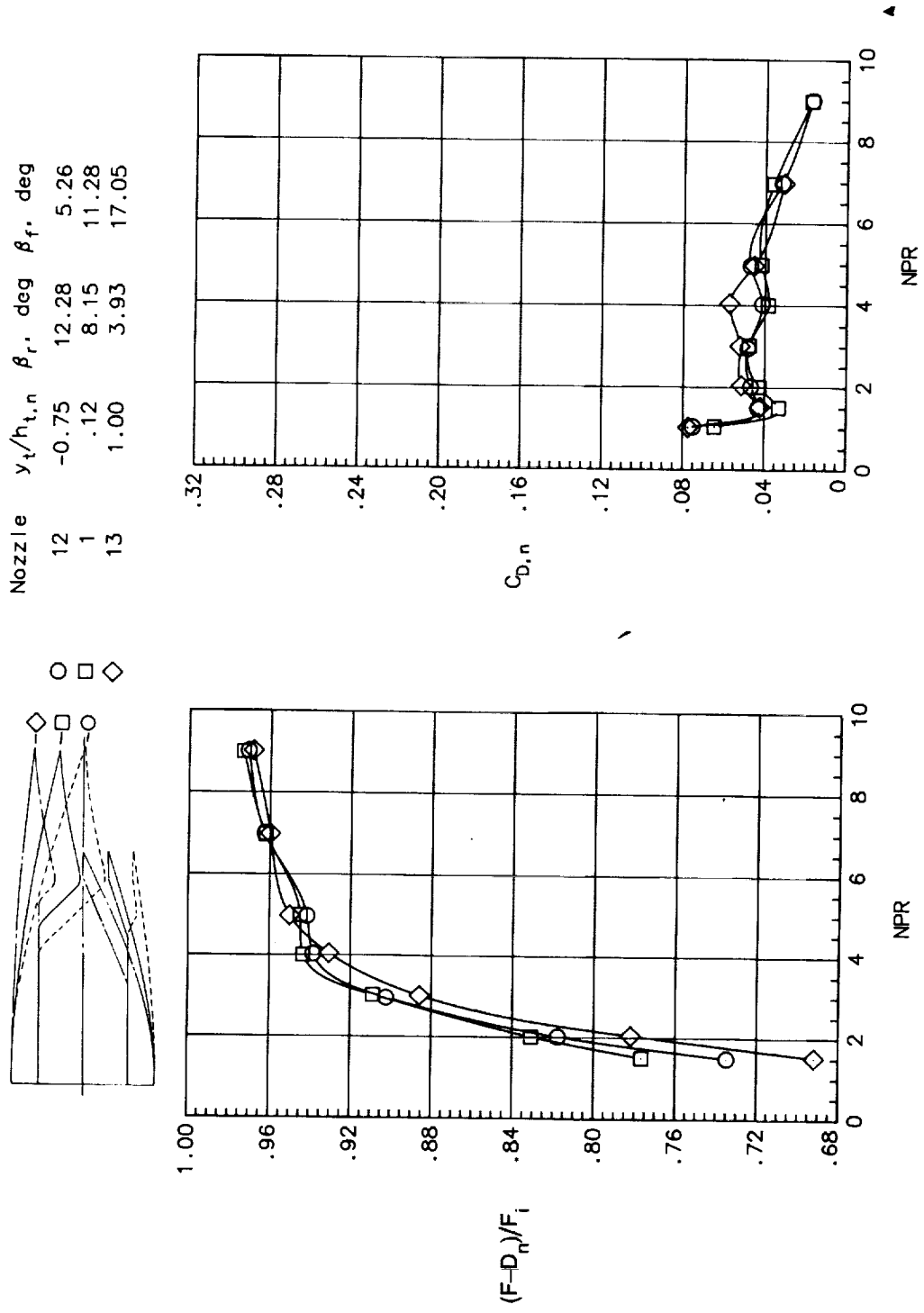
Figure 24. Continued.



(f)  $M = 0.90; \alpha = -6^\circ$ .

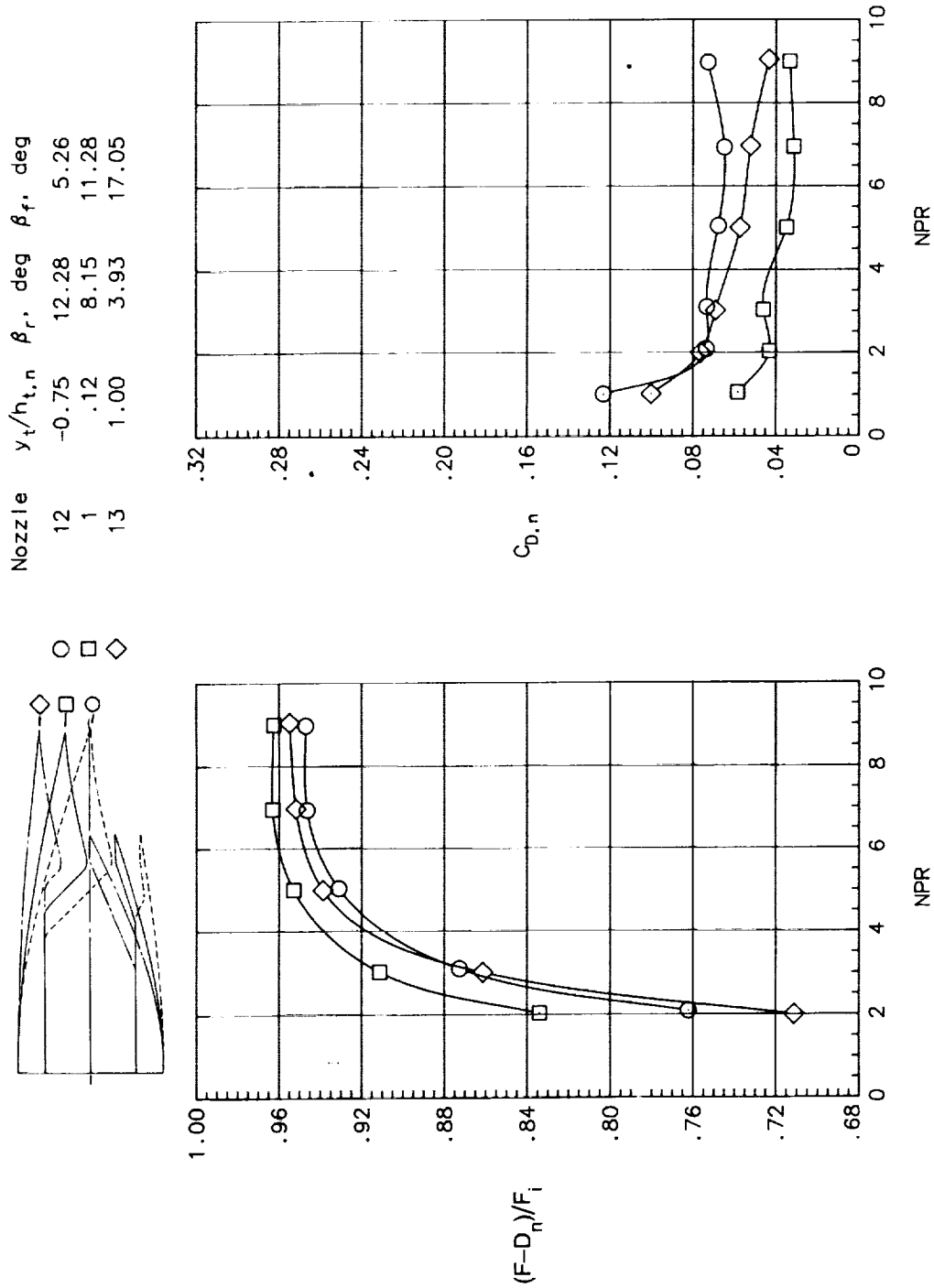
Figure 24. Continued.





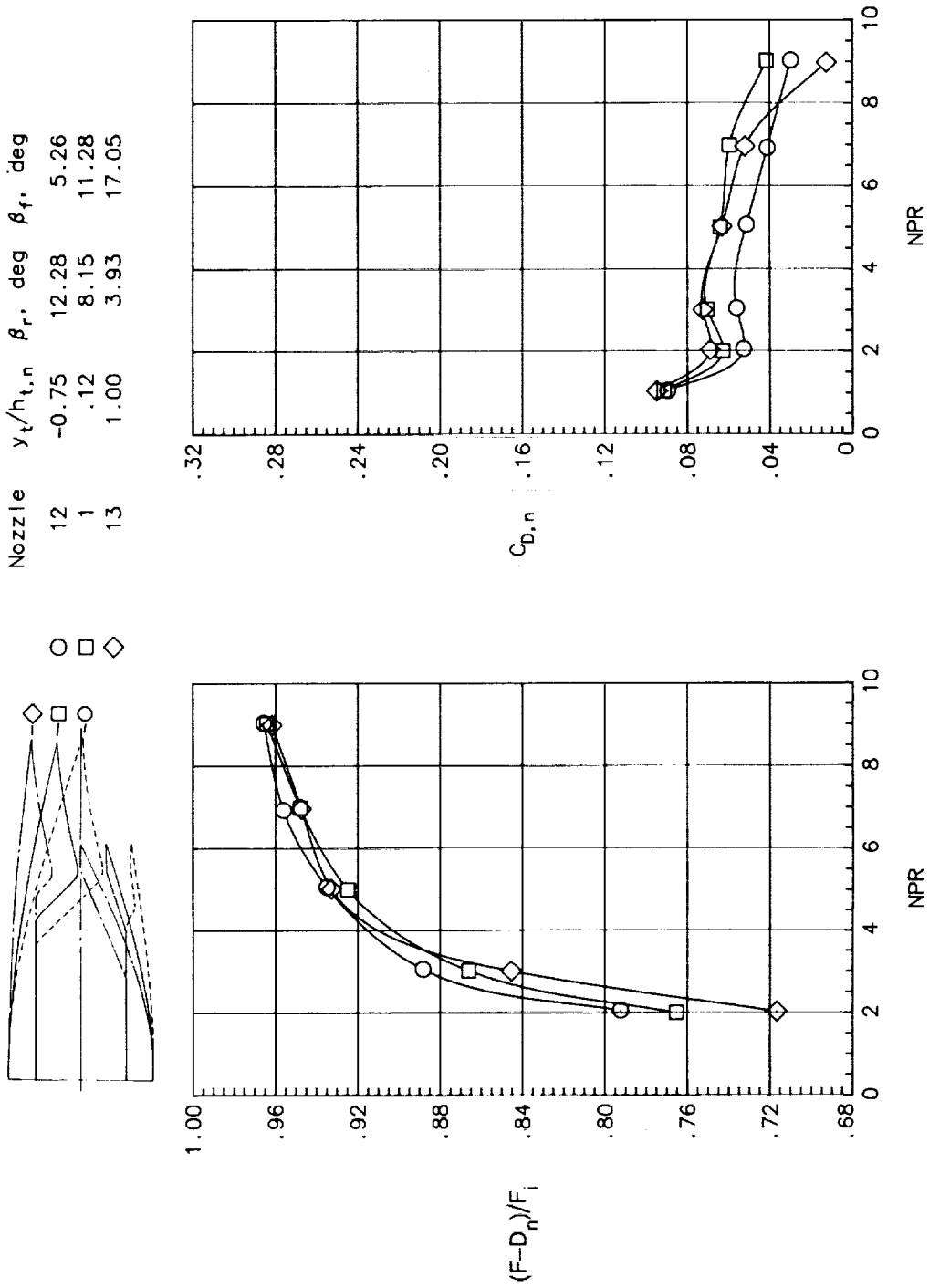
(g)  $M = 0.90; \alpha = 0^\circ$ .

Figure 24. Continued.



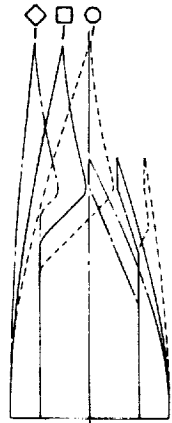
(h)  $M = 0.90; \alpha = 6^\circ$ .

Figure 24. Continued.



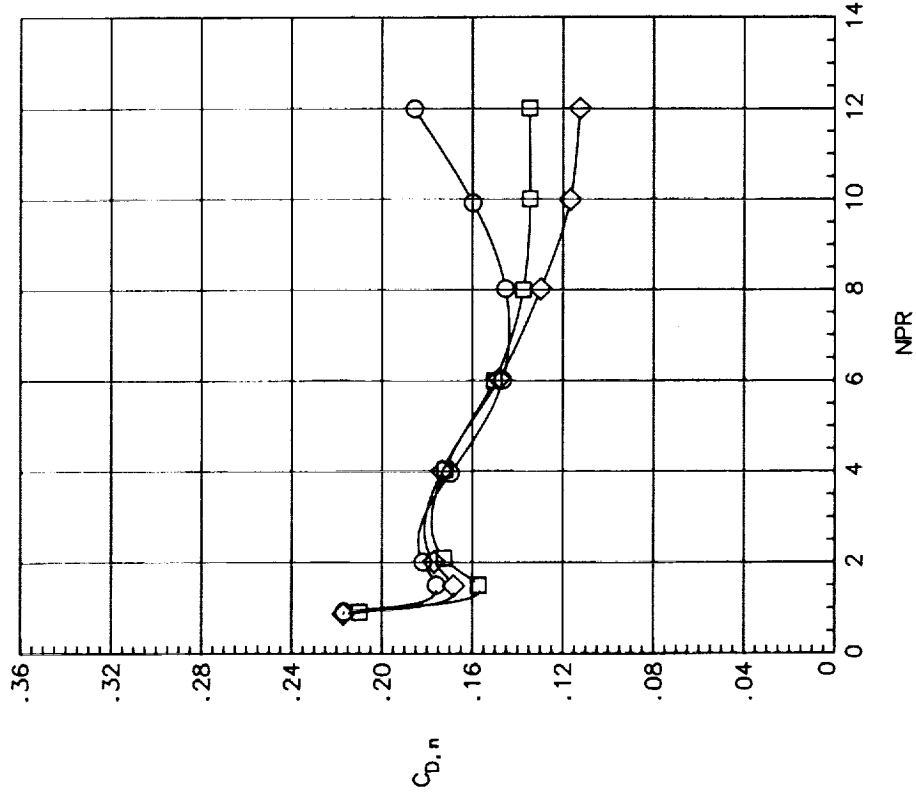
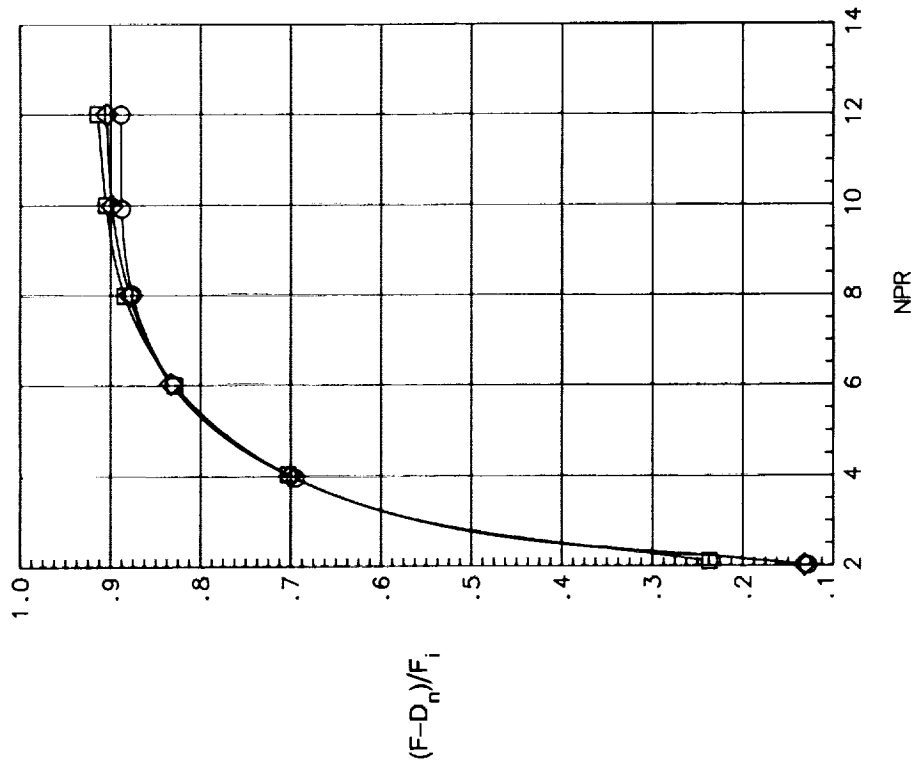
(i)  $M = 0.95$ ;  $\alpha = 0^\circ$ .

Figure 24. Continued.



Nozzle	$y_t/h_{t,n}$	$\beta_r$ , deg	$\beta_r$ , deg
12	-0.75	12.28	5.26
1	.12	8.15	11.28
13	1.00	3.93	17.05

○ □ ◇



(j)  $M = 1.20; \alpha = 0^\circ$ .

Figure 24. Concluded.

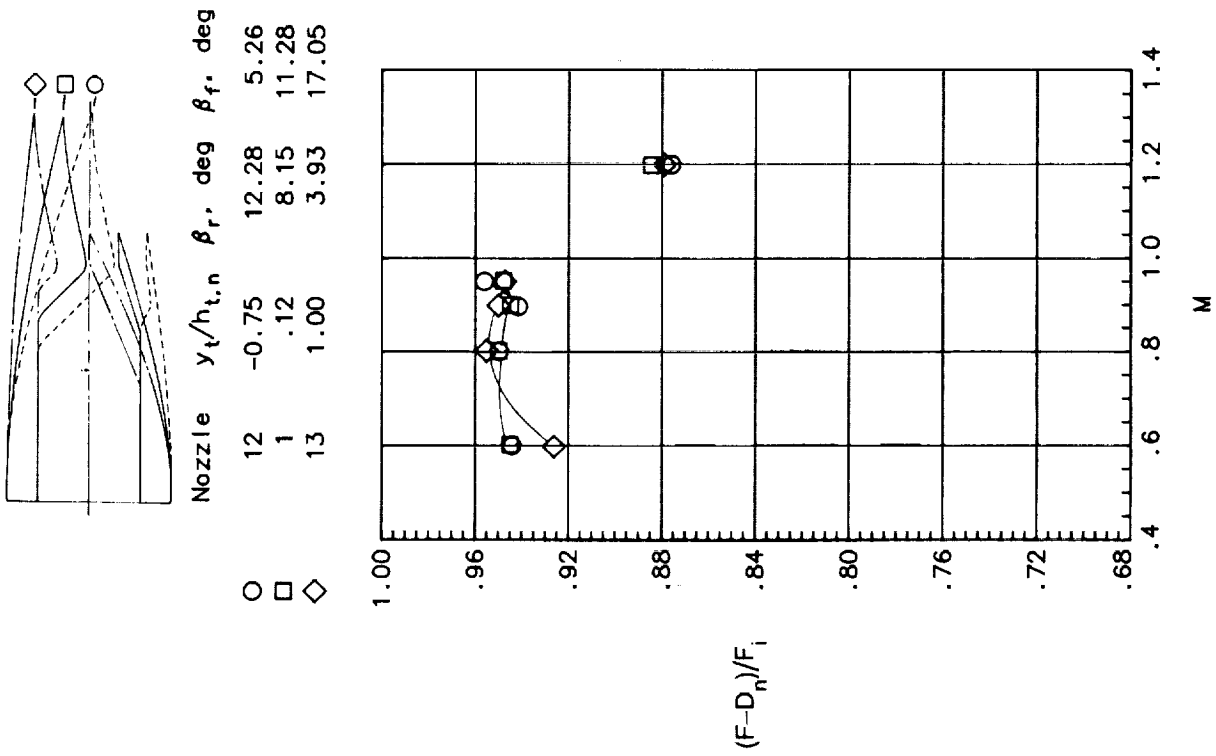
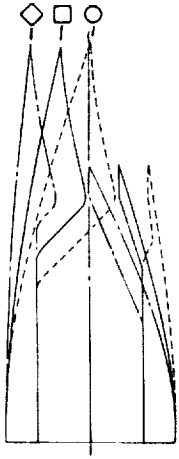


Figure 25. Effect of vertical location of nozzle throat on aerodynamic performance at scheduled NPR.  $l_t/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $l_f/h_{t,n} = 0.90$ ;  $\theta_f = 0^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $(A_e/A_t)_i = 1.19$ ;  $(A_e/A_t)_e = 1.69$ ;  $\alpha = 0^\circ$ .



Nozzle	$y_t/h_{t,n}$	$\beta_r$ , deg	$\beta_r$ , deg
○	-0.75	12.28	5.26
□	.12	8.15	11.28
◇	1.00	3.93	17.05

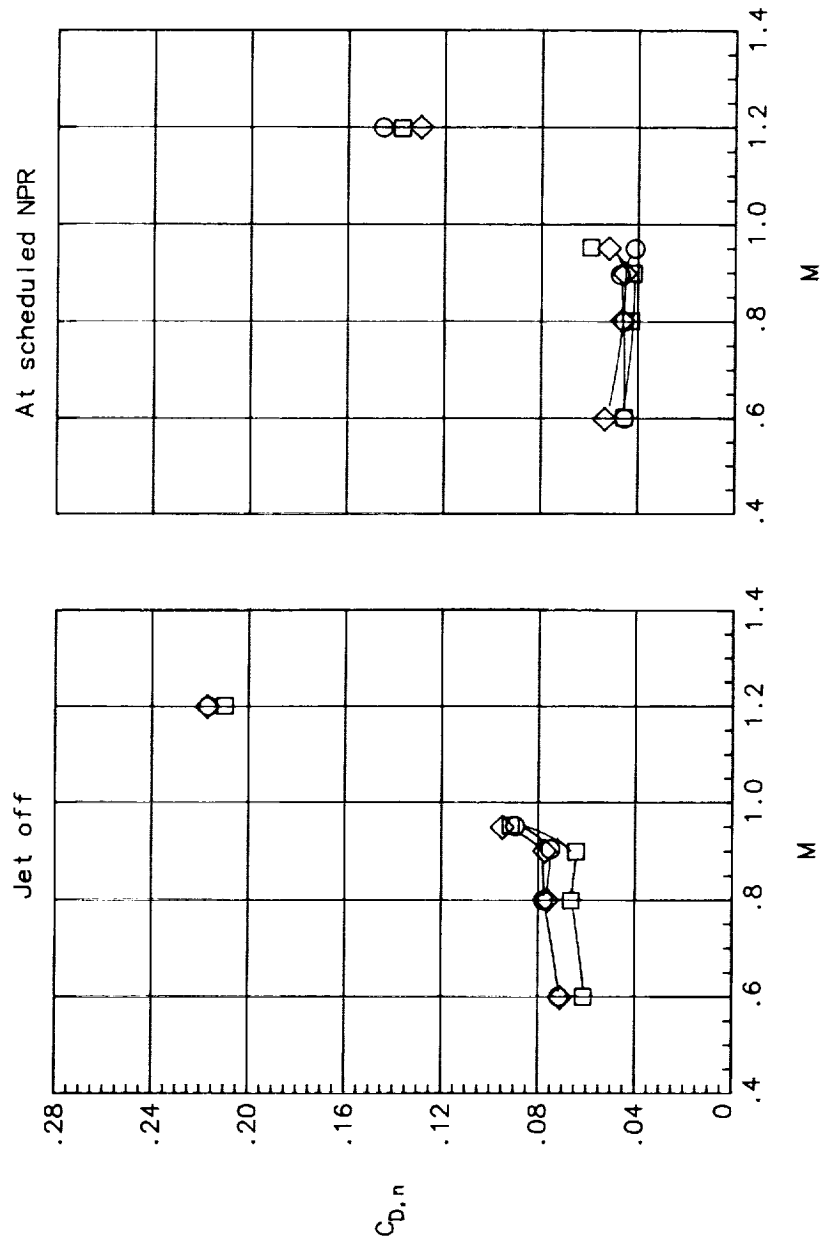
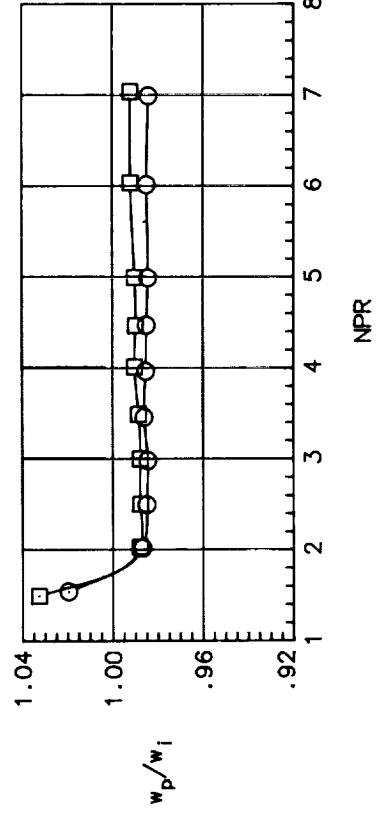
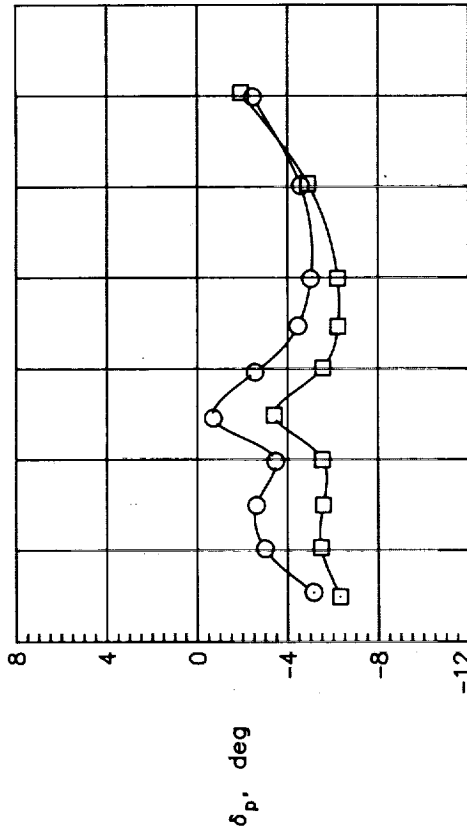
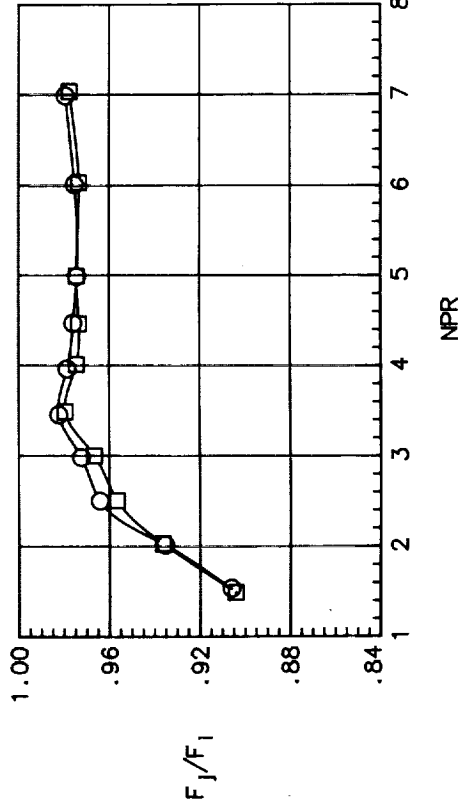
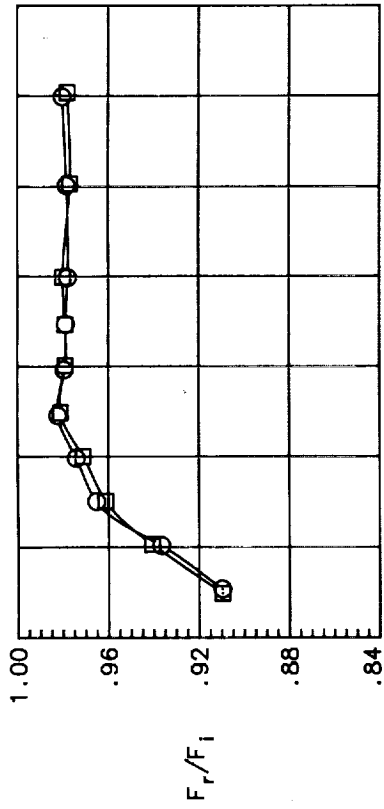
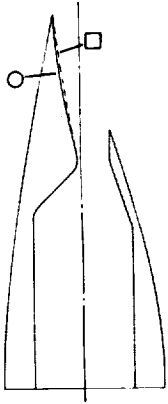


Figure 26. Effect of vertical location of nozzle throat on nozzle drag.  $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $l_f/h_{t,n} = 0.90$ ;  $\theta_f = 0^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $(A_e/A_t)_i = 1.19$ ;  $(A_e/A_t)_e = 1.69$ ;  $\alpha = 0^\circ$ .

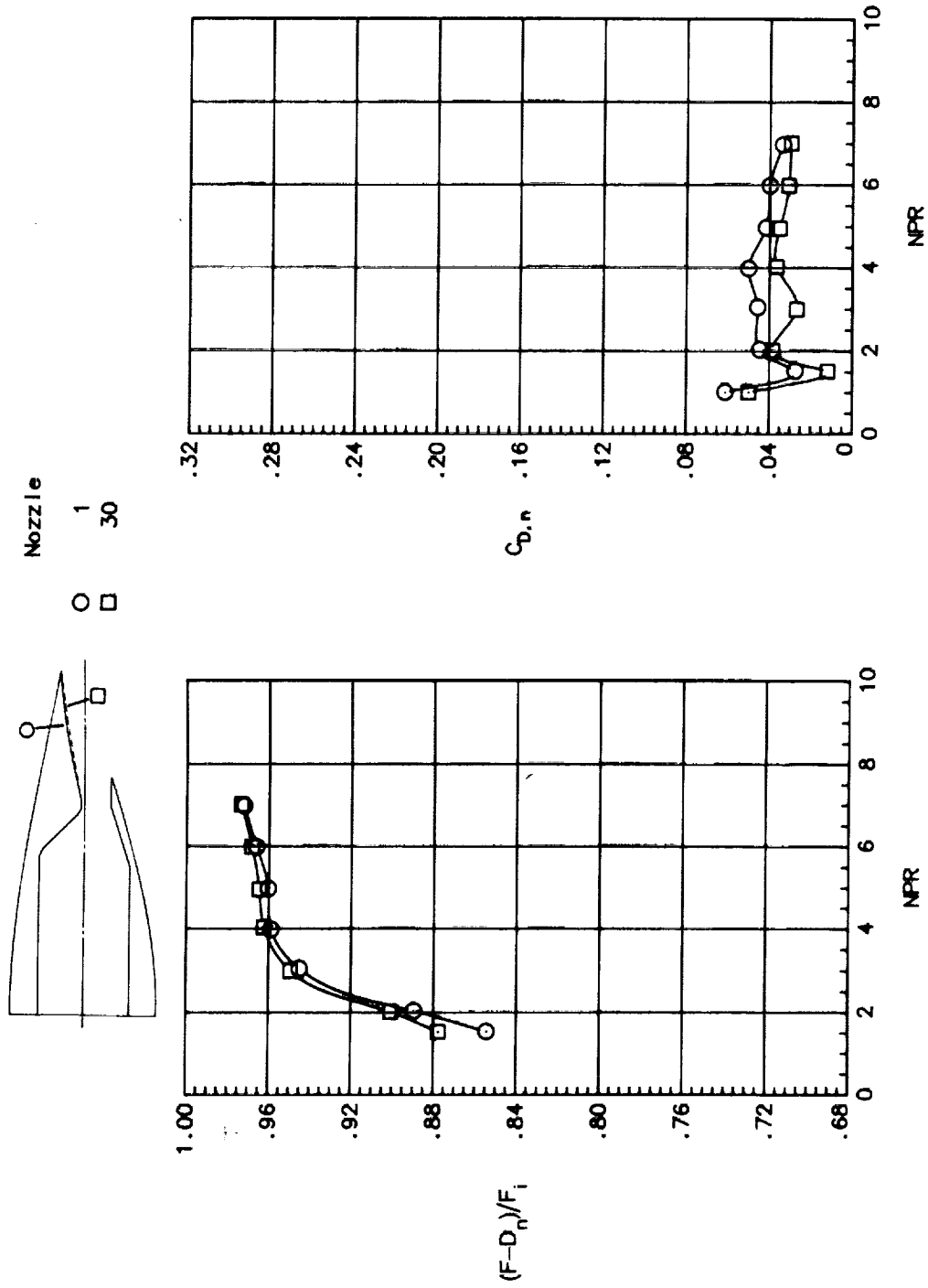
Nozzle

○ 1  
□ 30



(a)  $M = 0$ .

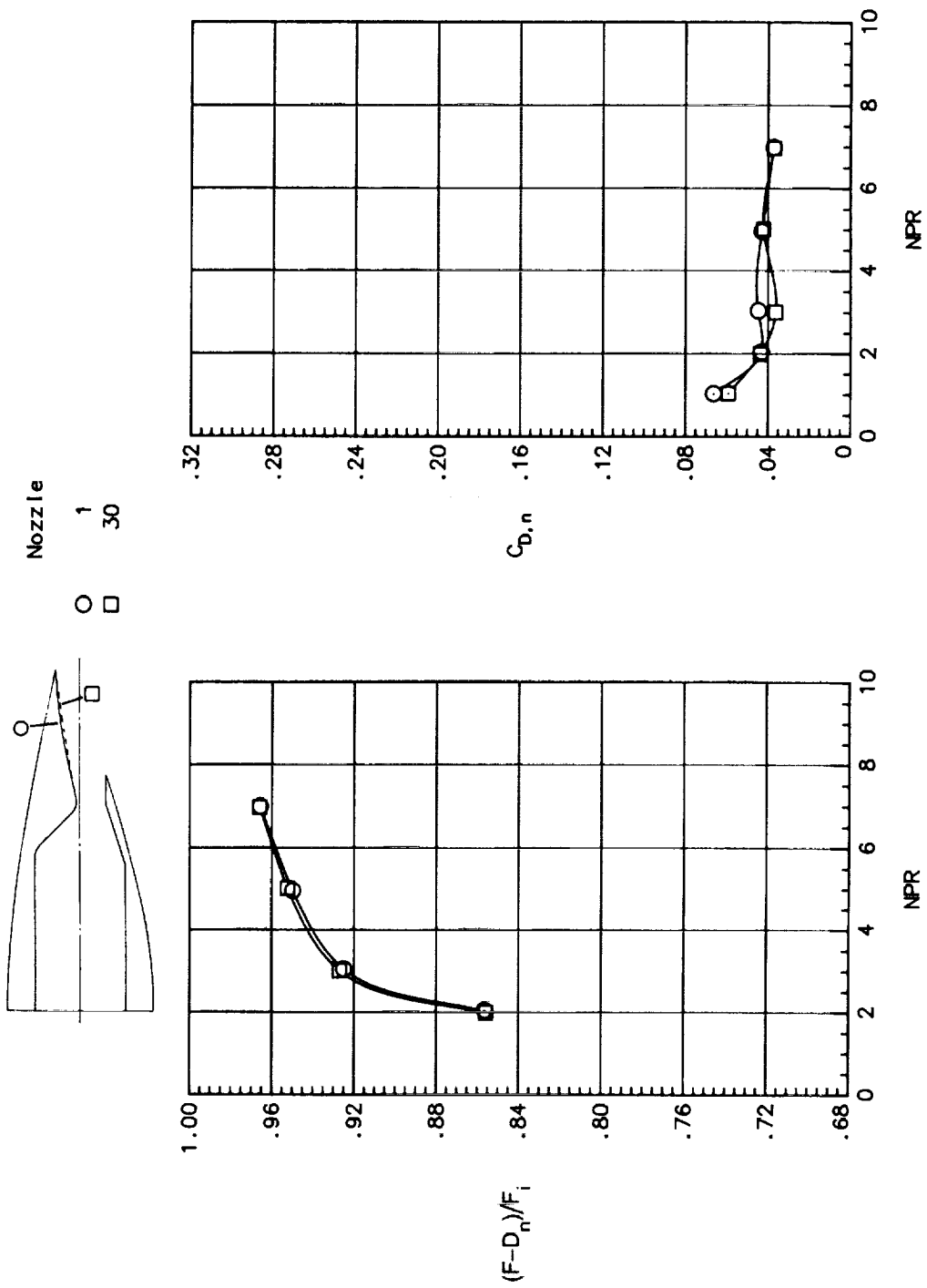
Figure 27. Effect of varying upper ramp expansion shape on acropulsive performance.  $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $\beta_r = 8.15^\circ$ ;  $l_f/h_{t,n} = 0.90$ ;  $\theta_f = 0^\circ$ ;  $\beta_f = 11.28^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .



(b)  $M = 0.60$ .

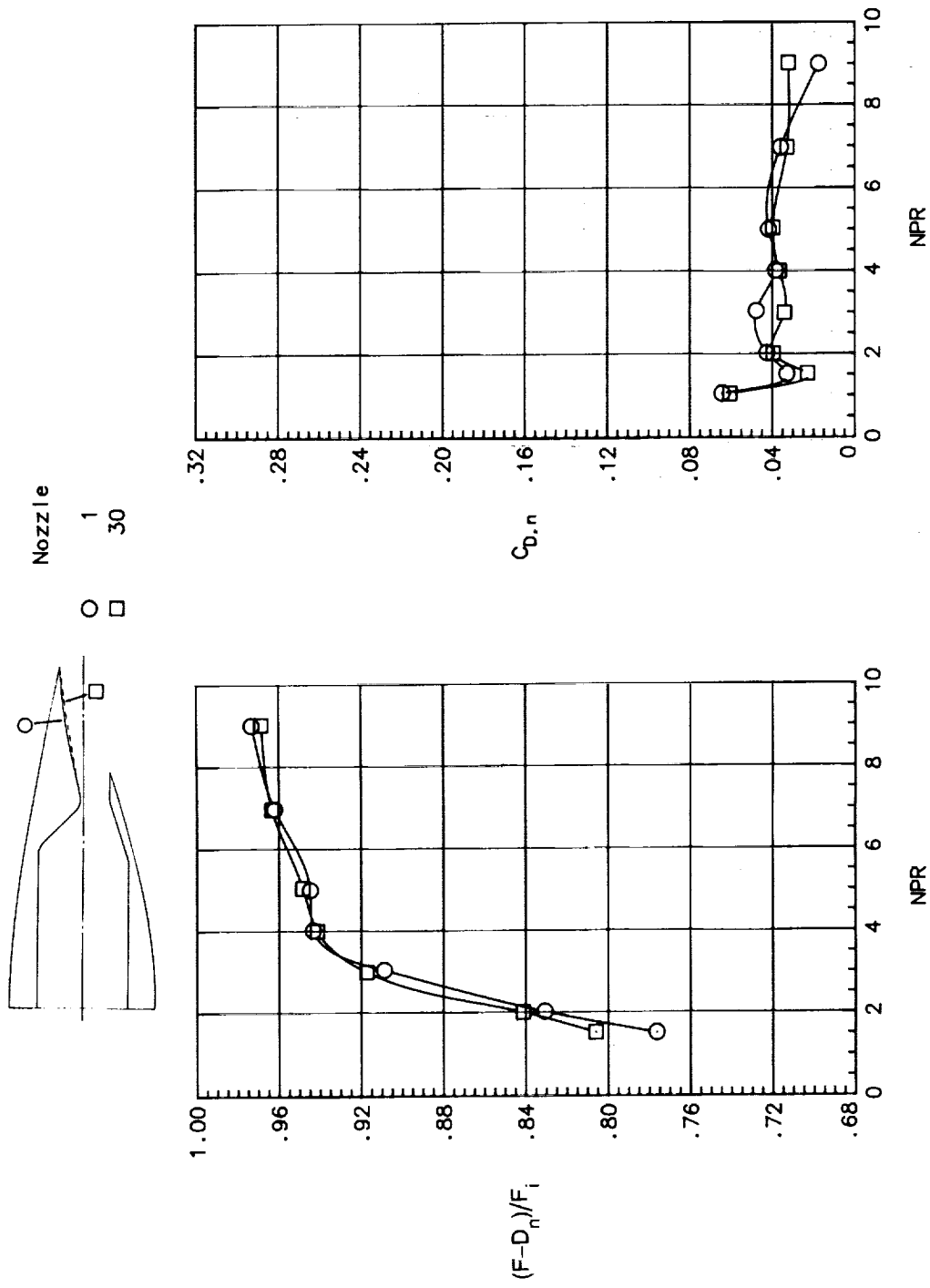
Figure 27. Continued.





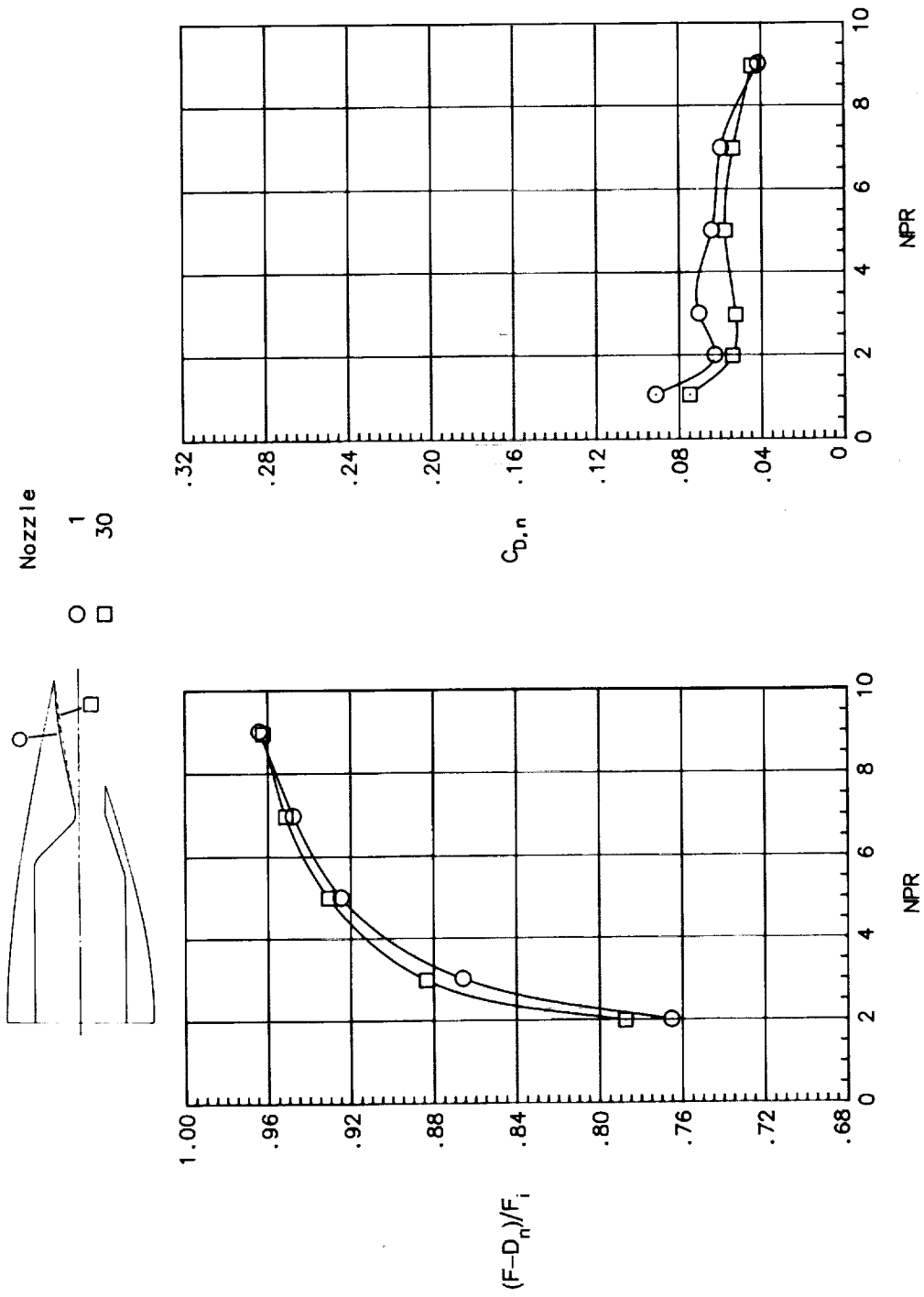
(c)  $M = 0.80$ .

Figure 27. Continued.



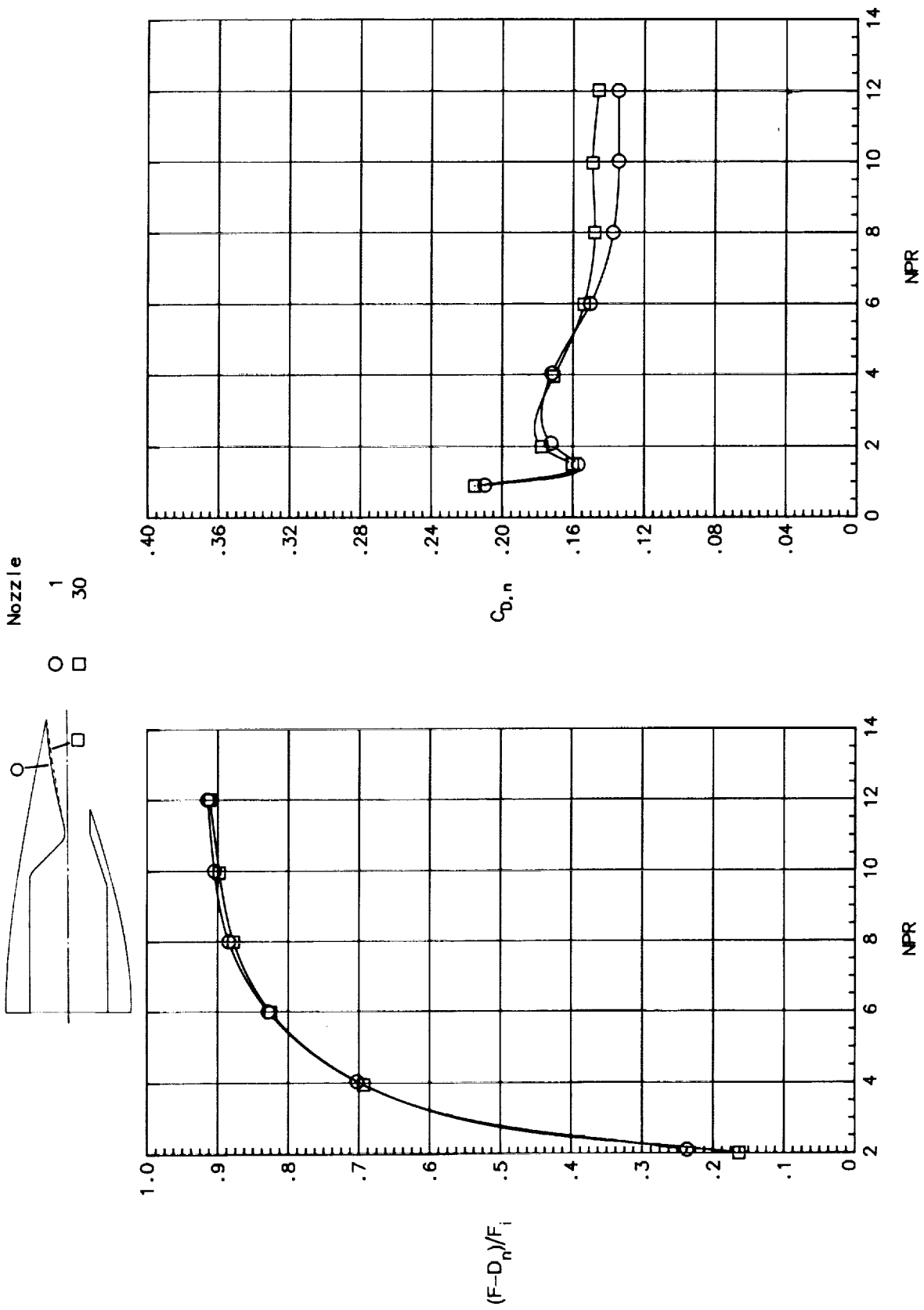
(d)  $M = 0.90$ .

Figure 27. Continued.



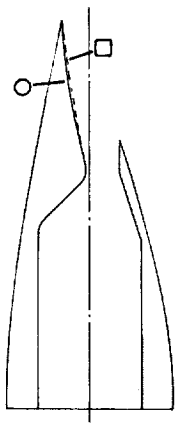
(e)  $M = 0.95$ .

Figure 27. Continued.



(f)  $M = 1.20$ .

Figure 27. Concluded.



Nozzle

○ 1  
□ 30

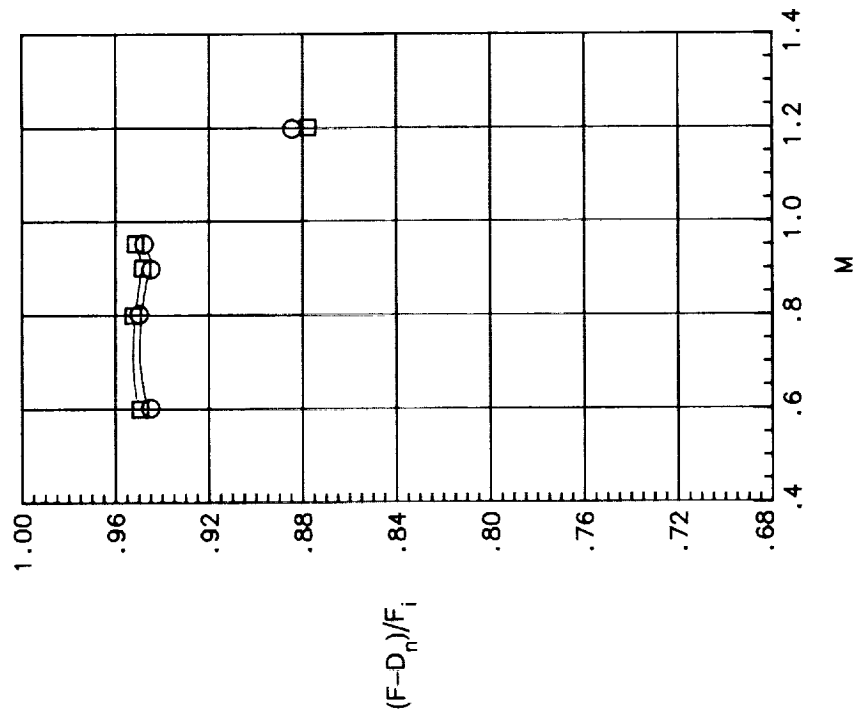
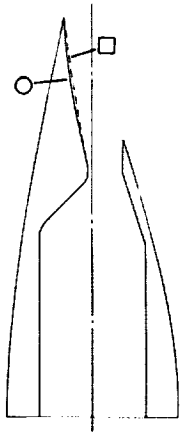


Figure 28. Effect of varying upper ramp expansion shape on aeropropulsive performance at scheduled NPR.  
 $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $\beta_r = 8.15^\circ$ ;  $l_f/h_{t,n} = 0.90$ ;  $\theta_f = 0^\circ$ ;  $\beta_f = 11.28^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  
 $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .



Nozzle  
 ○ 1  
 □ 30

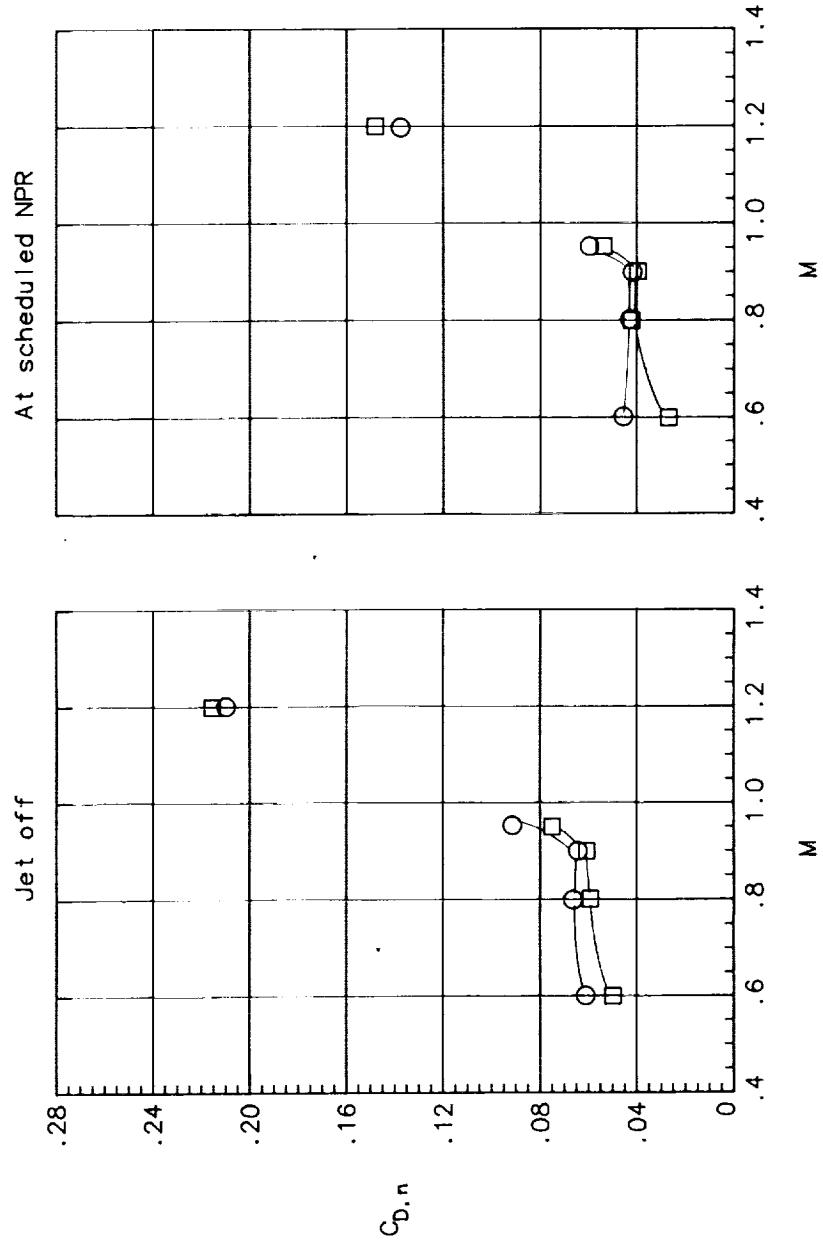
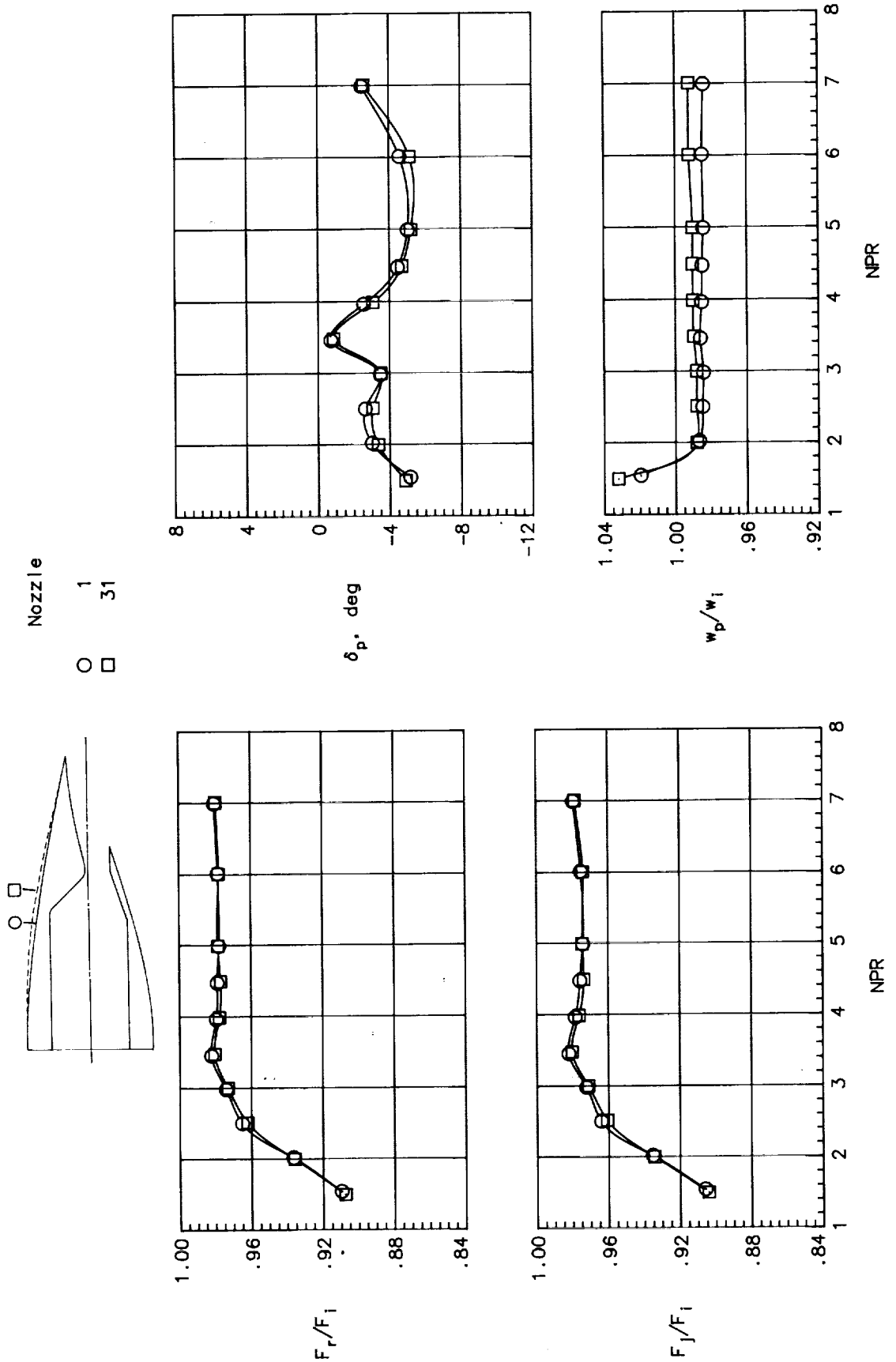
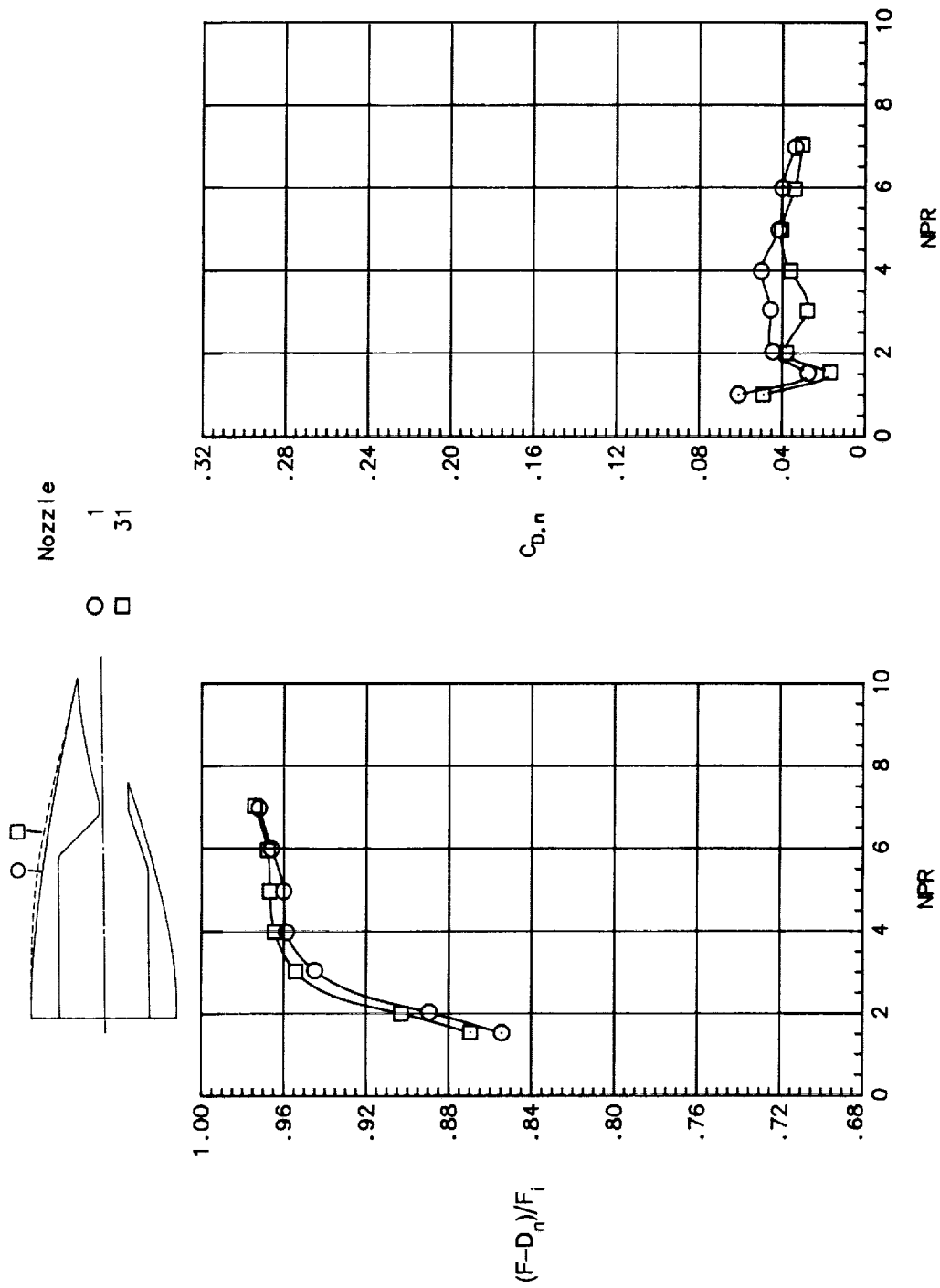


Figure 29. Effect of varying upper ramp expansion shape on nozzle drag.  $l_f/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $\beta_r = 8.15^\circ$ ;  $l_f/h_{t,n} = 0.90$ ;  $\theta_f = 0^\circ$ ;  $\beta_f = 11.28^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .



(a)  $M = 0$ .

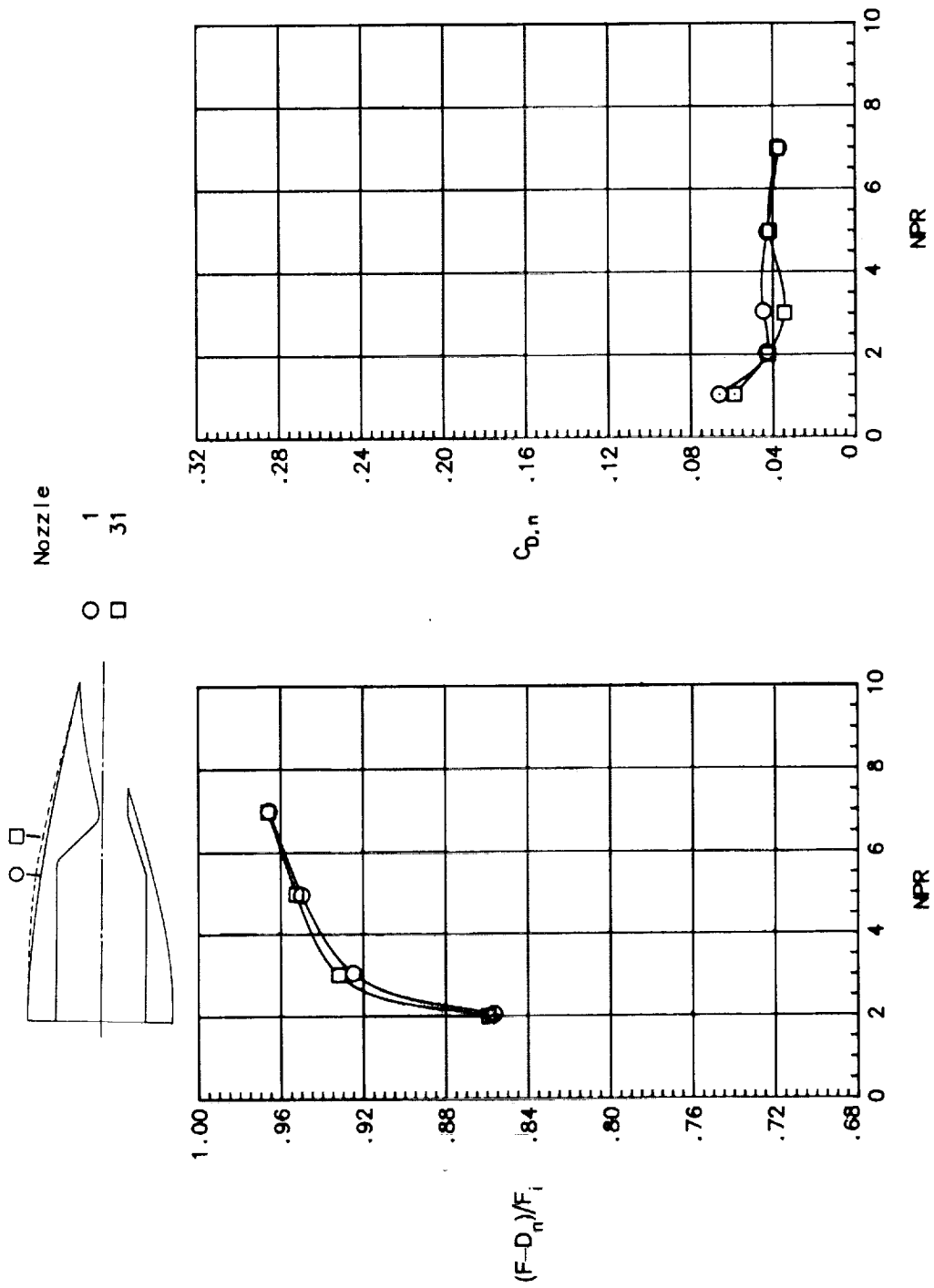
Figure 30. Effect of varying upper ramp external shape on aeropropulsive performance.  $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $\beta_r = 8.15^\circ$ ;  $l_f/h_{t,n} = 0.90$ ;  $\theta_f = 0^\circ$ ;  $\beta_f = 11.28^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .



(b)  $M = 0.60$ .

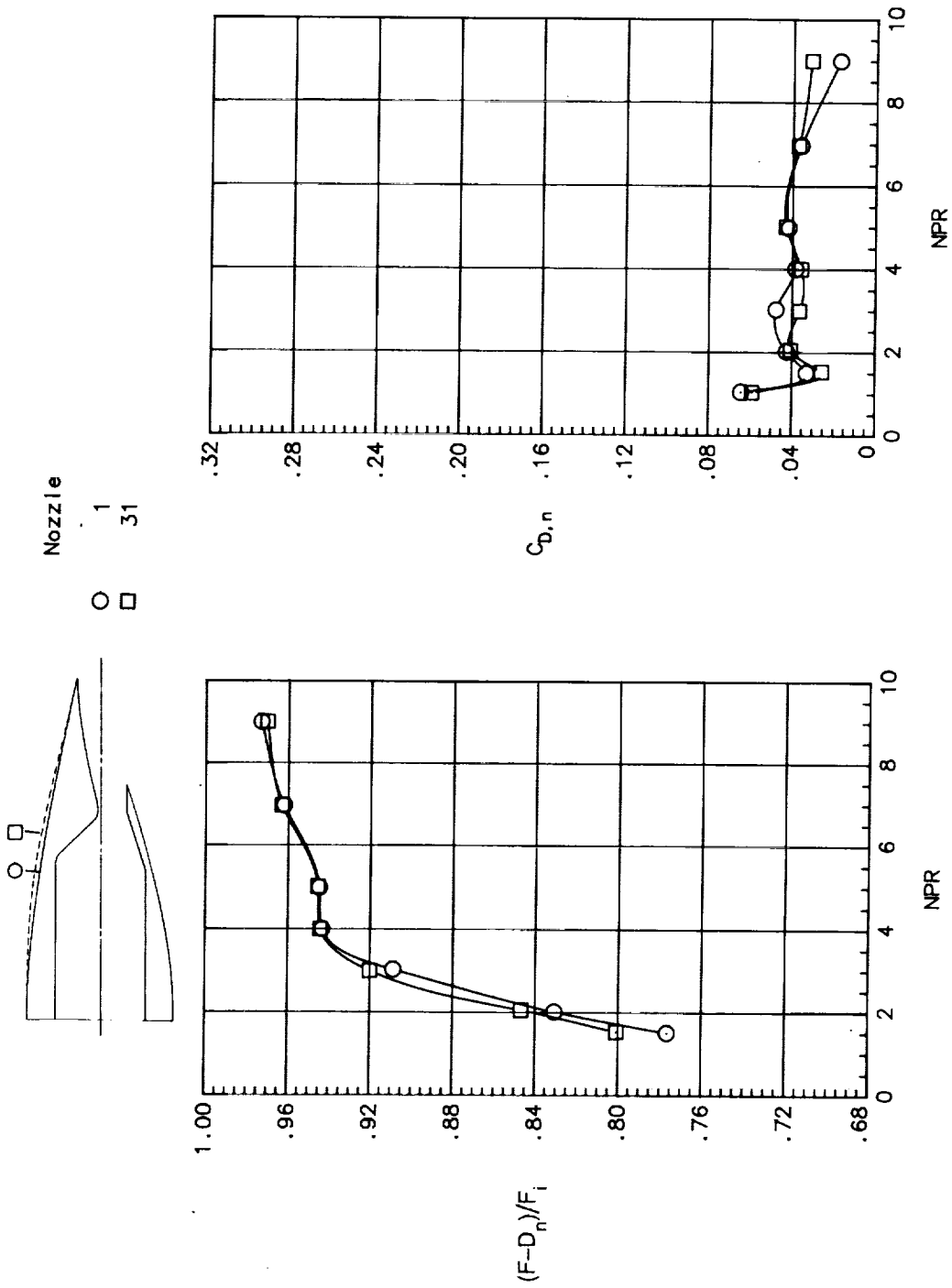
Figure 30. Continued.





(c)  $M = 0.80$ .

Figure 30. Continued.



(d)  $M = 0.90$ .

Figure 30. Continued.

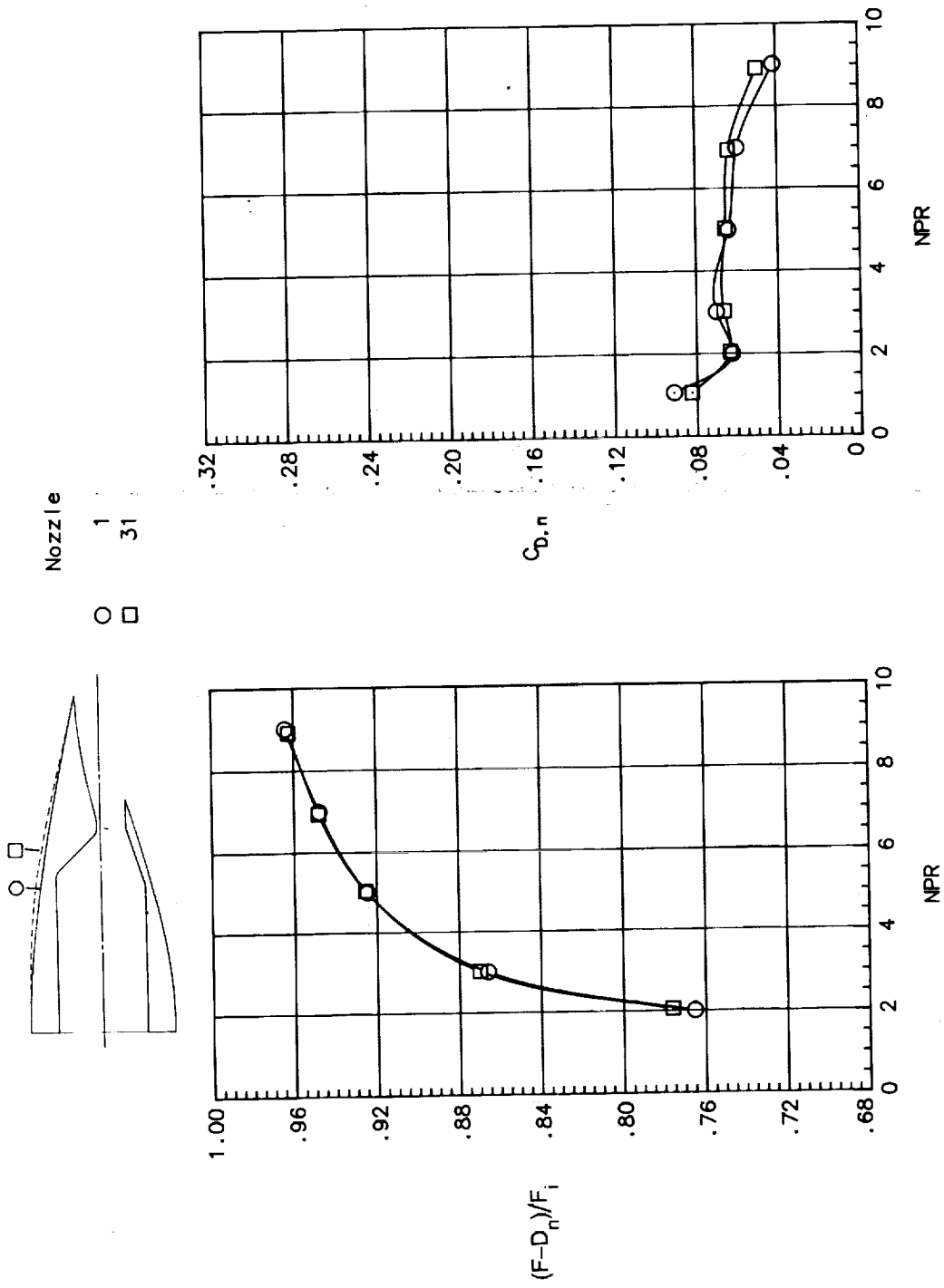
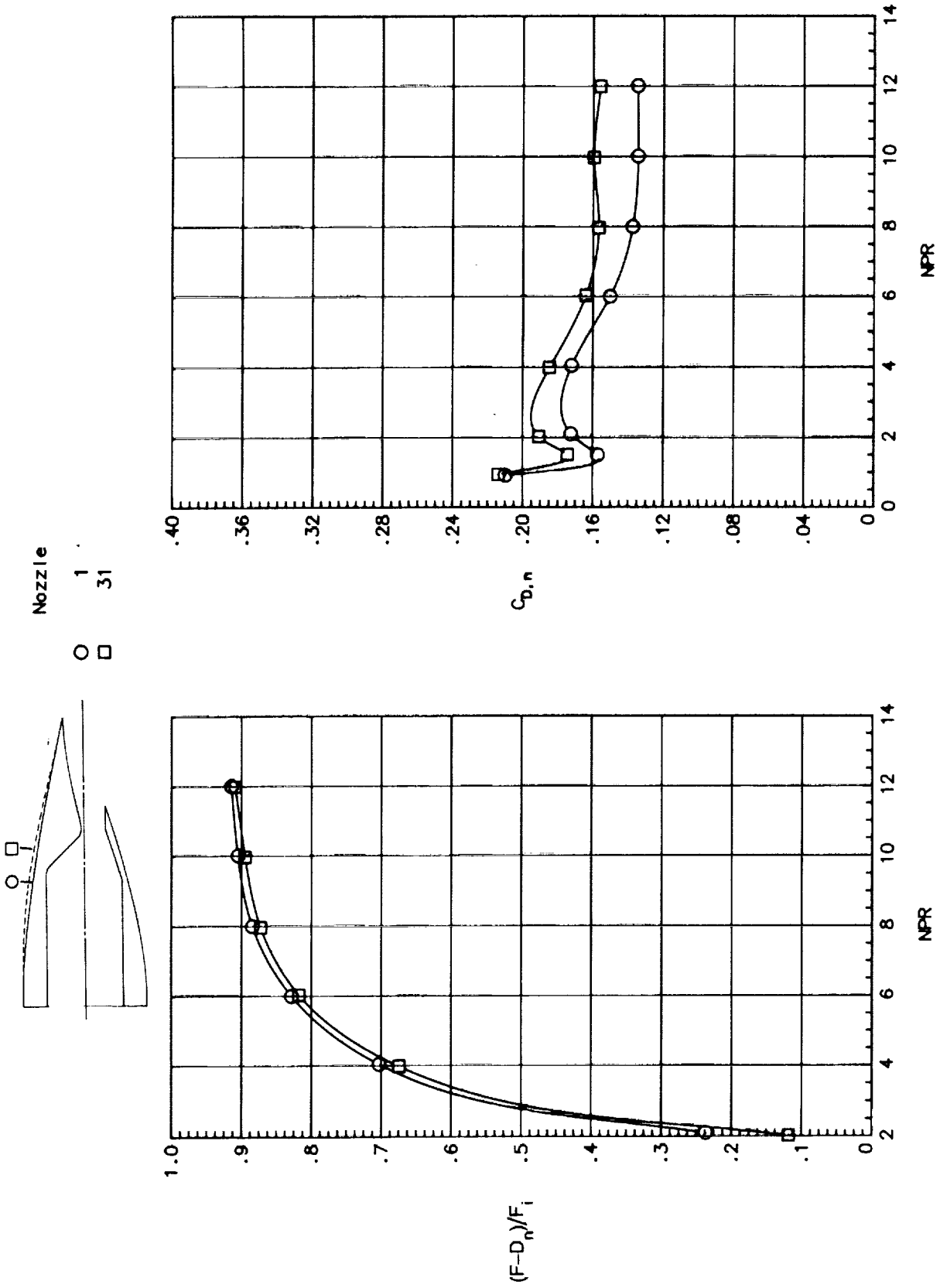


Figure 30. Continued.



(f)  $M = 1.20$ .

Figure 30. Concluded.

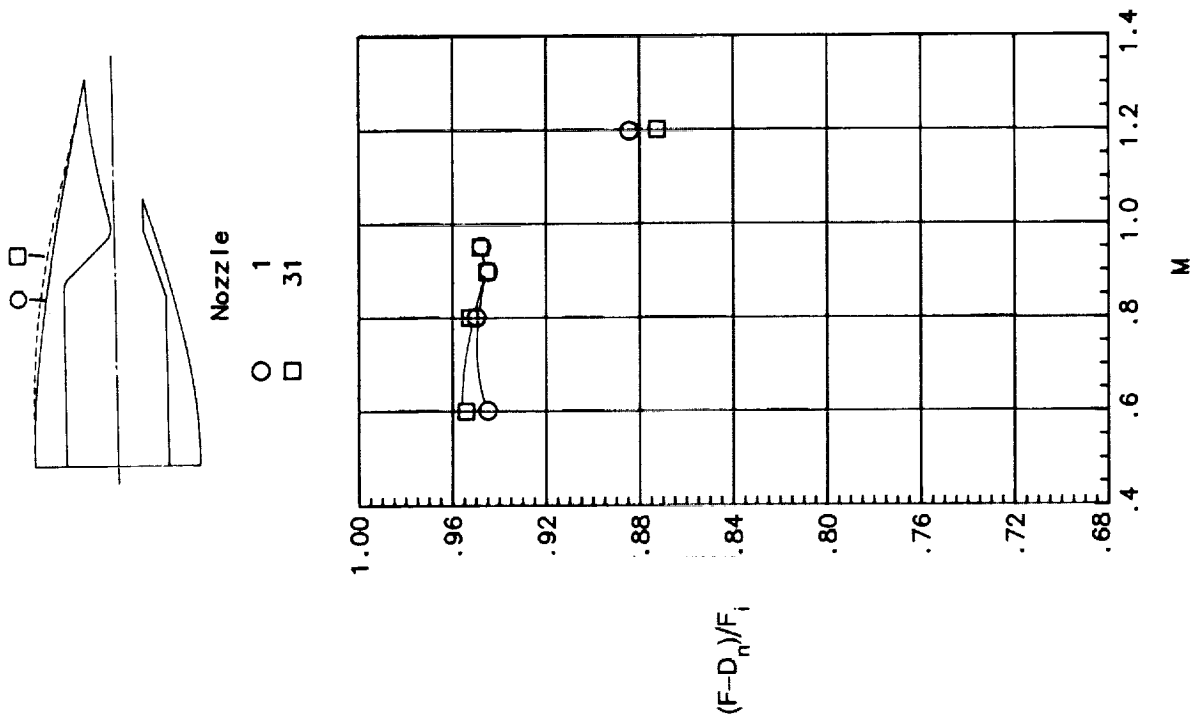
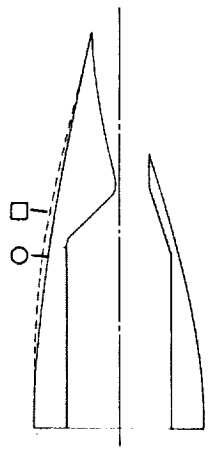


Figure 31. Effect of varying upper ramp external shape on aerodynamic performance at scheduled NPR.  
 $l_r/h_{t,n} = 4.50; \theta_r = 8.75^\circ; \beta_r = 8.15^\circ; l_f/h_{t,n} = 0.90; \theta_f = 0^\circ; \beta_f = 11.28^\circ; x_t/h_{t,n} = 7.25;$   
 $y_t/h_{t,n} = 0.12; \alpha = 0^\circ.$



Nozzle -

○ 1  
□ 31

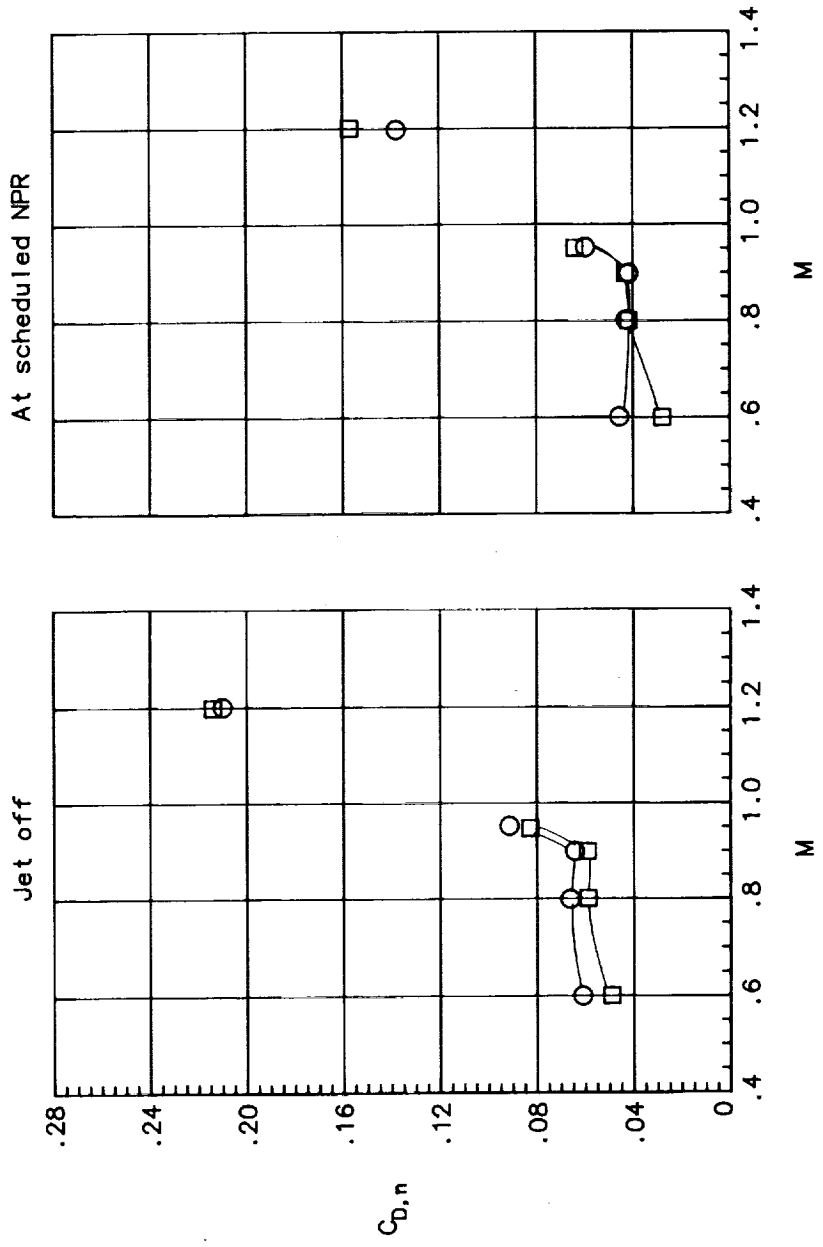
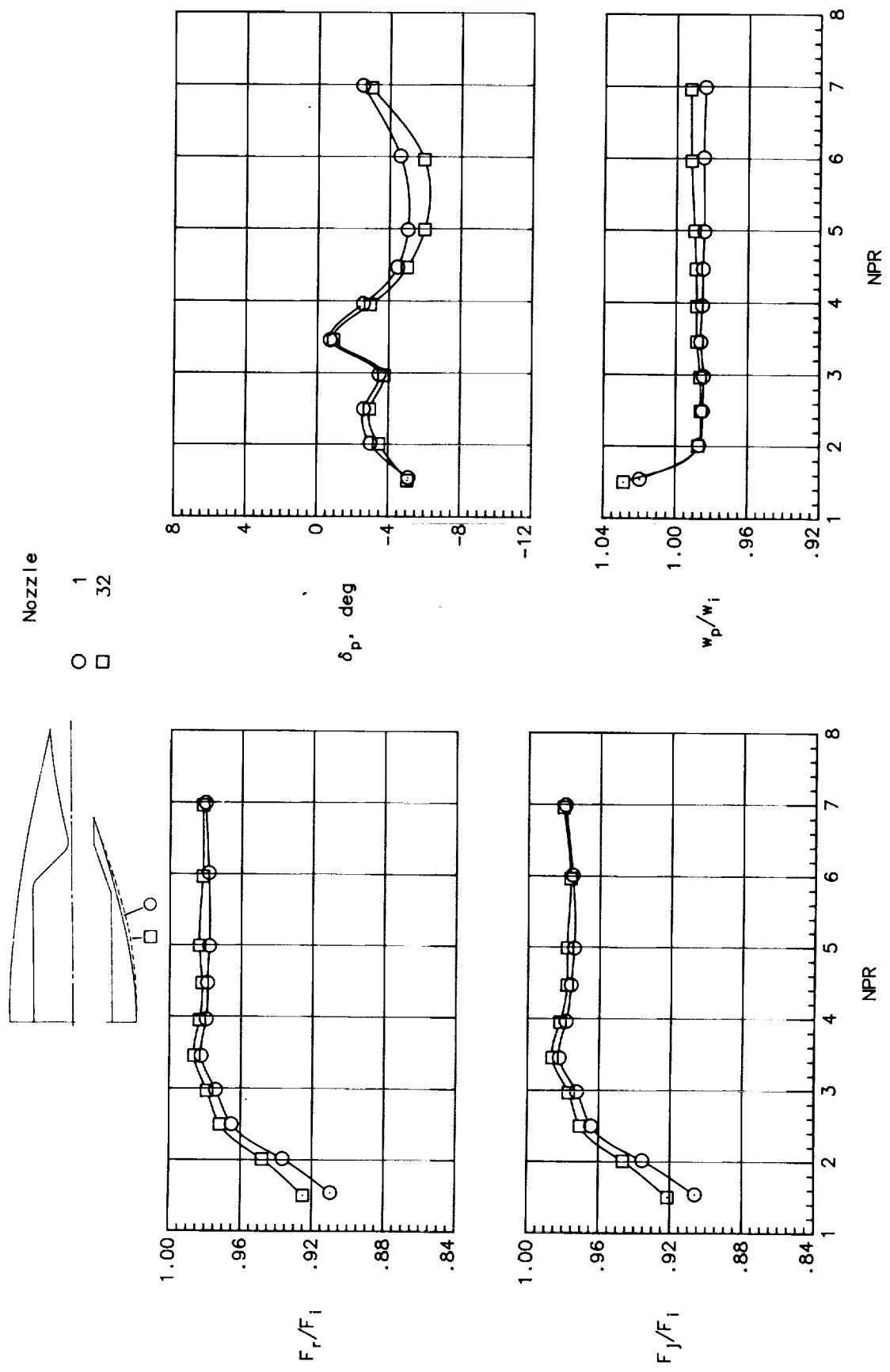
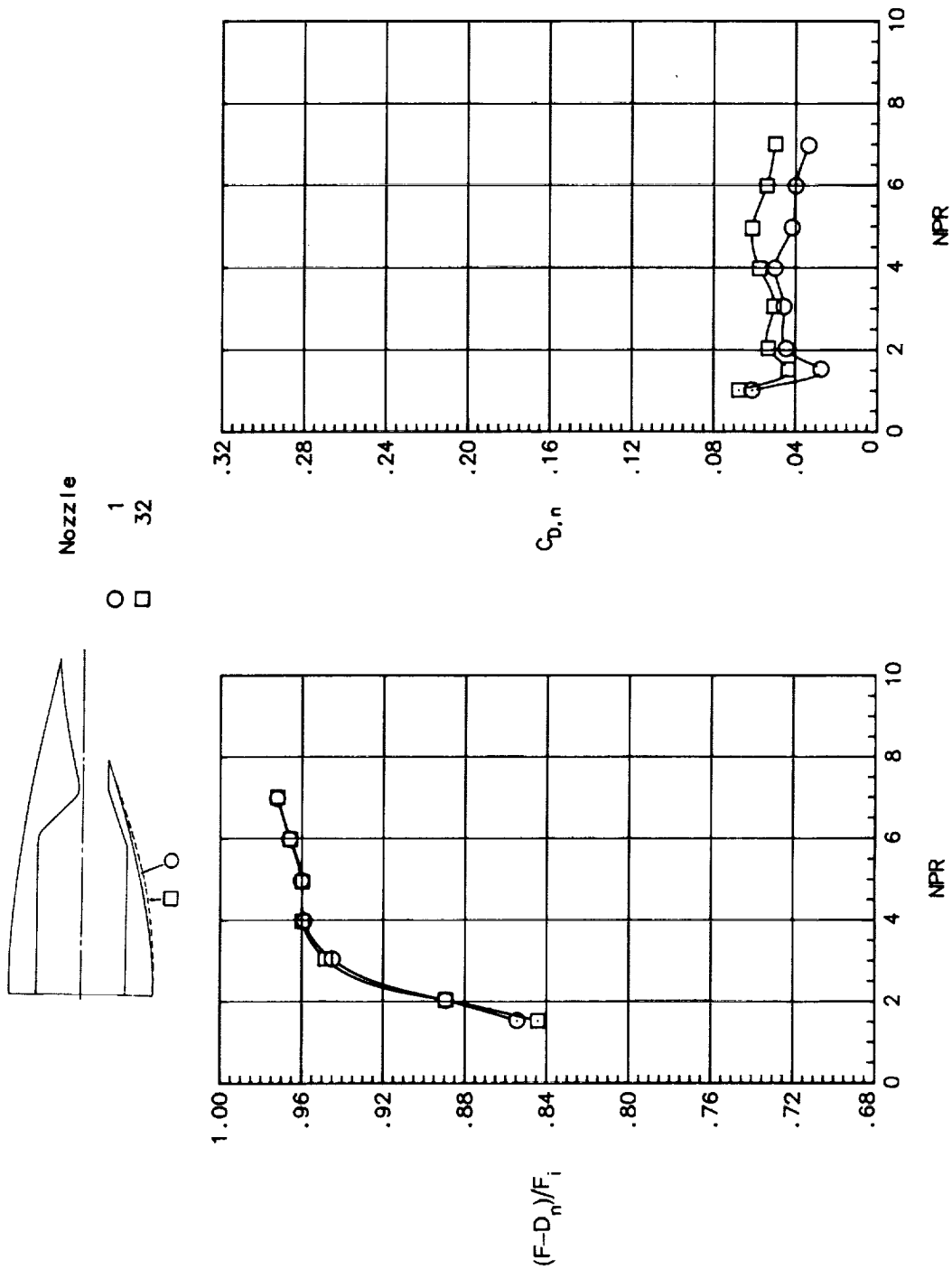


Figure 32. Effect of varying upper ramp external shape on nozzle drag.  $l_r/h_{t,n} = 4.50; \theta_r = 8.75^\circ; \beta_r = 8.15^\circ; l_f/h_{t,n} = 0.90; \theta_f = 0^\circ; \beta_f = 11.28^\circ; x_t/h_{t,n} = 7.25; y_t/h_{t,n} = 0.12; \alpha = 0^\circ$ .



(a)  $M = 0$ .

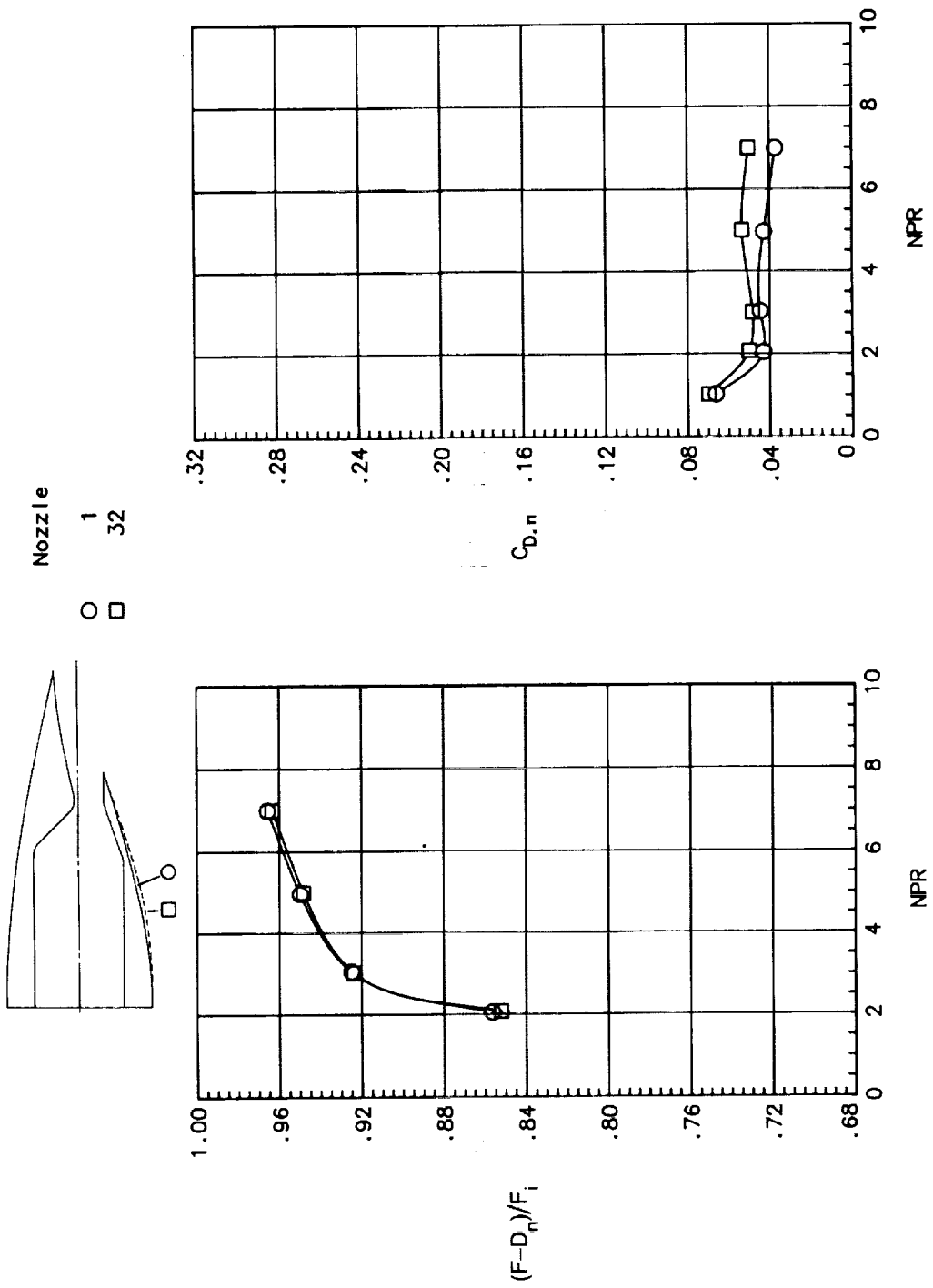
Figure 33. Effect of varying lower flap external shape on aeroperulsive performance.  $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $\beta_r = 8.15^\circ$ ;  $l_f/h_{t,n} = 0.90$ ;  $\theta_f = 0^\circ$ ;  $\beta_f = 11.28^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .



(b)  $M = 0.60$ .

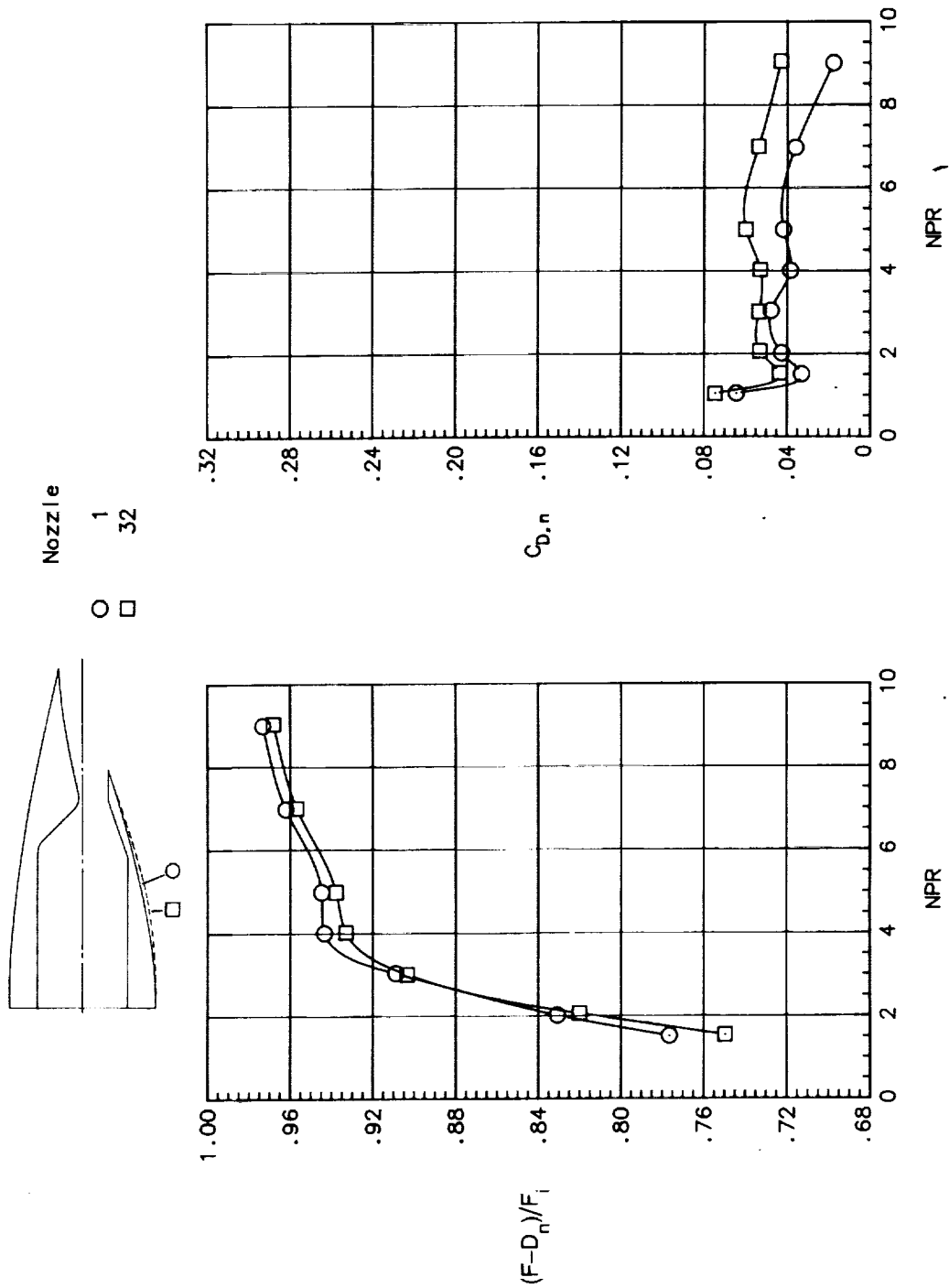
Figure 33. Continued.





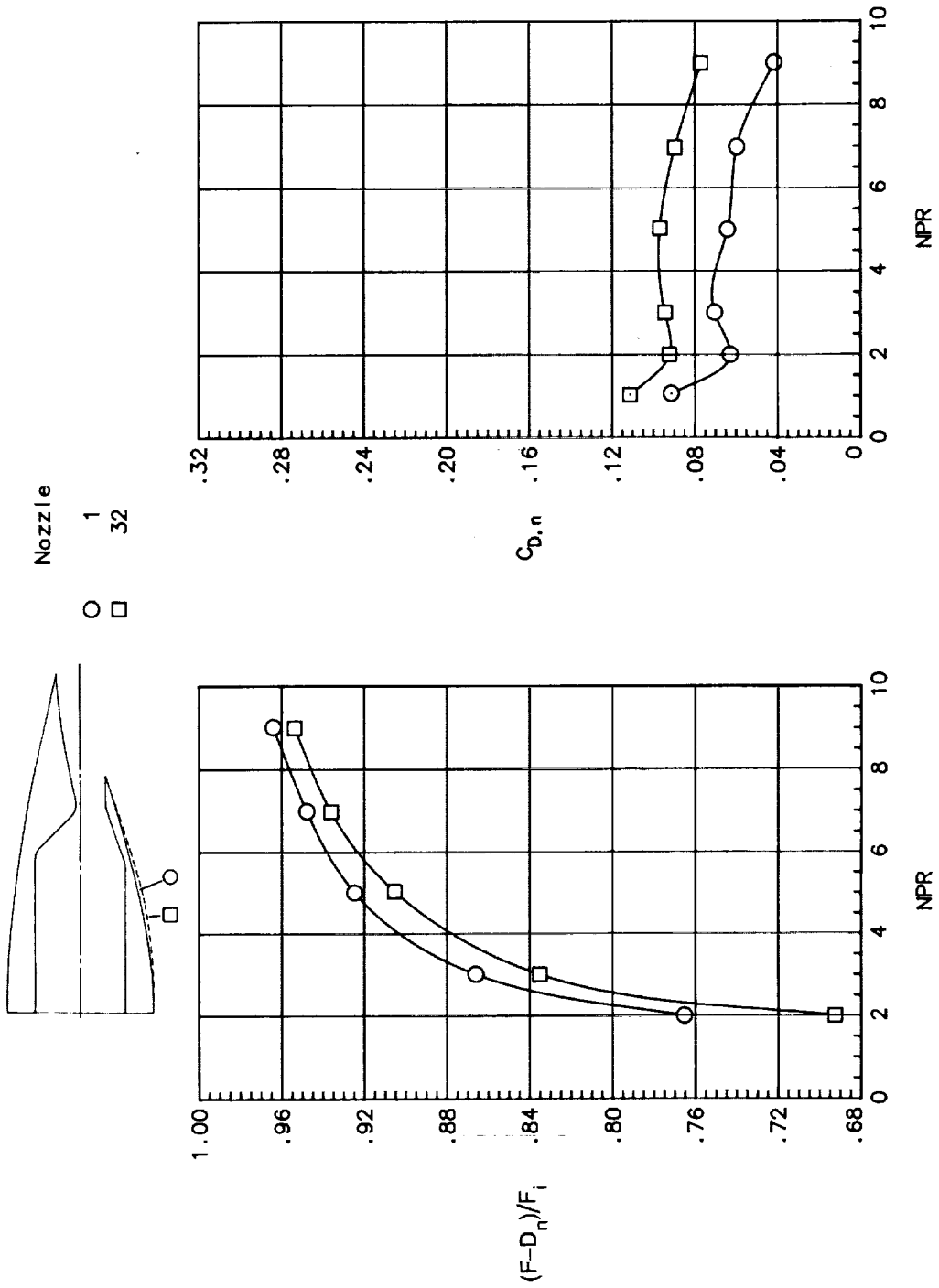
(c)  $M = 0.80$ .

Figure 33. Continued.



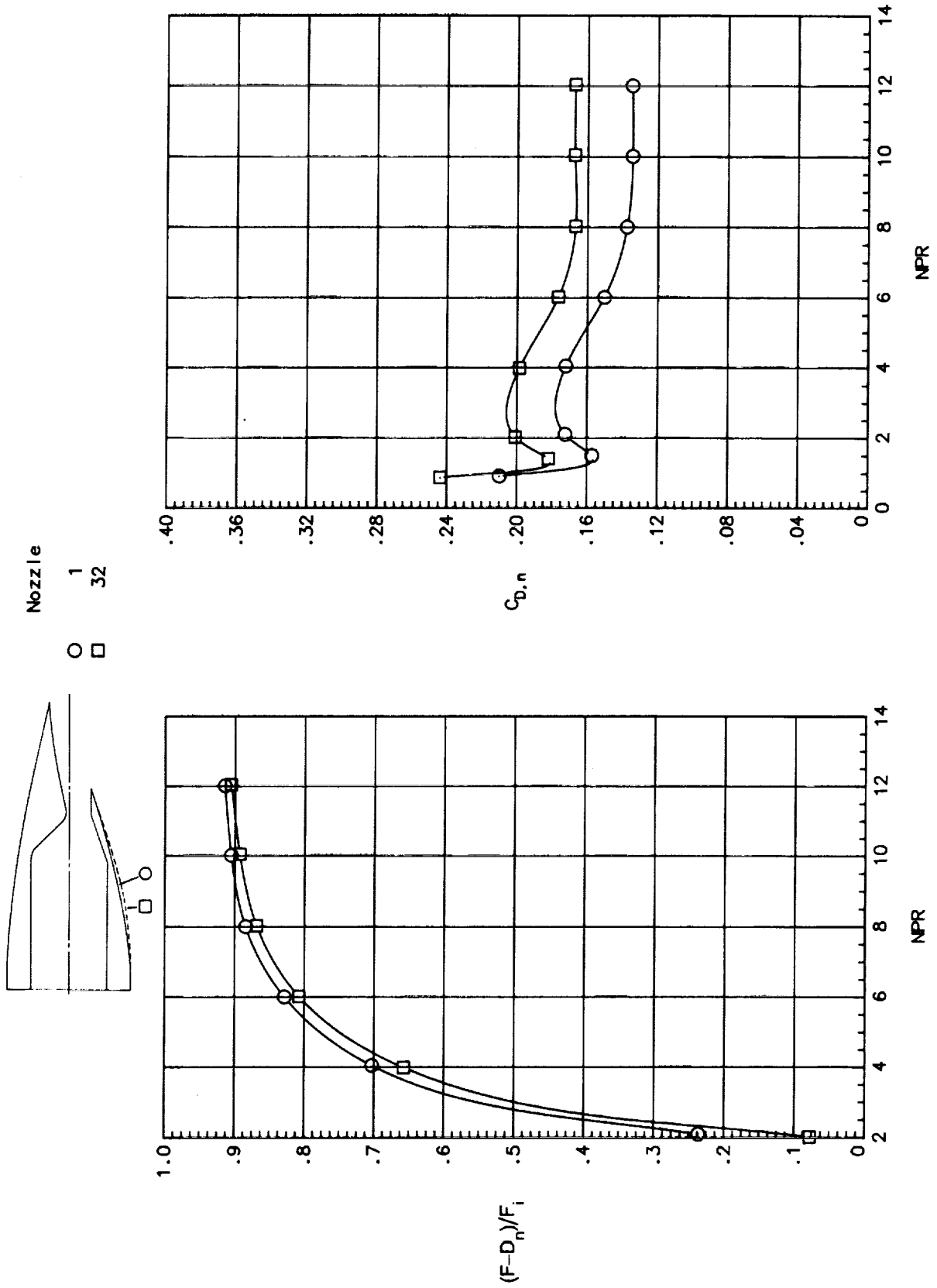
(d)  $M = 0.90$ .

Figure 33. Continued.



(e)  $M = 0.95$ .

Figure 33. Continued.



(f)  $M = 1.20$ .

Figure 33. Concluded.

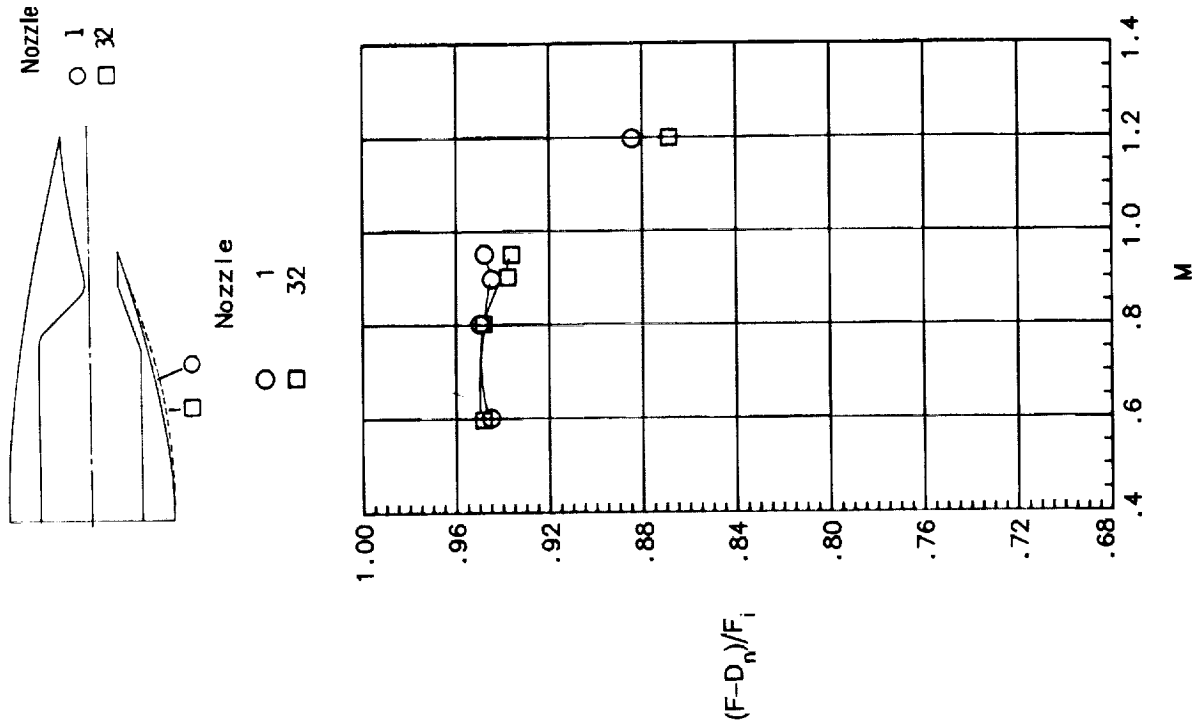


Figure 34. Effect of varying lower flap external shape on aeropropulsive performance at scheduled NPR.  
 $t_r/h_{t,n} = 4.50; \theta_r = 8.75^\circ; \beta_r = 8.15^\circ; t_f/h_{t,n} = 0.90; \theta_f = 0^\circ; \beta_f = 11.28^\circ; x_t/h_{t,n} = 7.25;$   
 $y_t/h_{t,n} = 0.12; \alpha = 0^\circ.$

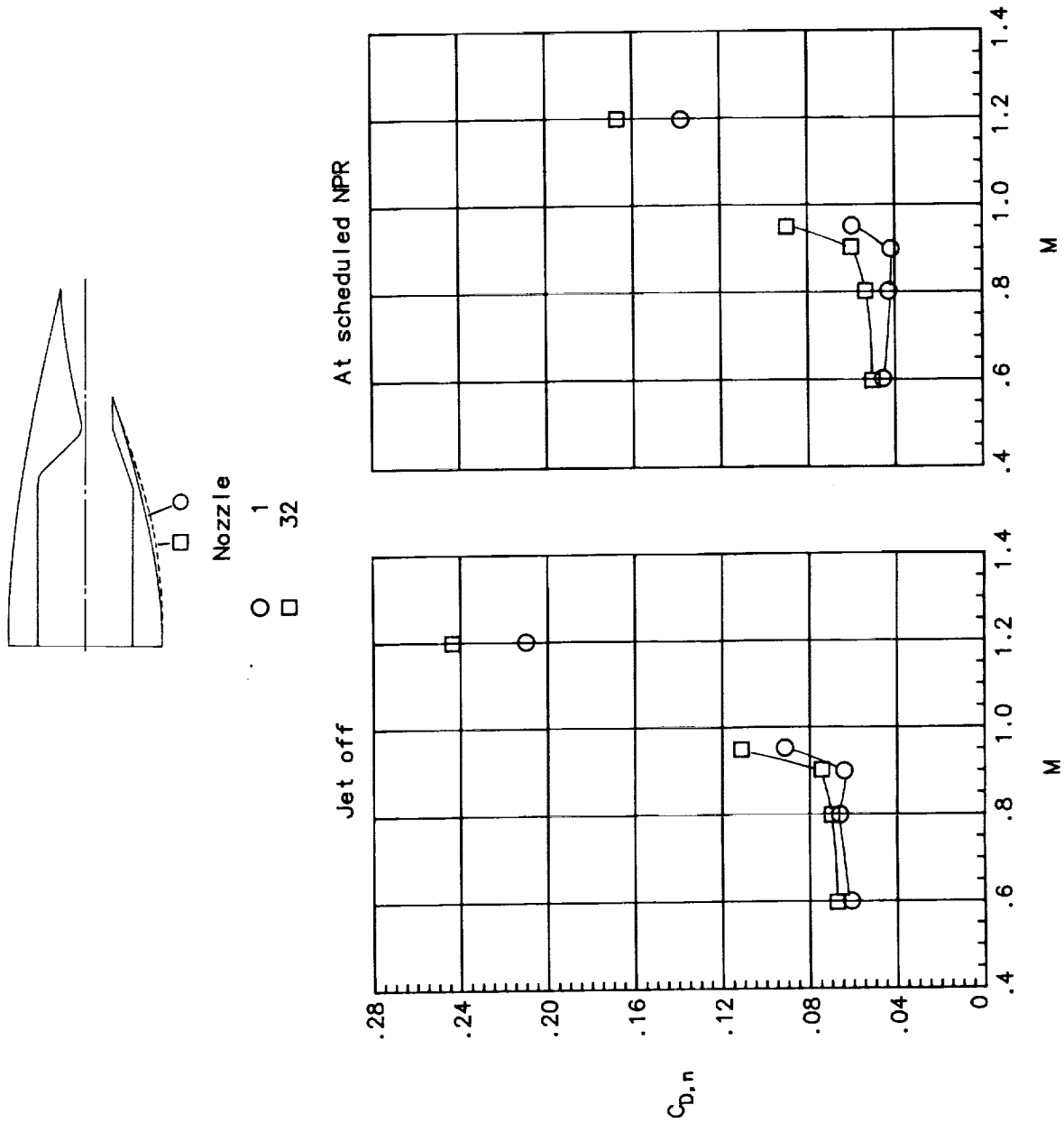
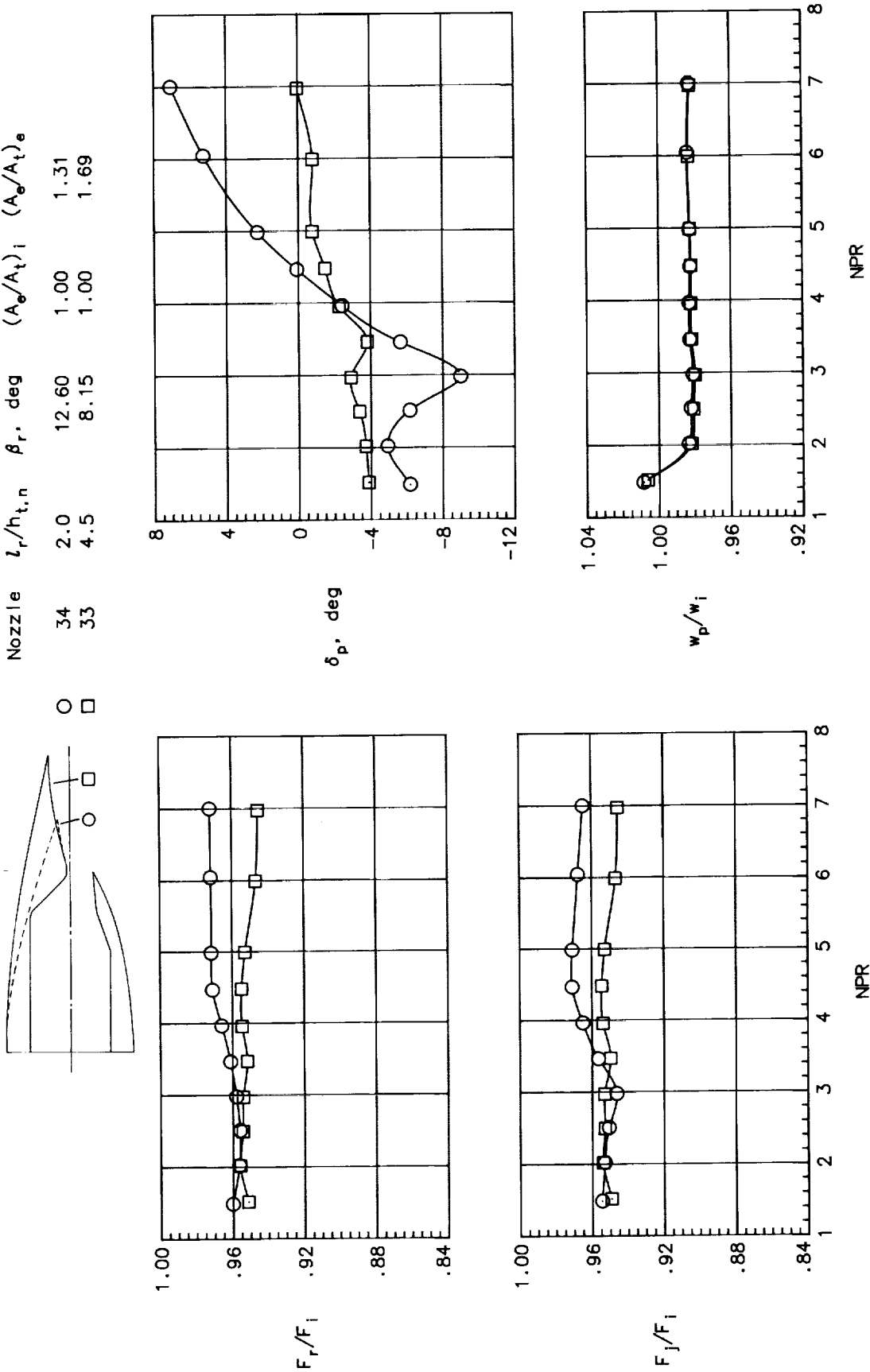
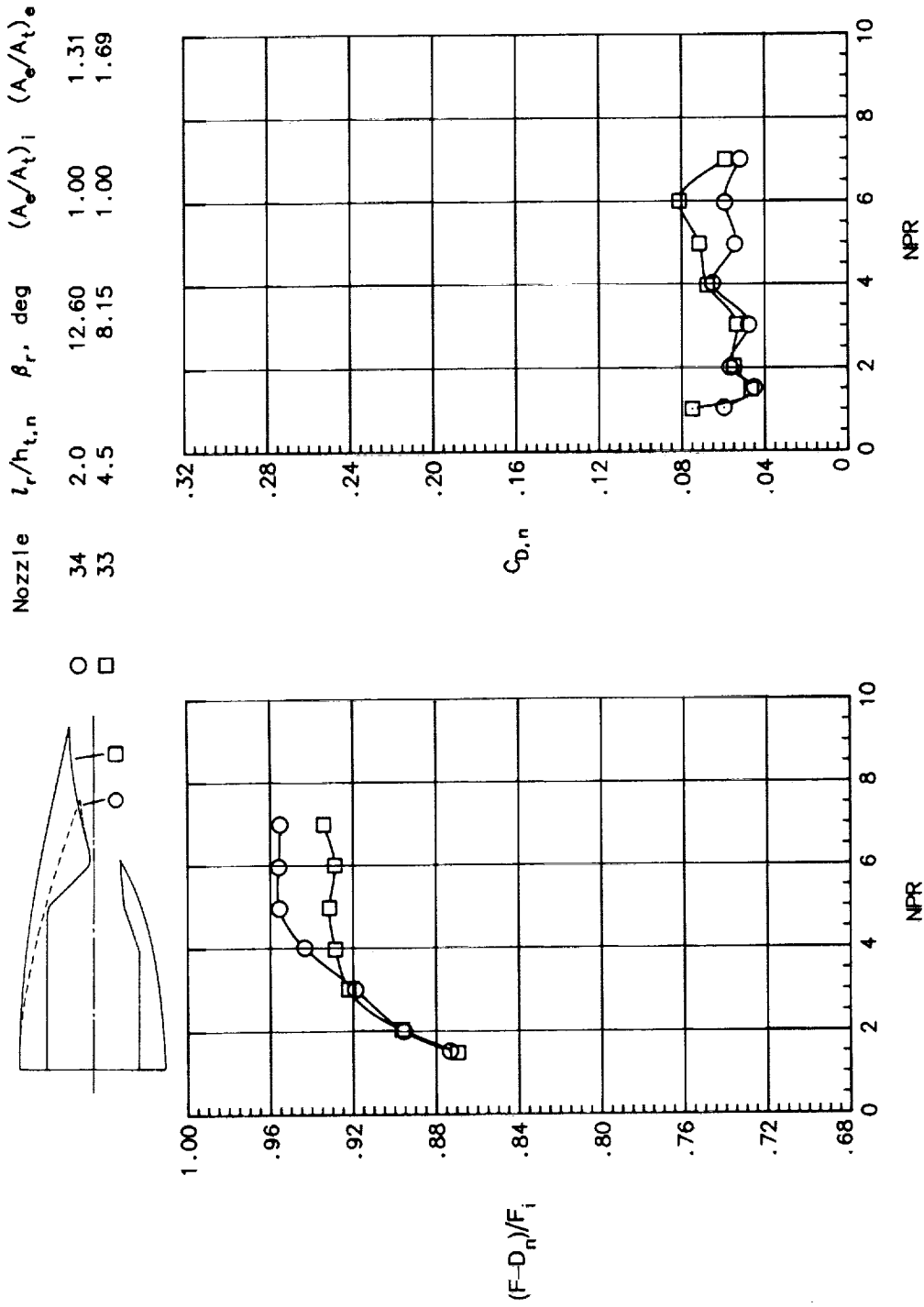


Figure 35. Effect of varying lower flap external shape on nozzle drag.  $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $\beta_r = 8.15^\circ$ ;  $l_f/h_{t,n} = 0.90$ ;  $\theta_f = 0^\circ$ ;  $\beta_f = 11.28^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .



(a)  $M = 0$ .

Figure 36. Effect of upper ramp length of convergent nozzles on aeropropulsive performance.  
 $\theta_r = 8.75^\circ$ ;  $l_f/h_{t,n} = 0$ ;  $\theta_f = -4^\circ$ ;  $\beta_f = 12.63^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .

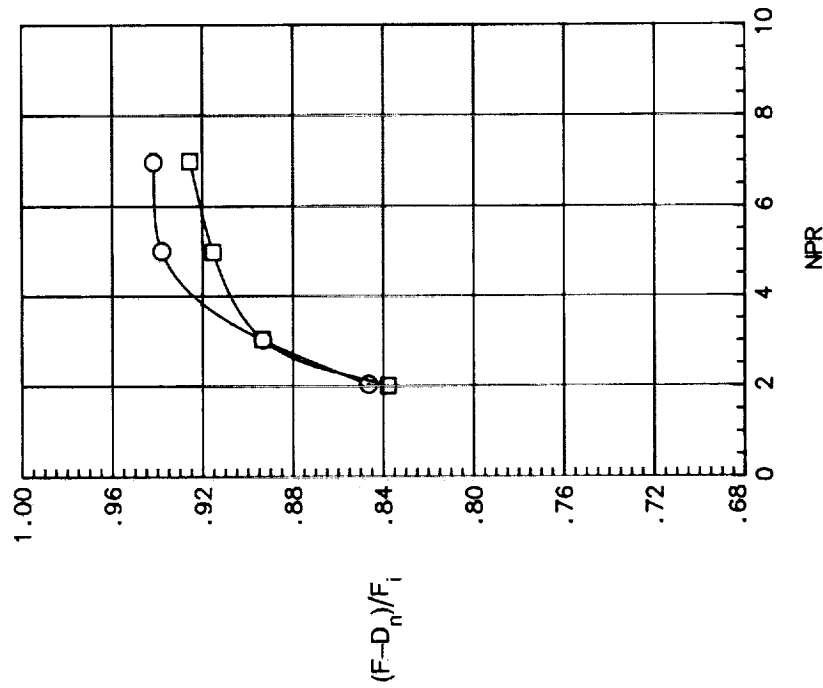
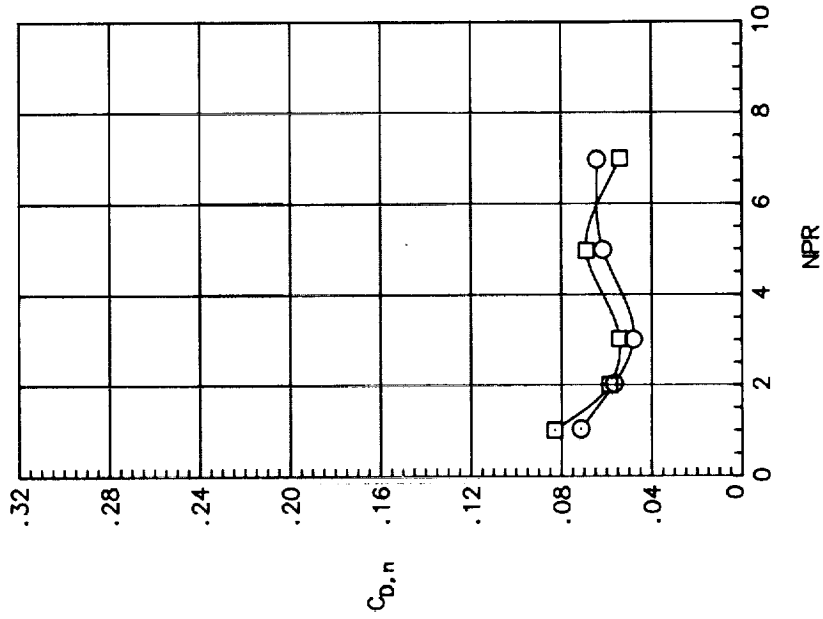
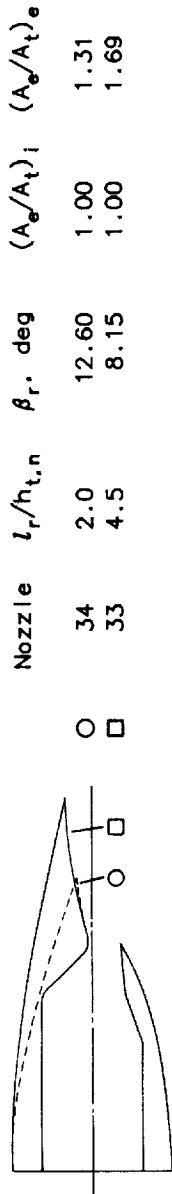


(b)  $M = 0.60$ .

Figure 36. Continued.

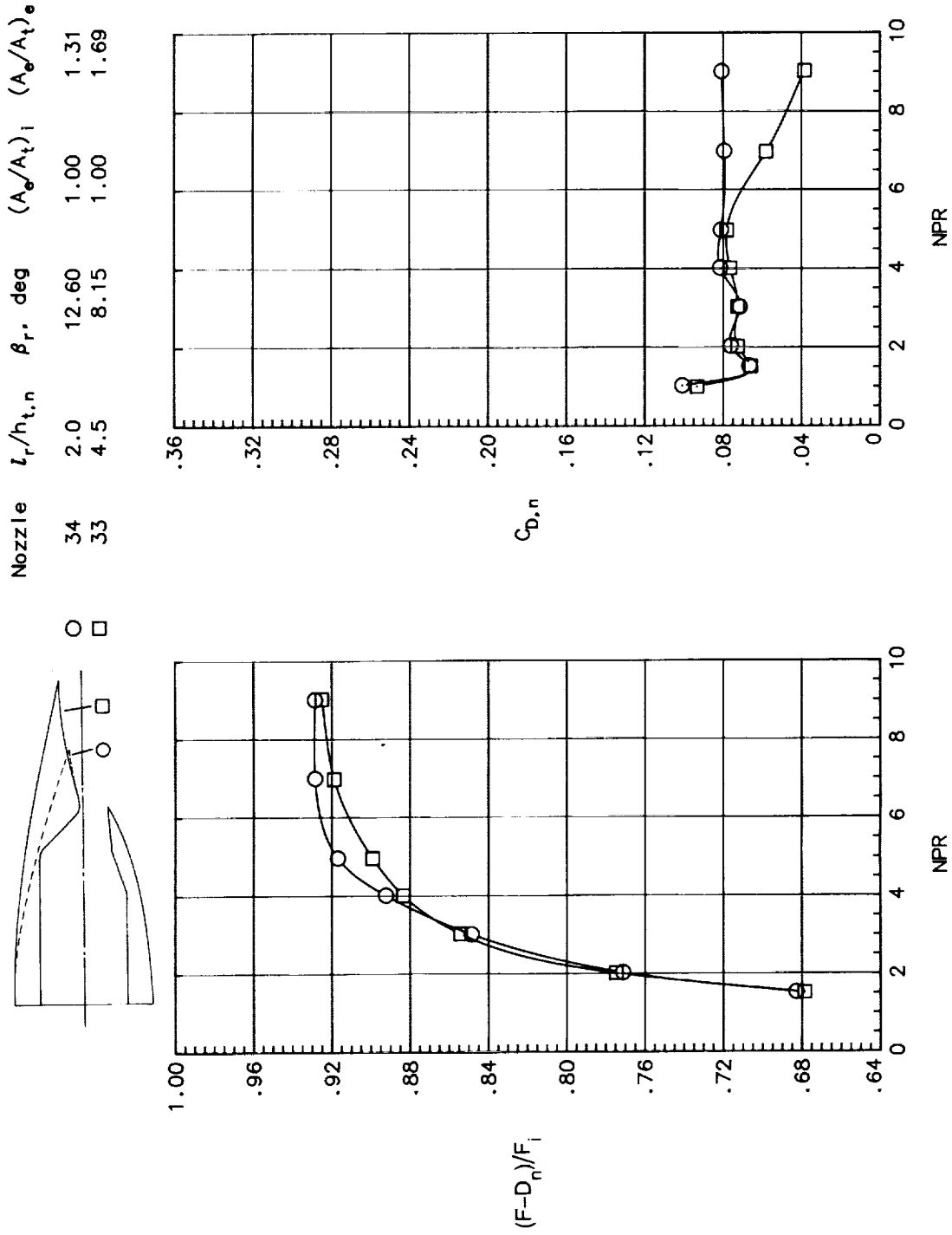
C-2





(c)  $M = 0.80$ .

Figure 36. Continued.



(d)  $M = 0.90$ .

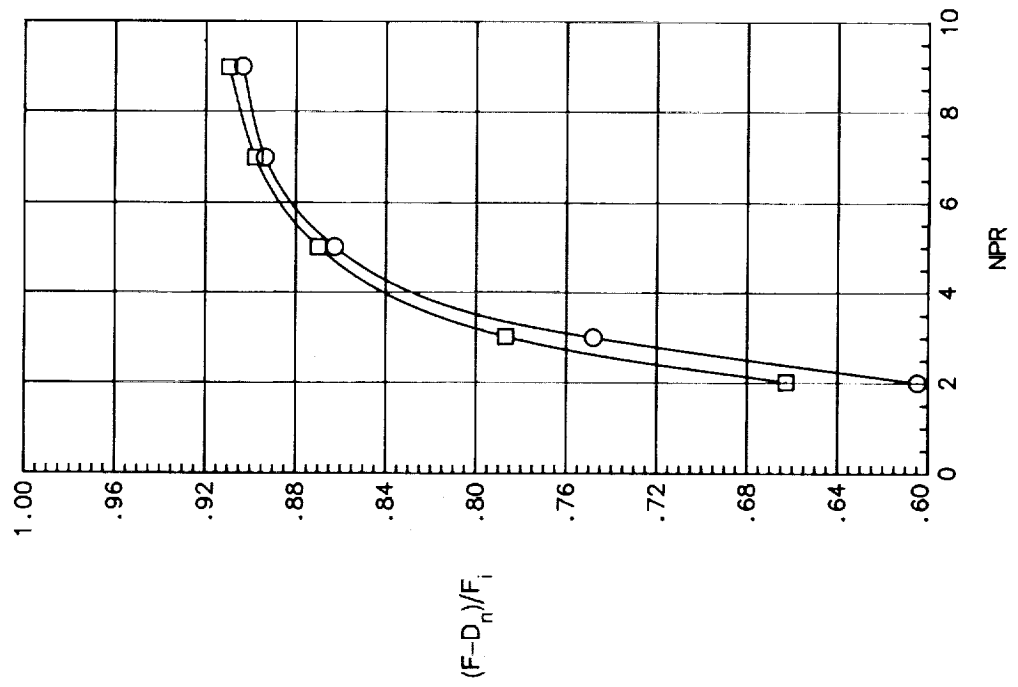
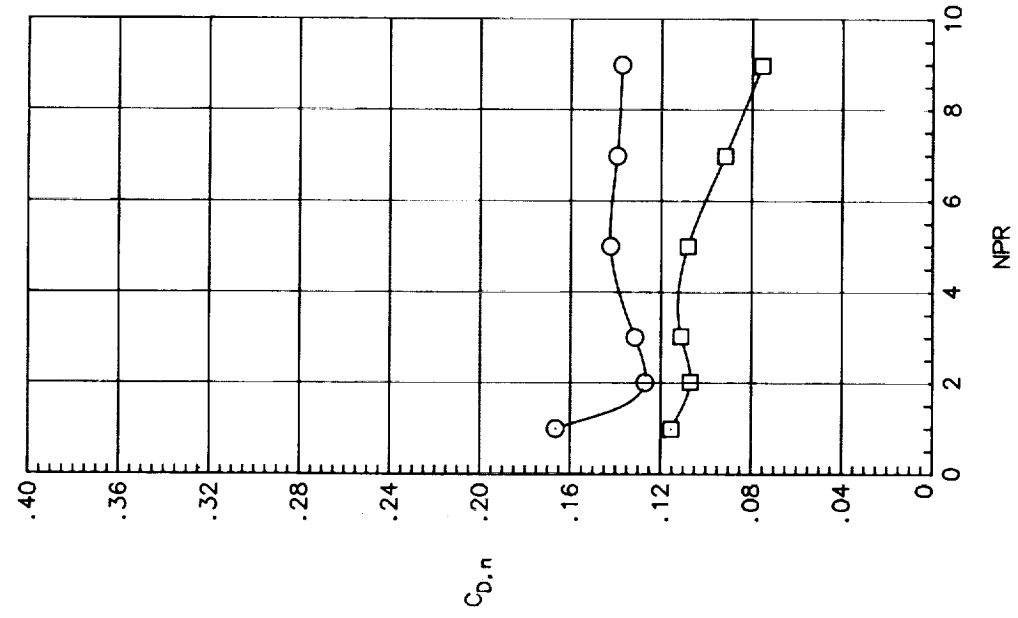
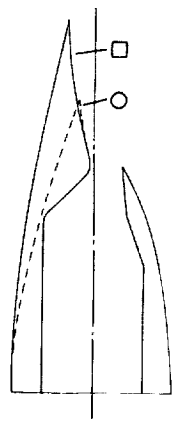
Figure 36. Continued.

Nozzle  $l_r/h_{t,n}$   $\beta_r$ , deg  $(A_e/A_t)_i$   $(A_e/A_t)_e$

34 2.0 12.60 1.00 1.31

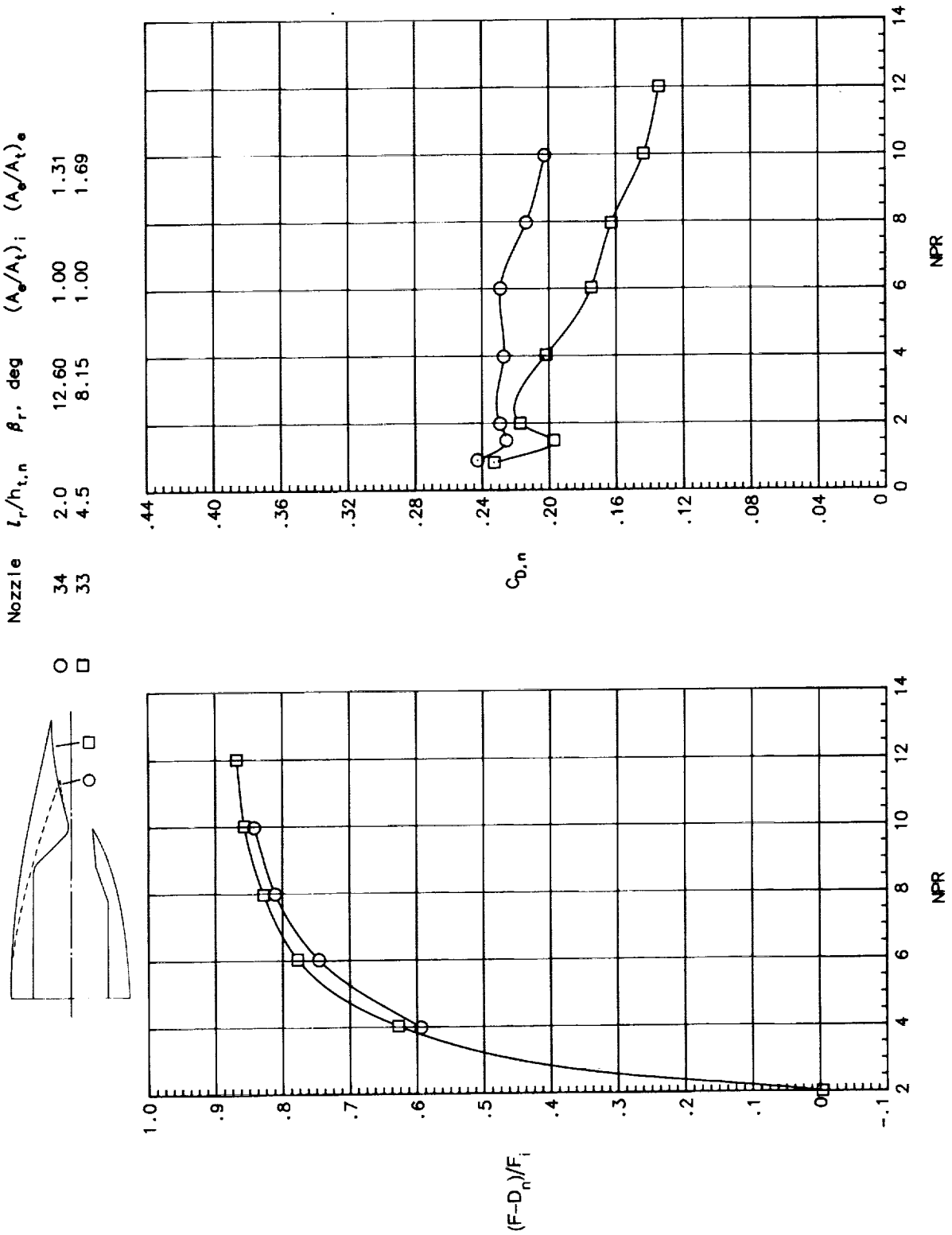
33 4.5 8.15 1.00 1.69

○ □



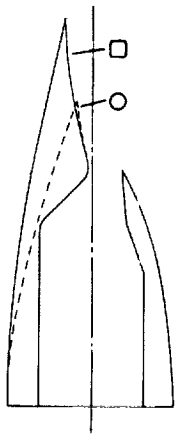
(e)  $M = 0.95$ .

Figure 36. Continued.



(f)  $M = 1.20$ .

Figure 36. Concluded.



Nozzle	$l_r/h_{t,n}$	$\beta_r, \text{deg}$	$(A_0/A_t)_i$	$(A_e/A_t)_e$
34	2.0	12.60	1.00	1.31
33	4.5	8.15	1.00	1.69

○ □

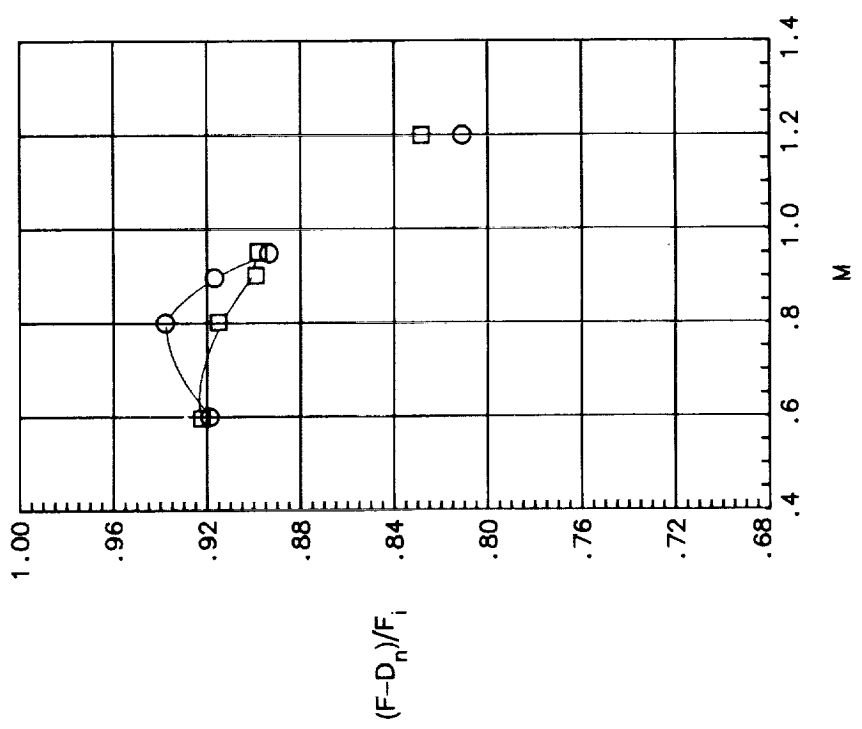
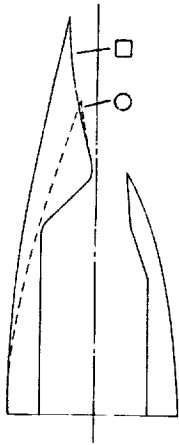


Figure 37. Effect of upper ramp length of convergent nozzles on aerodynamic performance at scheduled NPR.  $\theta_r = 8.75^\circ; l_f/h_{t,n} = 0; \theta_f = -4^\circ; \beta_f = 12.63^\circ; x_t/h_{t,n} = 7.25; y_t/h_{t,n} = 0.12; \alpha = 0^\circ$ .



Nozzle	$l_r/h_{t,n}$	$\beta_r$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
○	34	2.0	12.60	1.00
□	33	4.5	8.15	1.00
			1.00	1.69

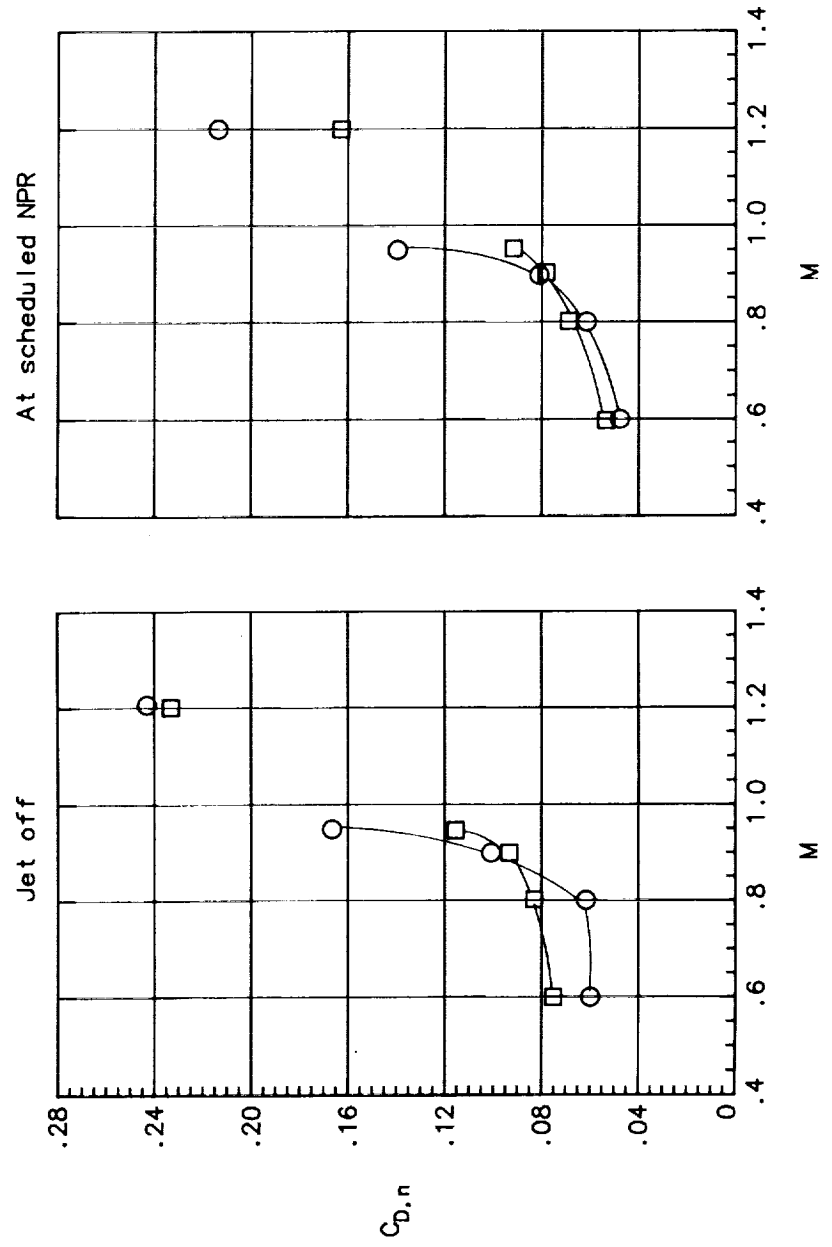
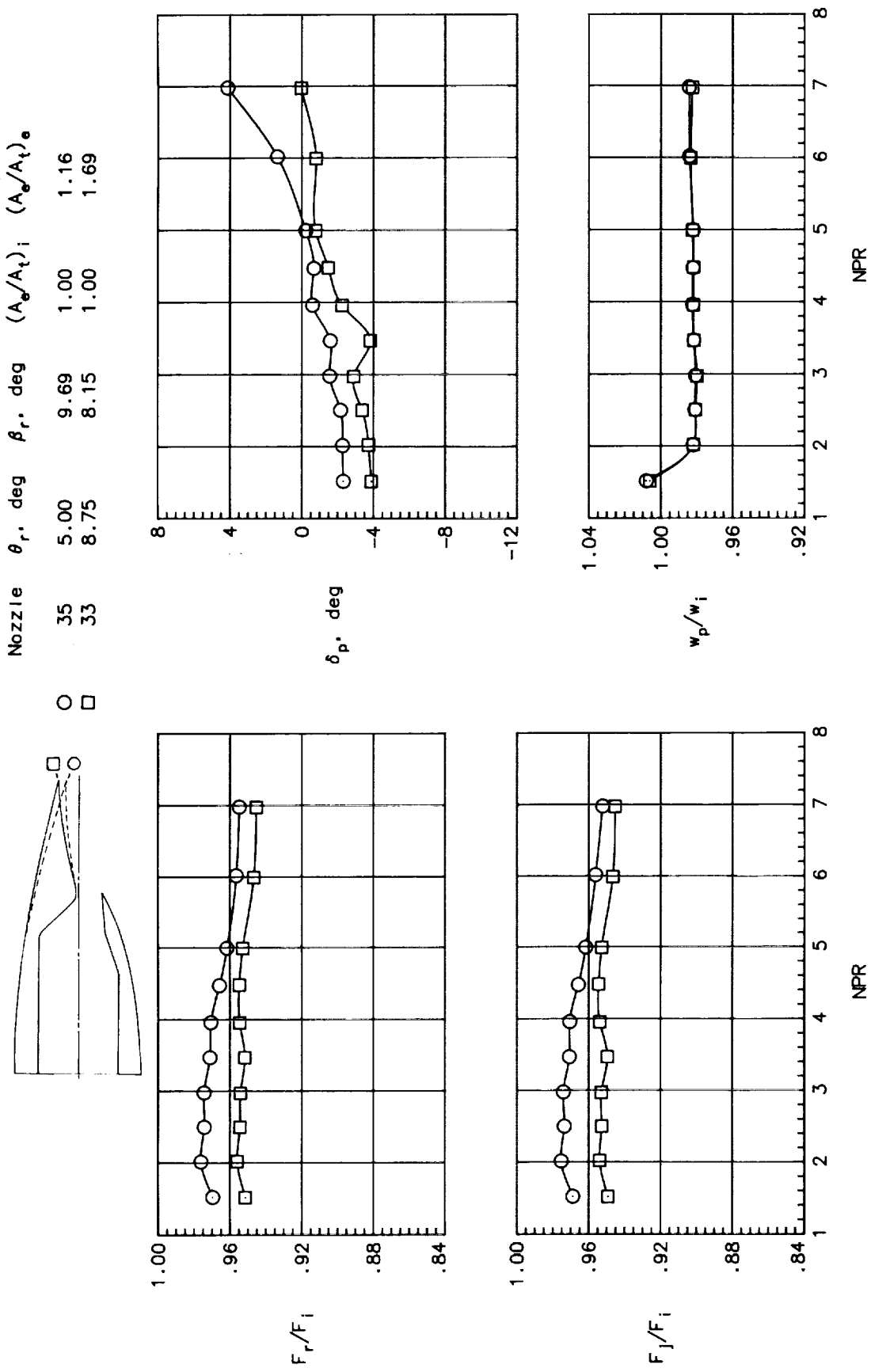
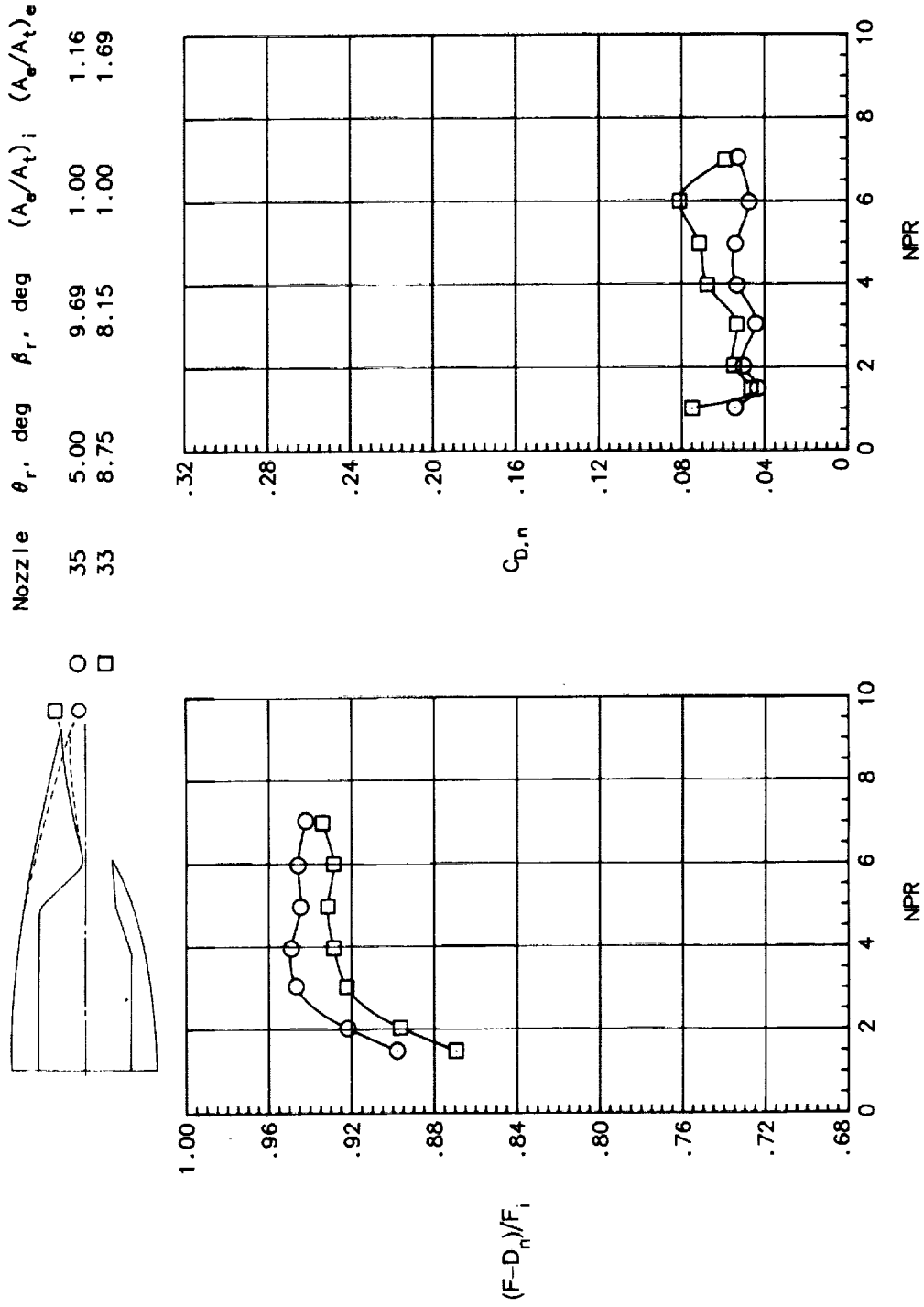


Figure 38. Effect of upper ramp length of convergent nozzles on nozzle drag.  $\theta_r = 8.75^\circ$ ;  $l_f/h_{t,n} = 0$ ;  $\theta_f = -4^\circ$ ;  $\beta_f = 12.63^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .



(a)  $M = 0$ .

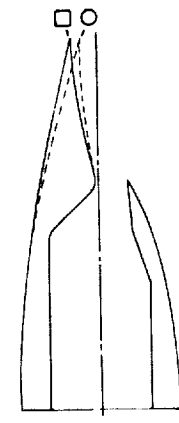
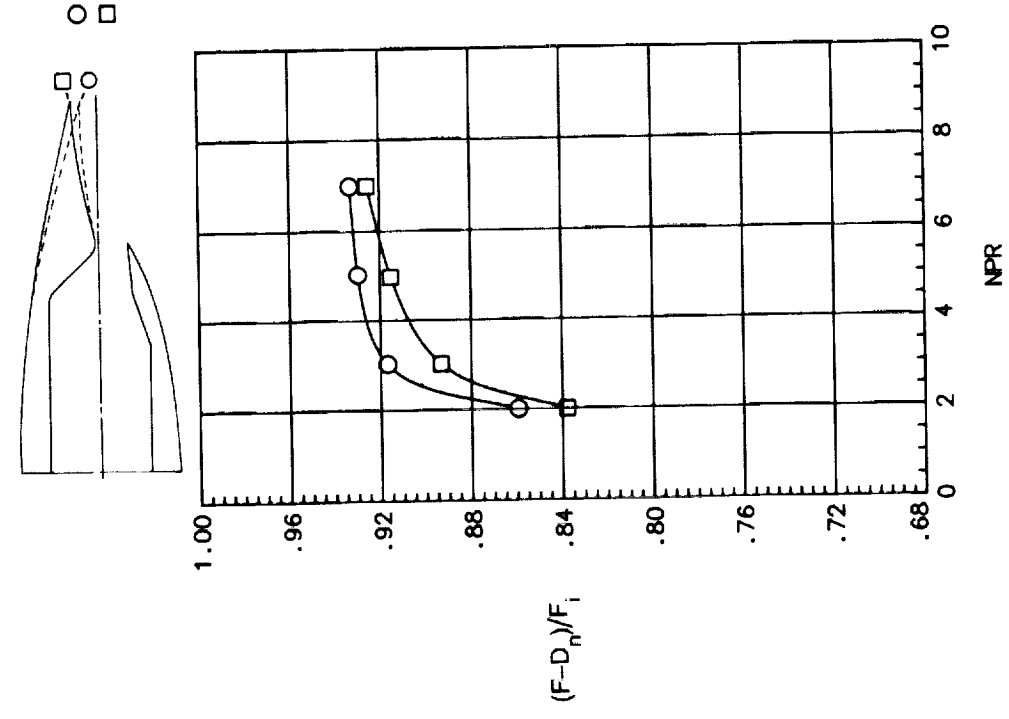
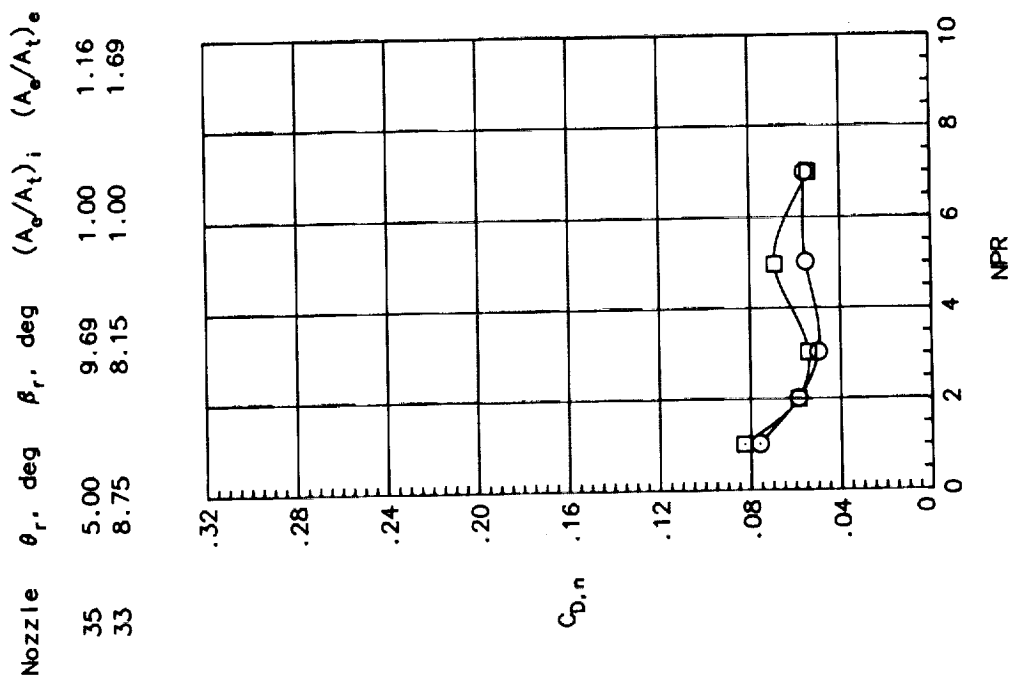
Figure 39. Effect of upper ramp angle of convergent nozzles on aeropulsive performance.  
 $l_r/h_{t,n} = 4.50; l_f/h_{t,n} = 0; \theta_f = -4^\circ; \beta_f = 12.63^\circ; x_t/h_{t,n} = 7.25; y_t/h_{t,n} = 0.12; \alpha = 0^\circ$ .



(b)  $M = 0.60$ .

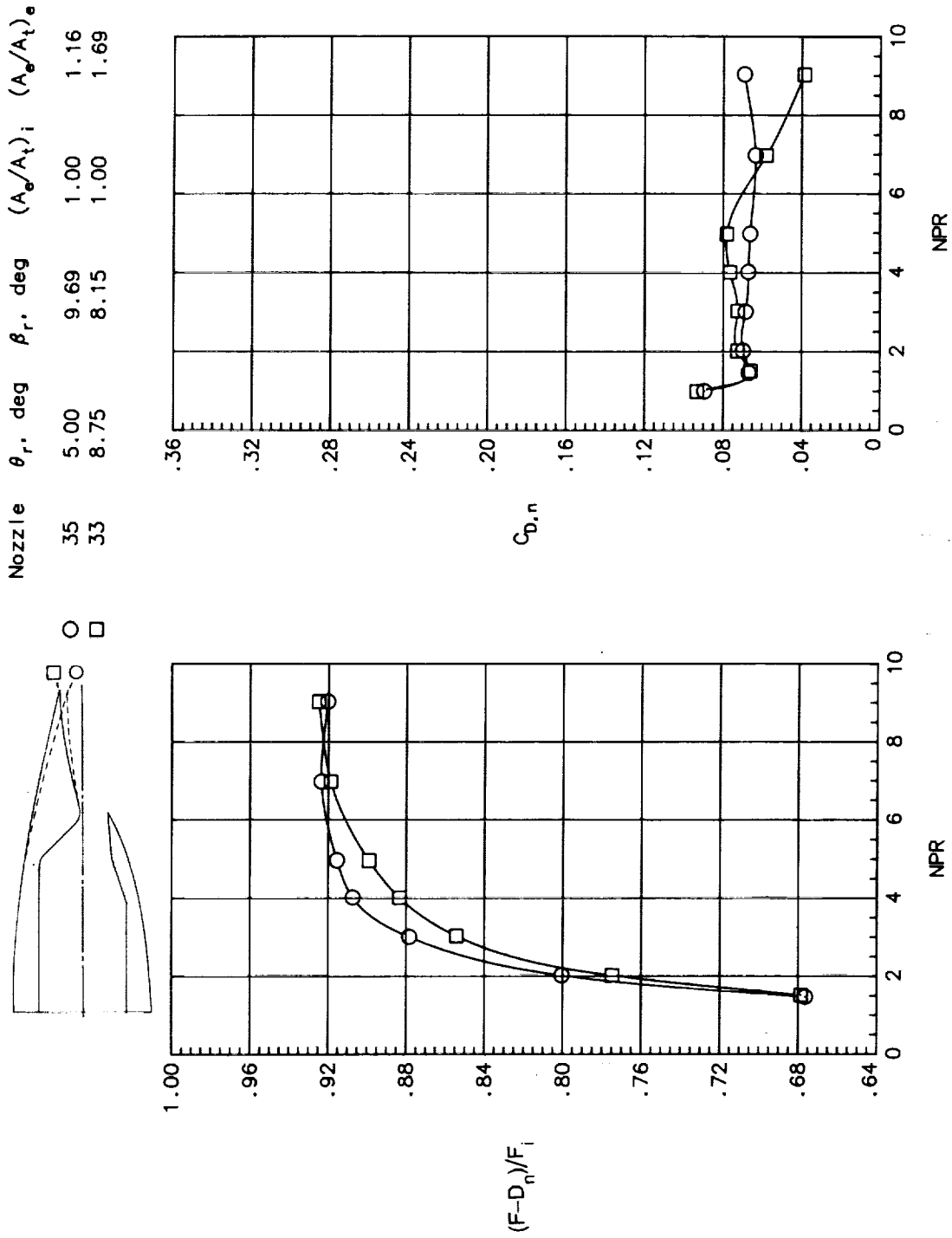
Figure 39. Continued.





(c)  $M = 0.80$ .

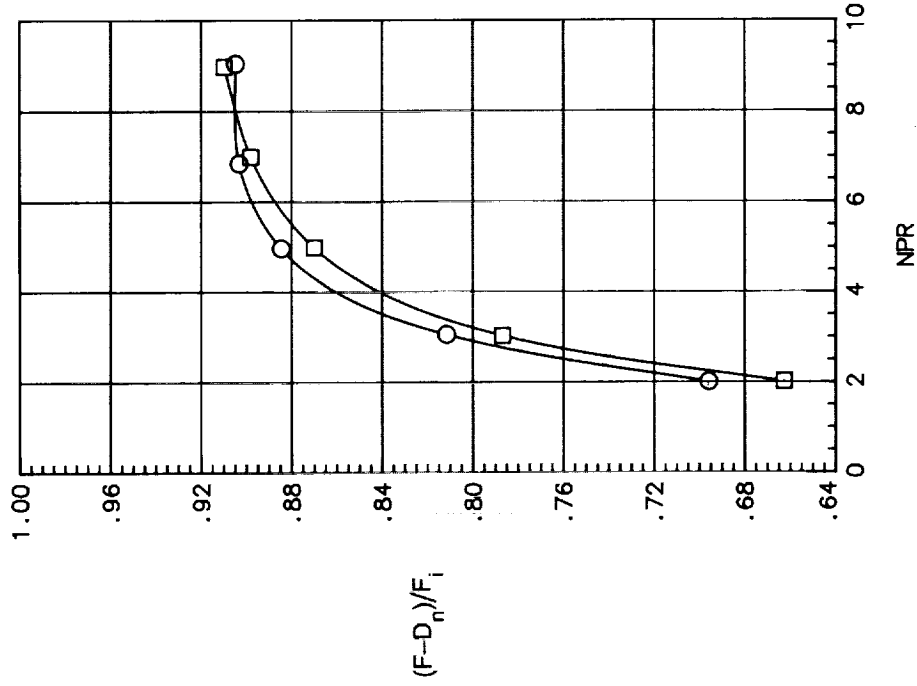
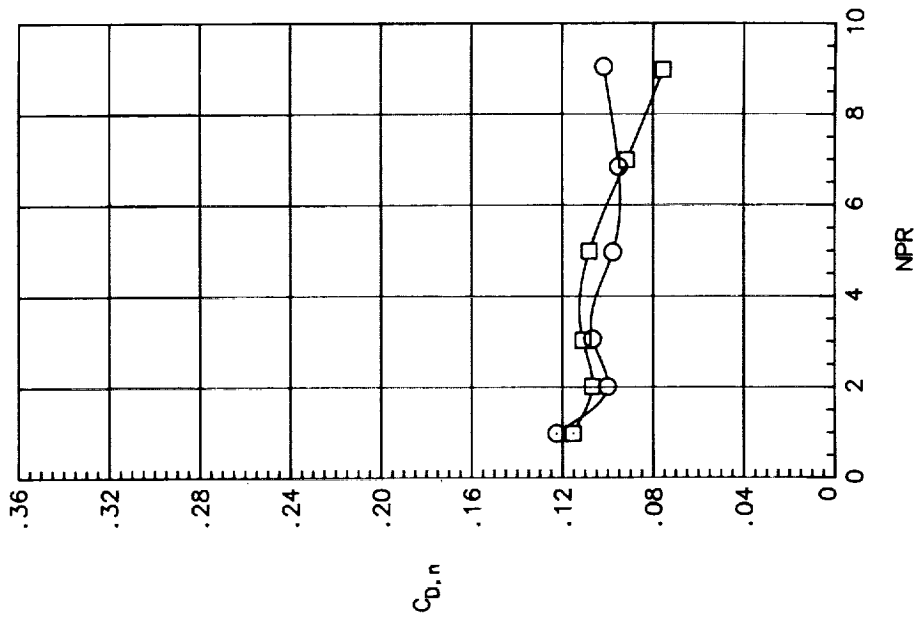
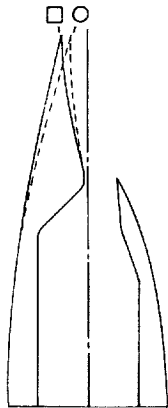
Figure 39. Continued.



(d)  $M = 0.90$ .

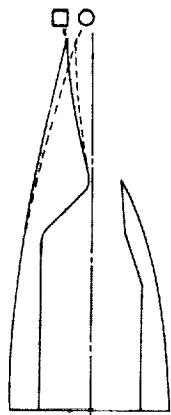
Figure 39. Continued.

Nozzle	$\theta_r$ , deg	$\beta_r$ , deg	$(A_o/A_t)_i$	$(A_o/A_t)_e$
○	35	5.00	1.00	1.16
□	33	8.75	1.00	1.69



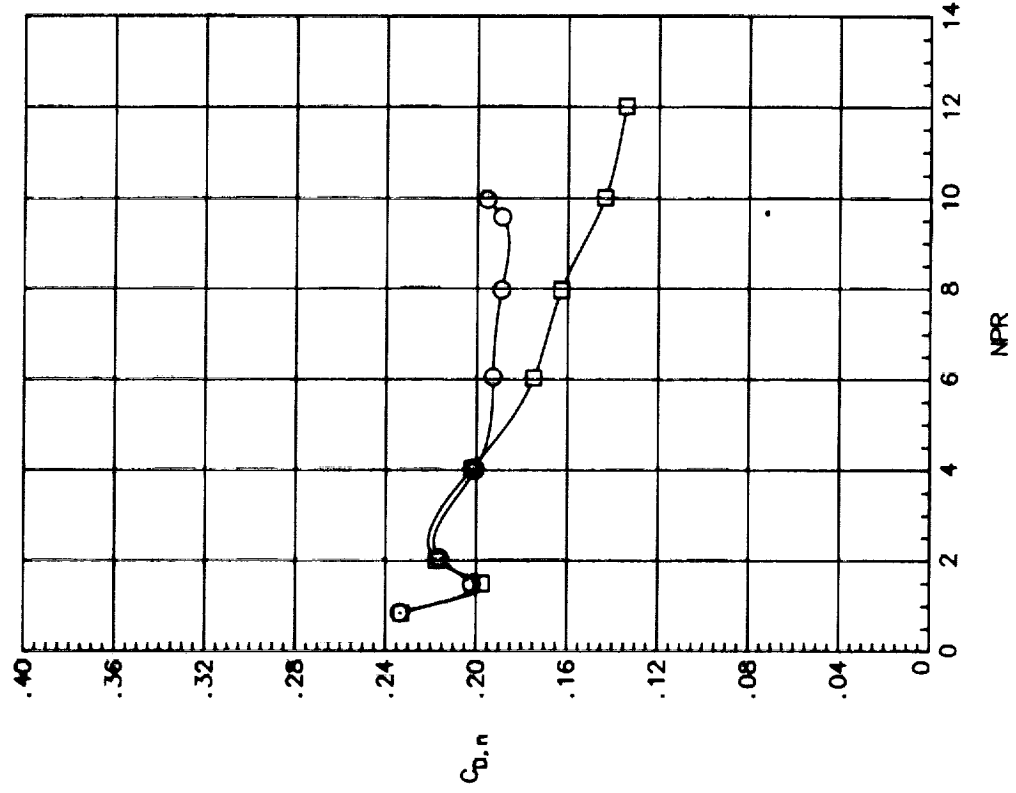
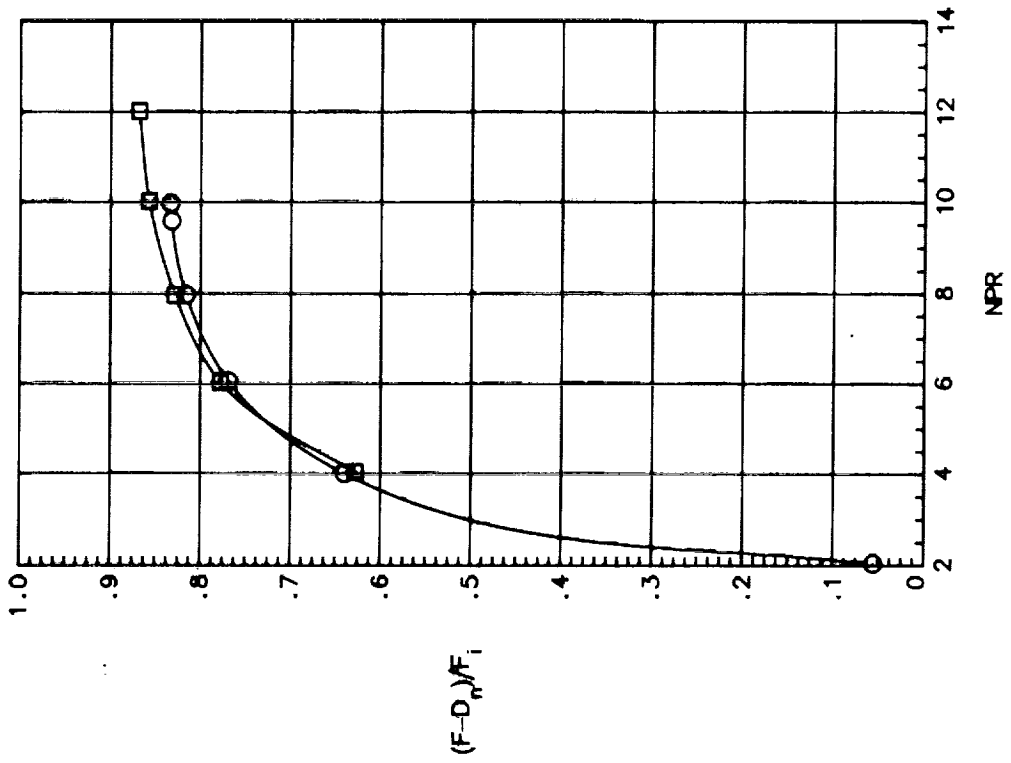
(e)  $M = 0.95$ .

Figure 39. Continued.



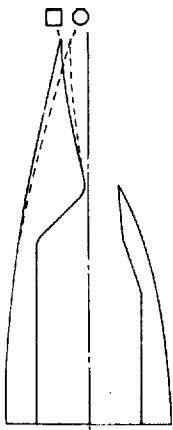
Nozzle	$\theta_r$ , deg	$\beta_r$ , deg	$(A_0/A_1)_i$	$(A_0/A_1)_e$
35	5.00	9.69	1.00	1.16
33	8.75	8.15	1.00	1.69

○ □



(f)  $M = 1.20$ .

Figure 39. Concluded.



Nozzle	$\theta_r$ , deg	$\beta_r$ , deg	$(A_0/A_t)_i$	$(A_0/A_t)_e$
○	5.00	9.69	1.00	1.16
□	8.75	8.15	1.00	1.69

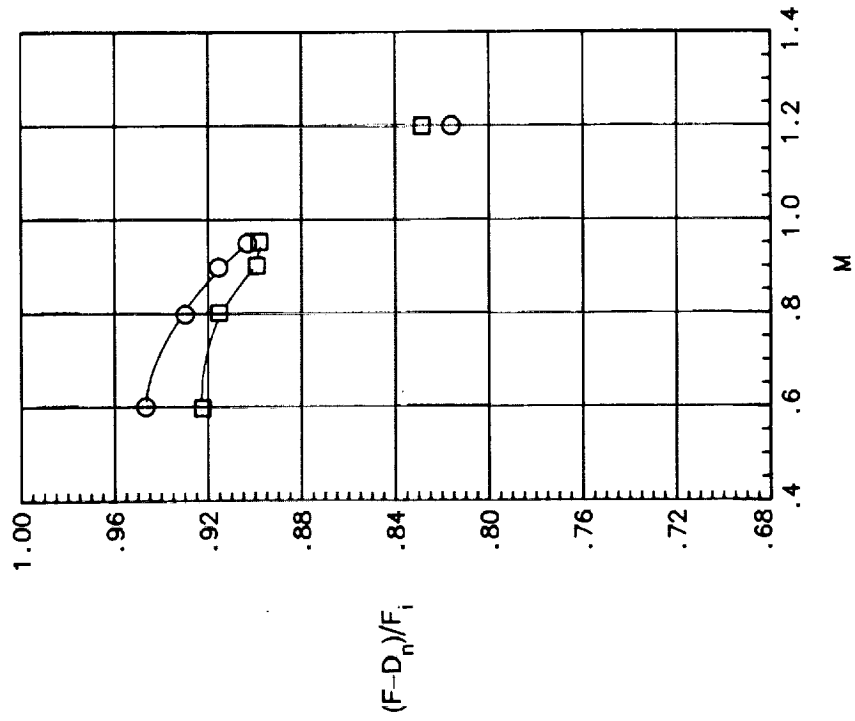


Figure 40. Effect of upper ramp angle of convergent nozzles on aerodynamic performance at scheduled NPR.  $l_r/h_{t,n} = 4.50$ ;  $l_f/h_{t,n} = 0$ ;  $\theta_f = -4^\circ$ ;  $\beta_f = 12.63^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .

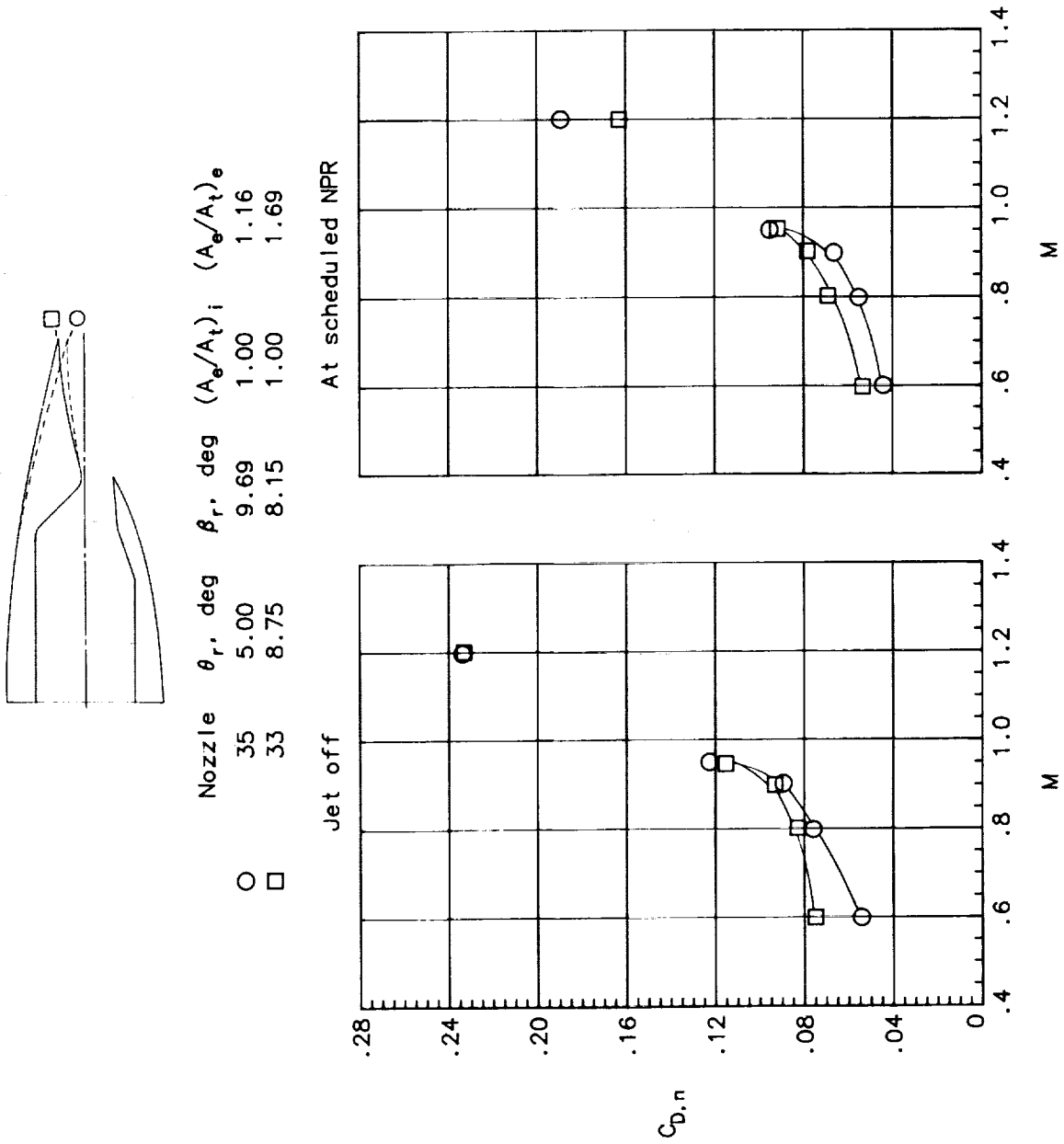
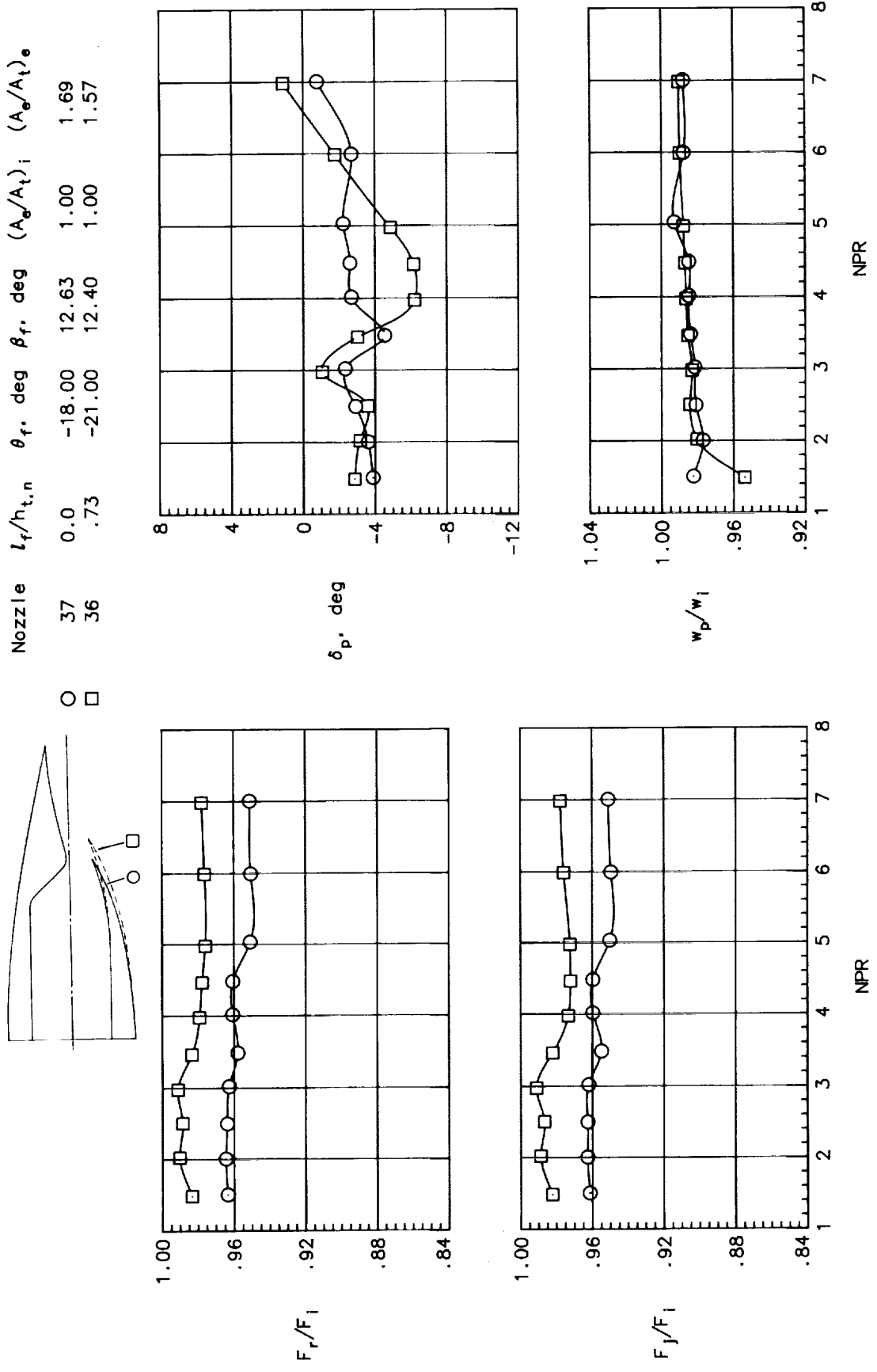
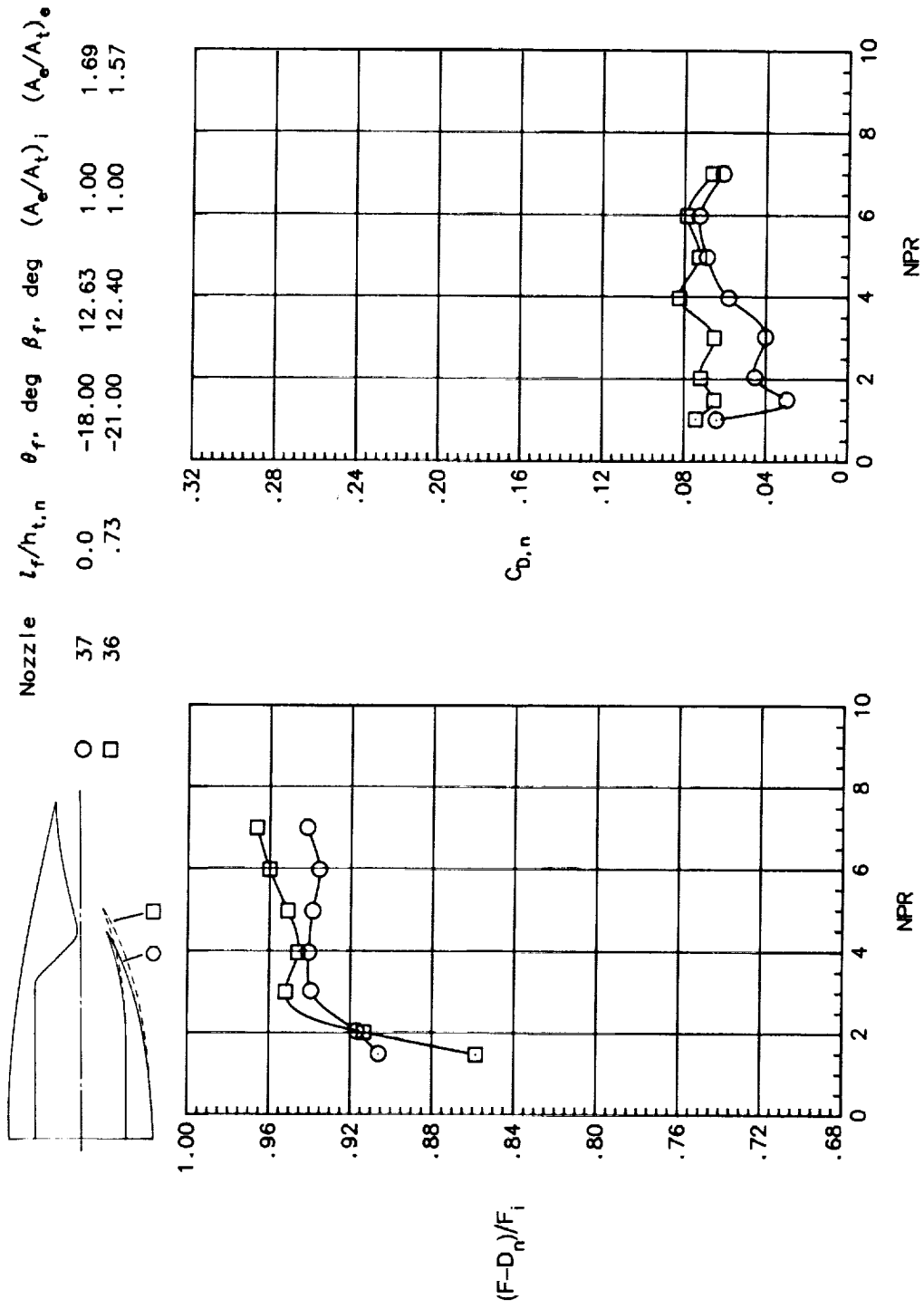


Figure 41. Effect of upper ramp angle of convergent nozzles on nozzle drag.  $l_r/h_{t,n} = 4.50$ ;  $l_f/h_{t,n} = 0$ ;  $\theta_f = -4^\circ$ ;  $\beta_f = 12.63^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .



(a)  $M = 0$ .

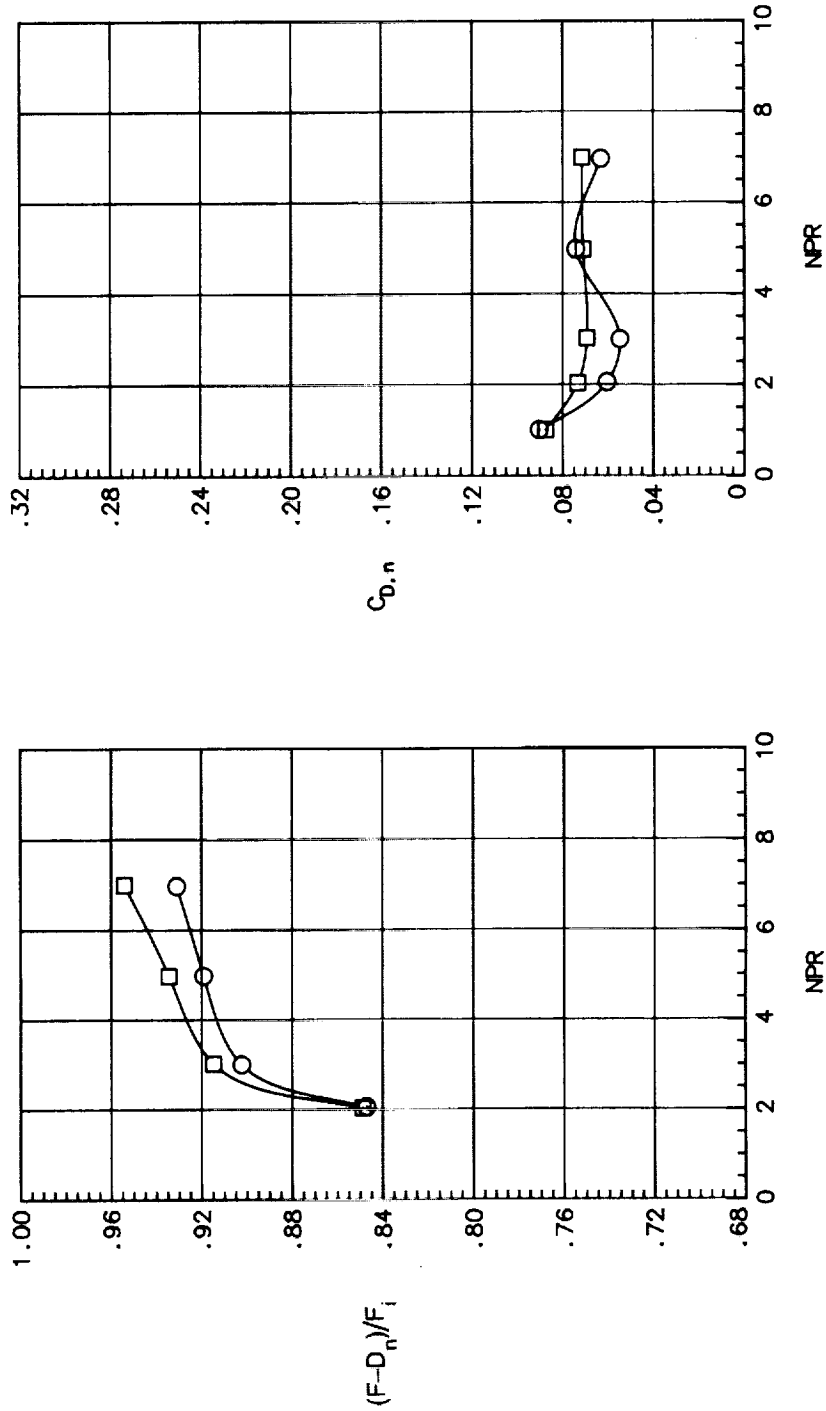
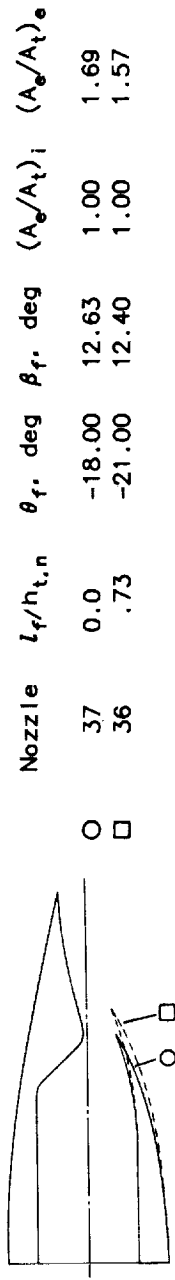
Figure 42. Effect of lower flap length of convergent nozzles on aeropulsive performance.  $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $\beta_r = 8.15^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .



(b)  $M = 0.60$ .

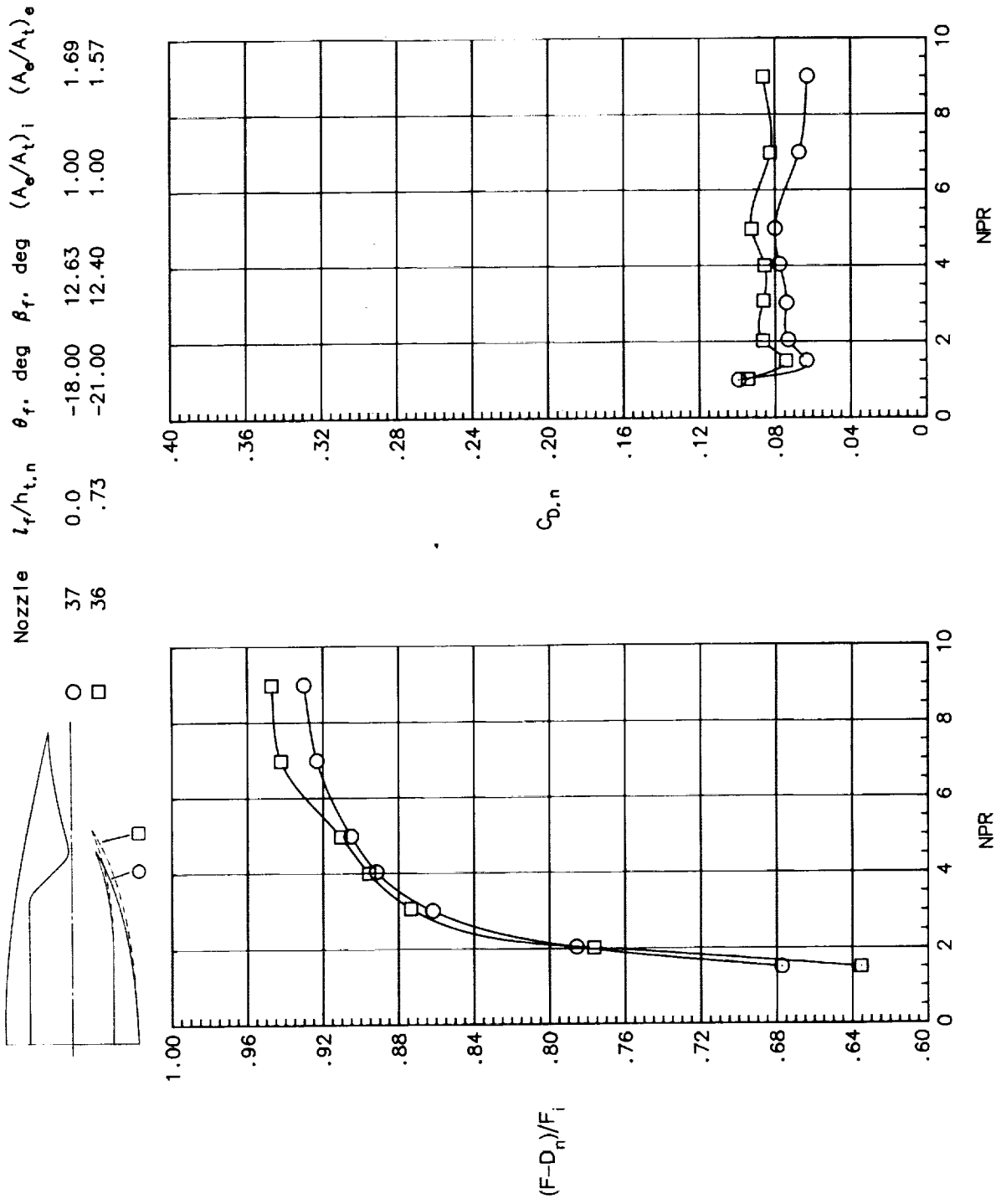
Figure 42. Continued.





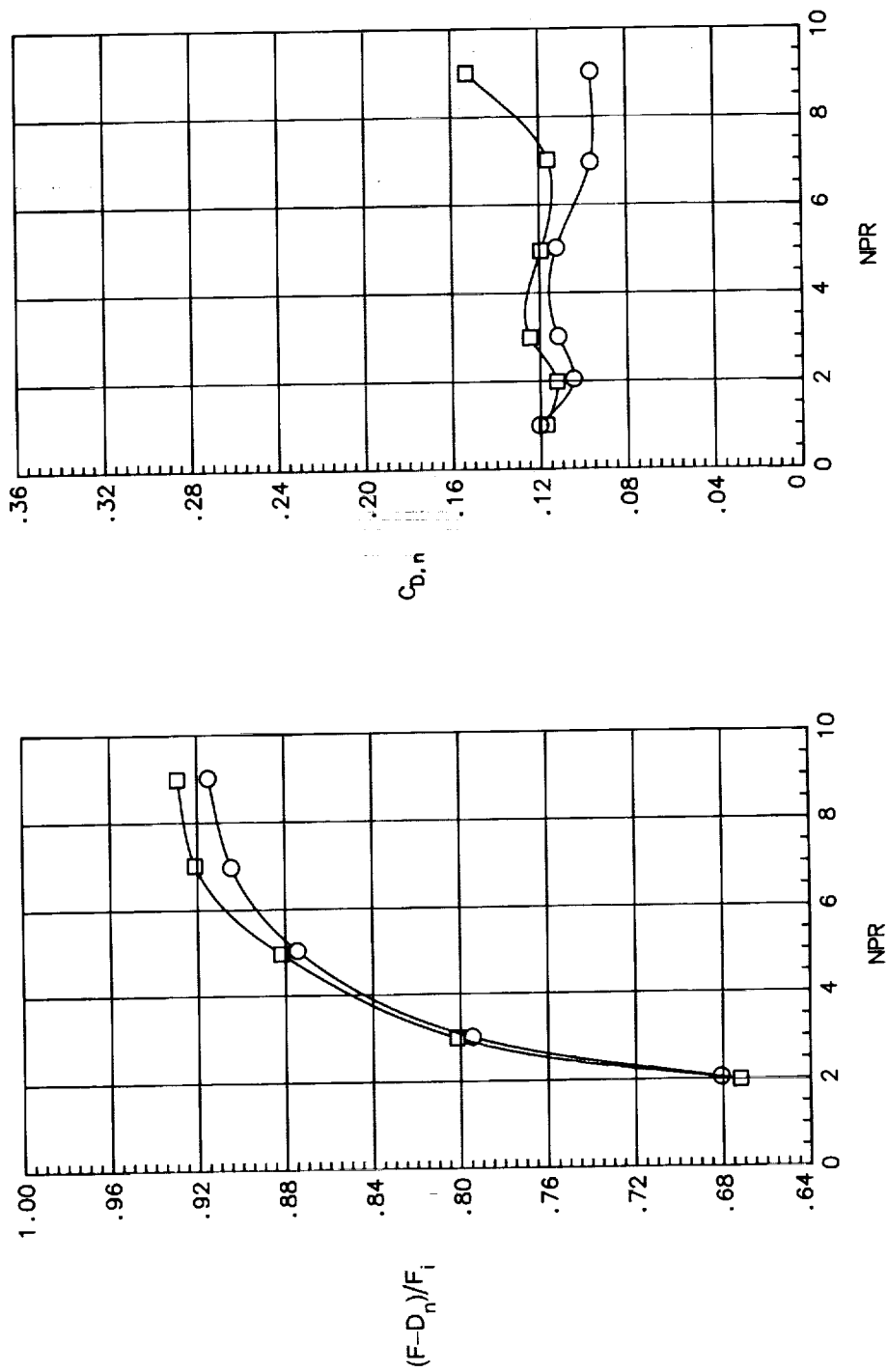
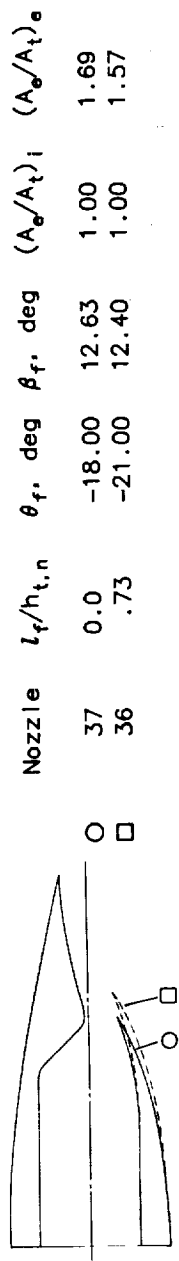
(c)  $M = 0.80$ .

Figure 42. Continued.



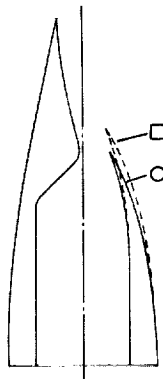
(d)  $M = 0.90$ .

Figure 42. Continued.

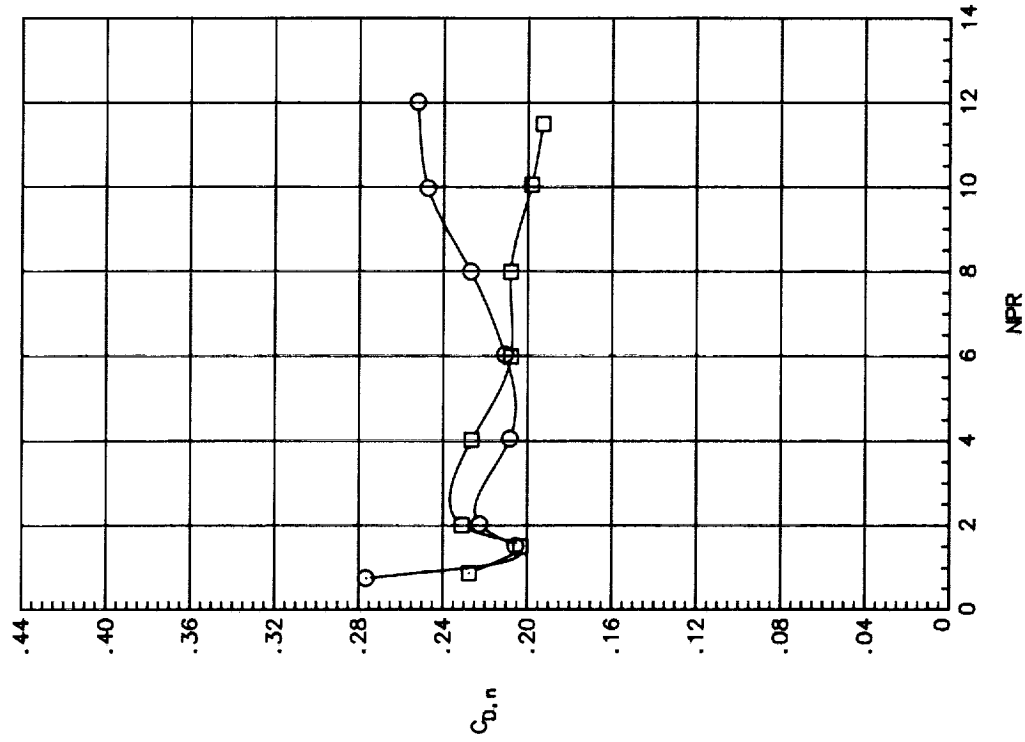
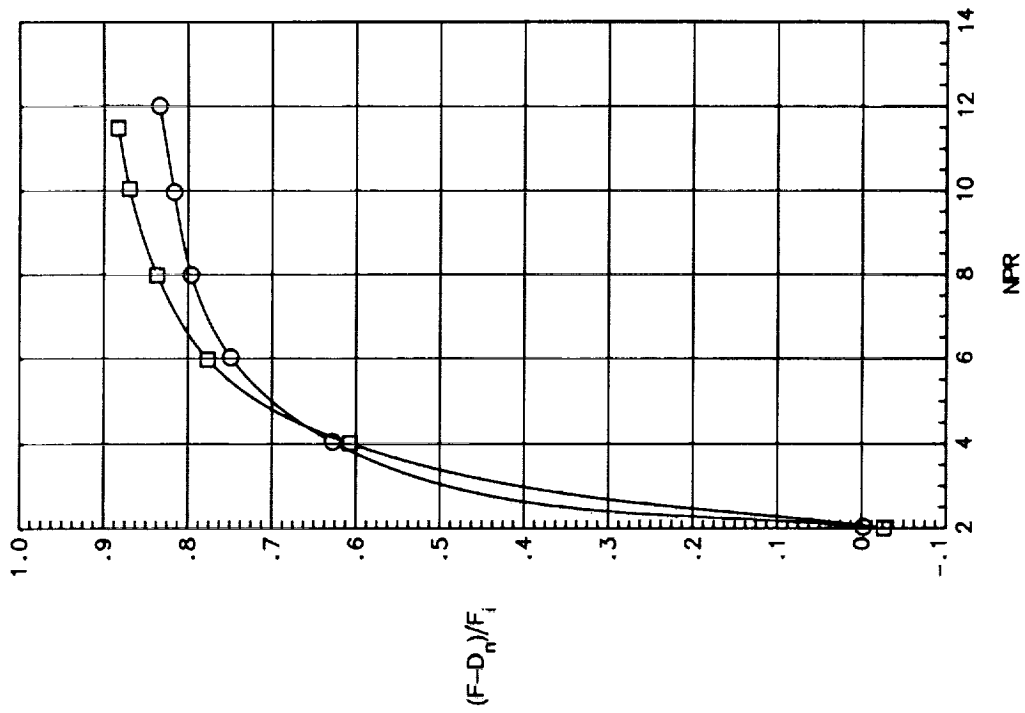


(e)  $M = 0.95$ .

Figure 42. Continued.



Nozzle	$L_f/h_{t,n}$	$\theta_r$ , deg	$\beta_f$ , deg	$(A_o/A_t)_i$	$(A_o/A_t)_o$
○	0.0	-18.00	12.63	1.00	1.69
□	.73	-21.00	12.40	1.00	1.57



(f)  $M = 1.20$ .

Figure 42. Concluded.

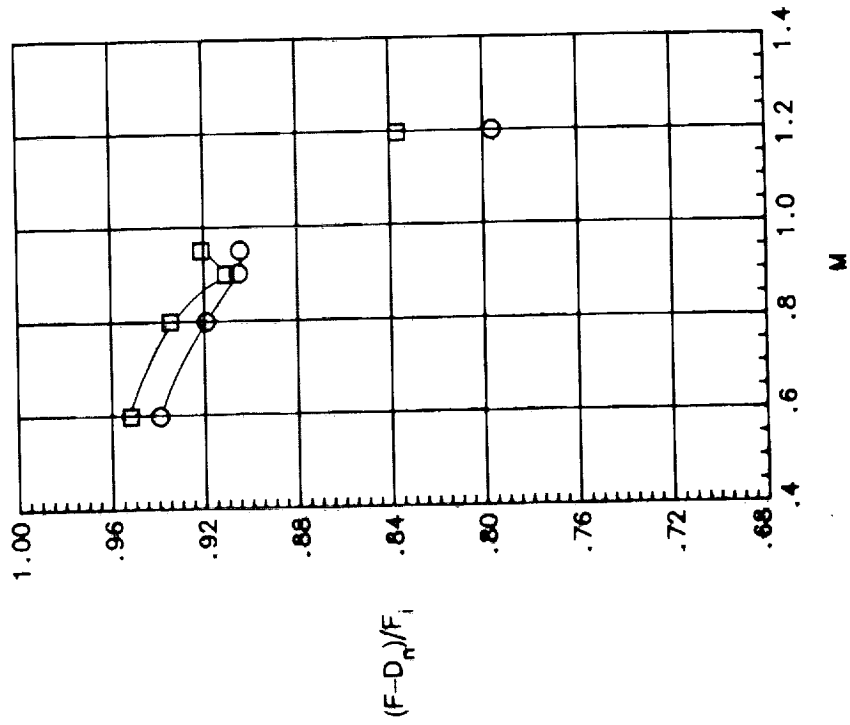
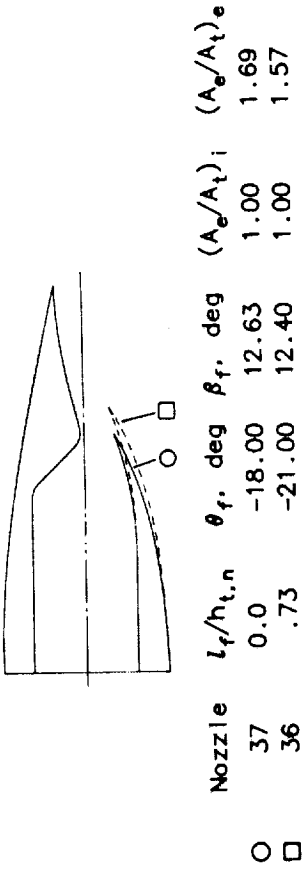
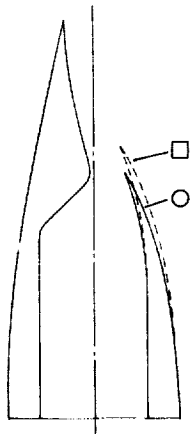


Figure 43. Effect of lower flap length of convergent nozzles on aerodynamic performance at scheduled NPR.  $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $\beta_r = 8.15^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .



Nozzle	$l_f/h_{t,n}$	$\theta_f$ , deg	$\beta_r$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
○	37	-18.00	12.63	1.00	1.69
□	36	-21.00	12.40	1.00	1.57

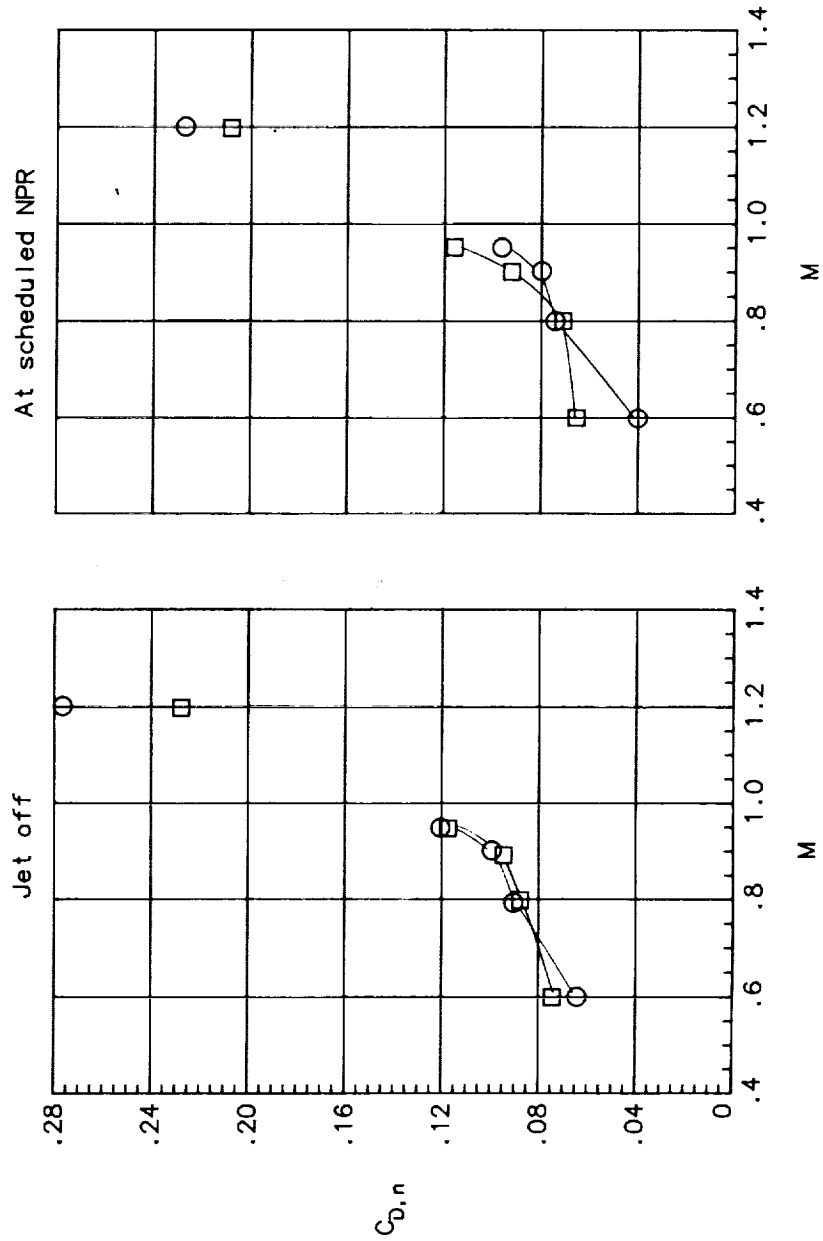
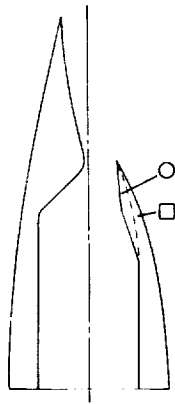
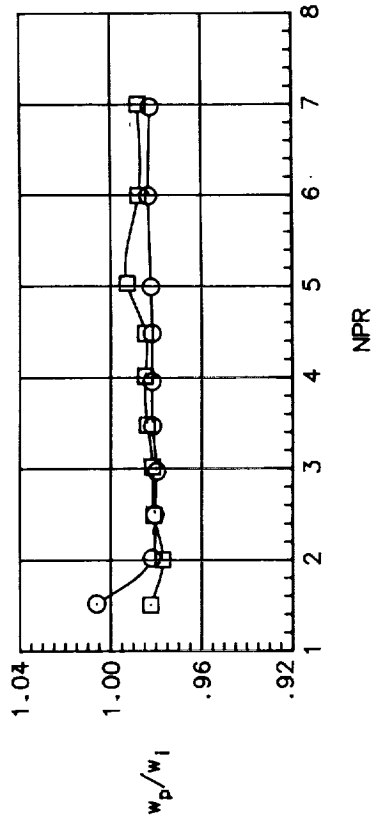
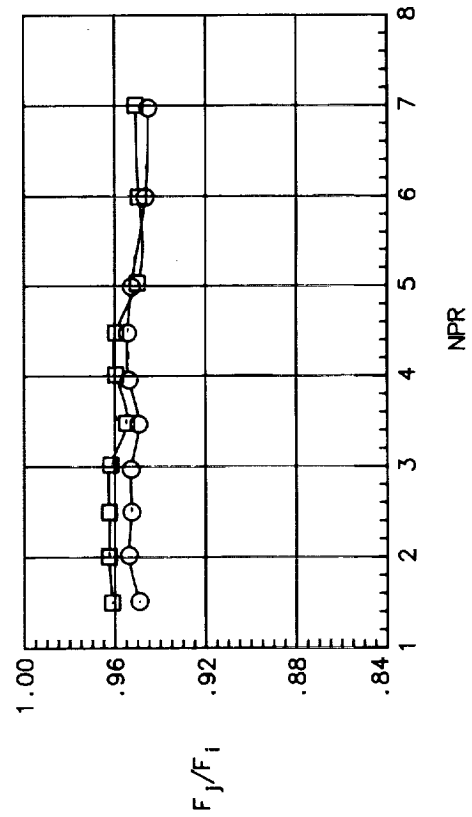
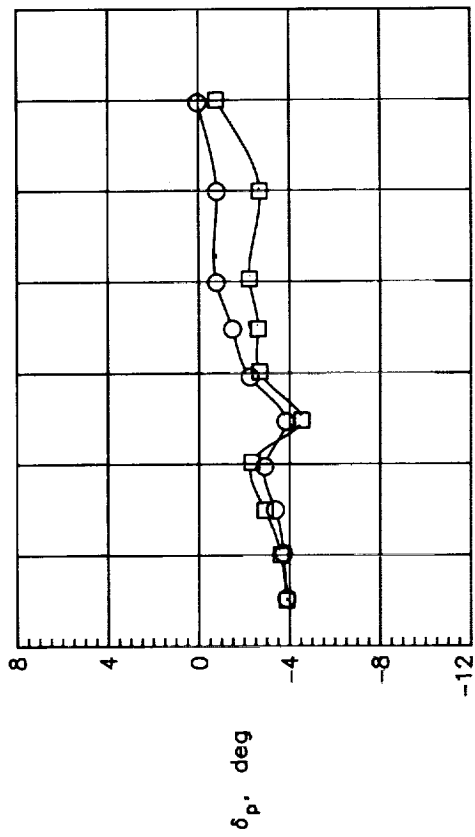
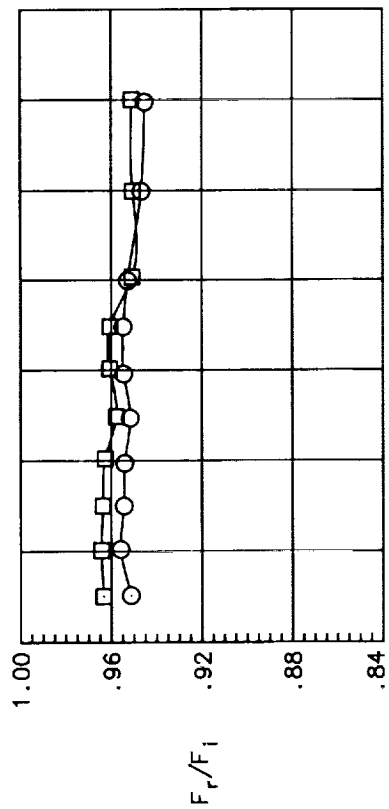


Figure 44. Effect of lower flap length of convergent nozzles on nozzle drag.  $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $\beta_r = 8.15^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .



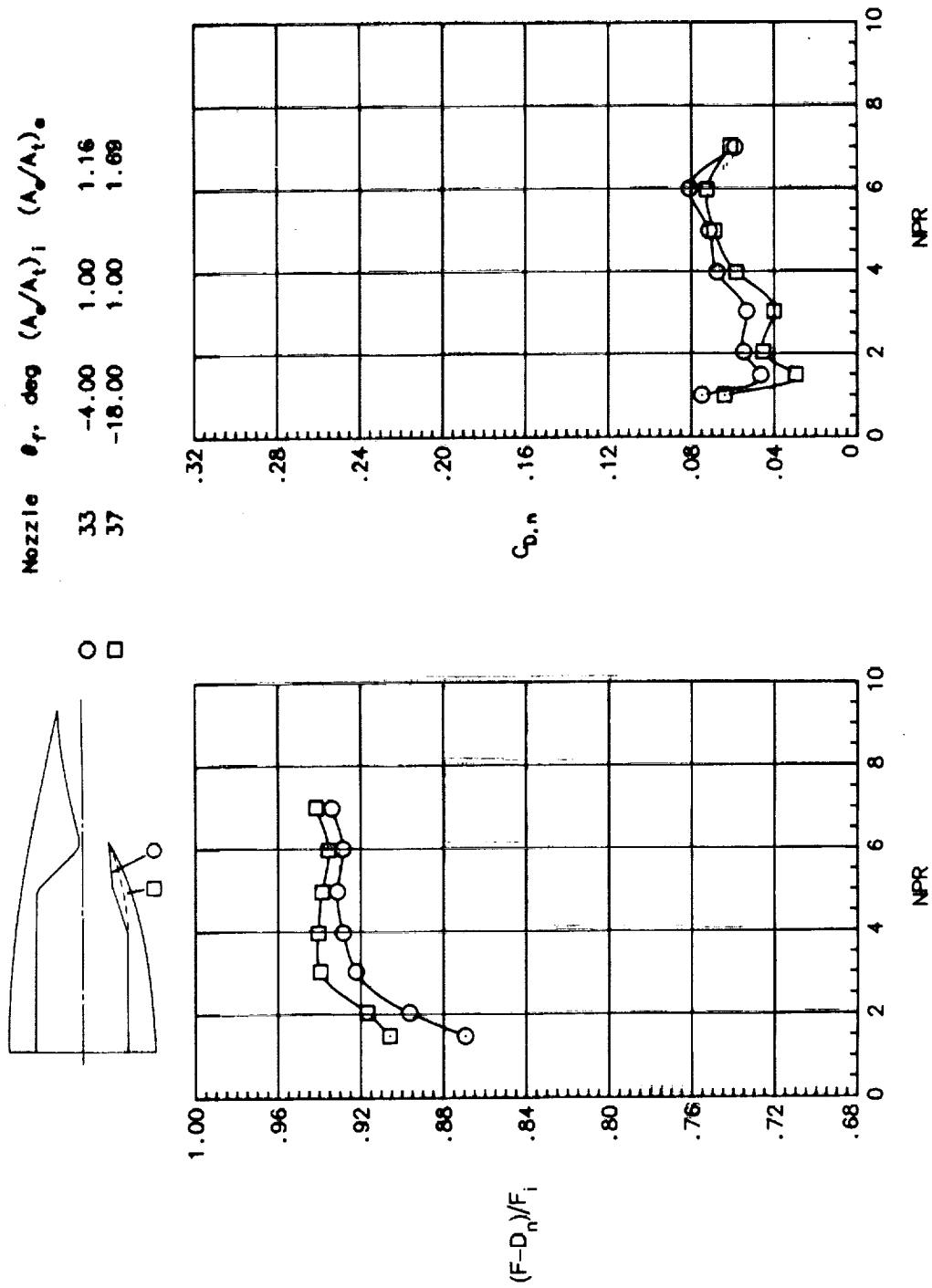
Nozzle	$\theta_f$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
33	-4.00	1.00	1.16
37	-18.00	1.00	1.69

○ □



(a)  $M = 0$ .

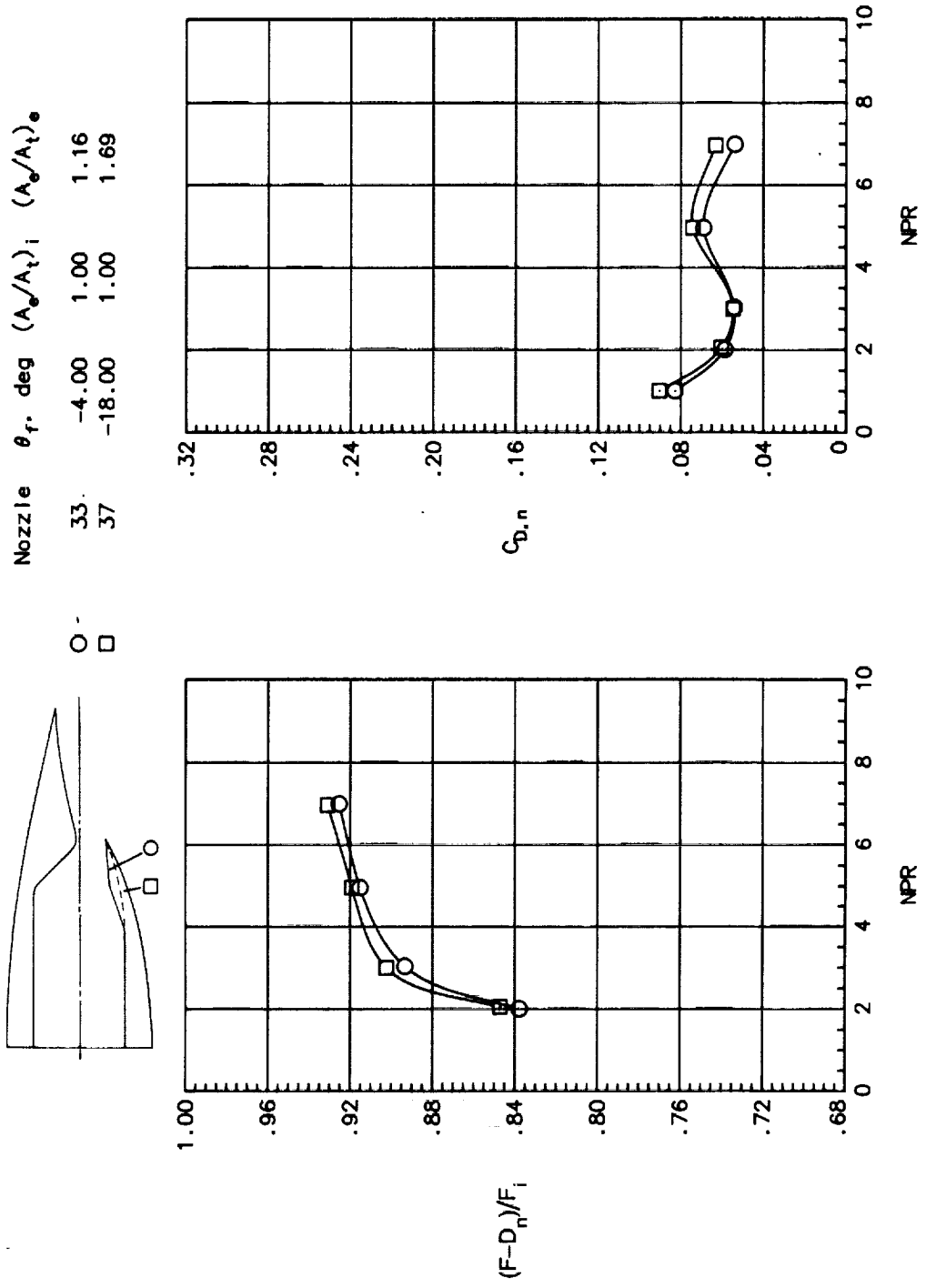
Figure 45. Effect of lower flap angle of convergent nozzles on aeropropulsive performance.  $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $\beta_r = 8.15^\circ$ ;  $l_f/h_{t,n} = 0$ ;  $\beta_f = 12.63^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .



(b)  $M = 0.60$ .

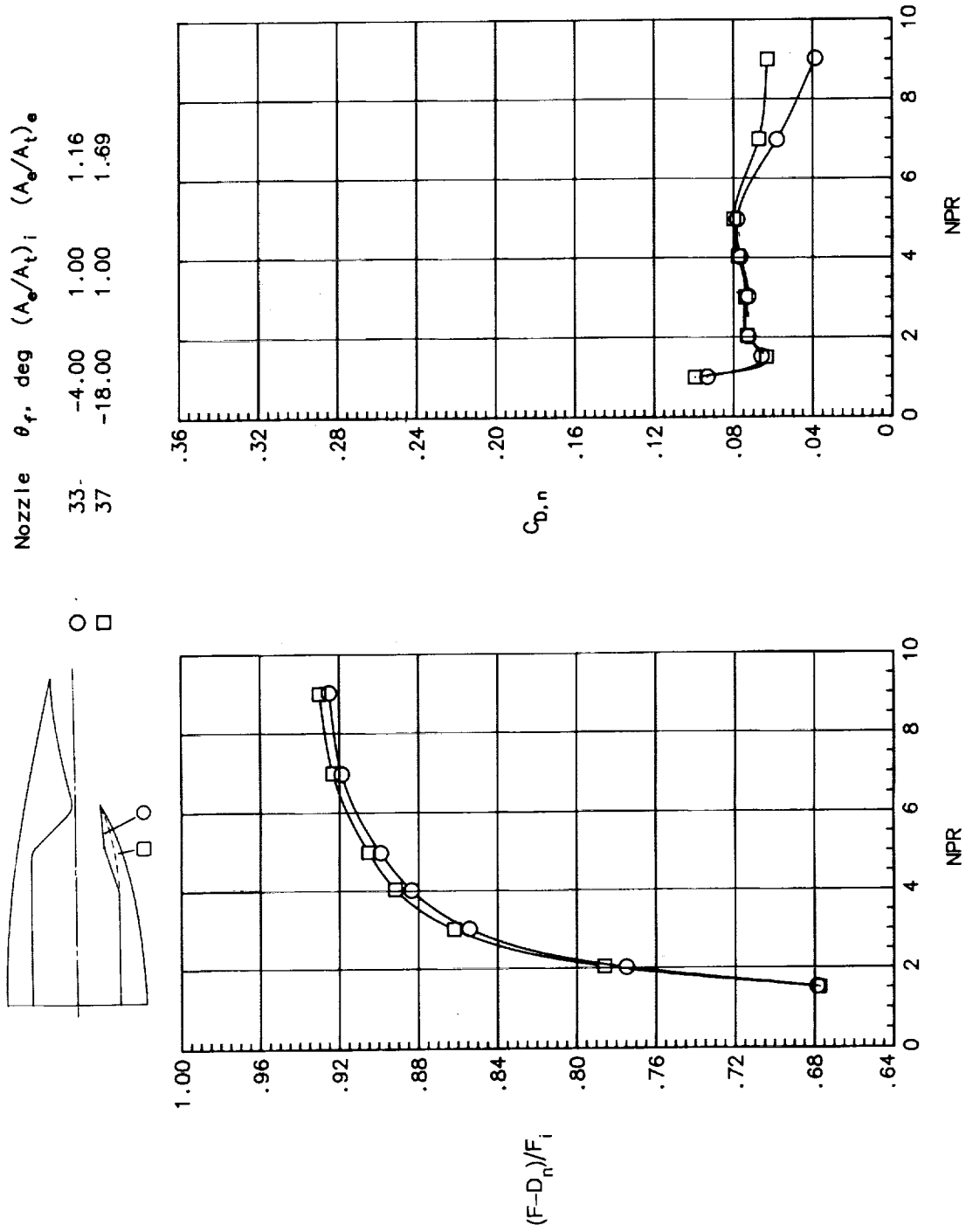
Figure 45. Continued.





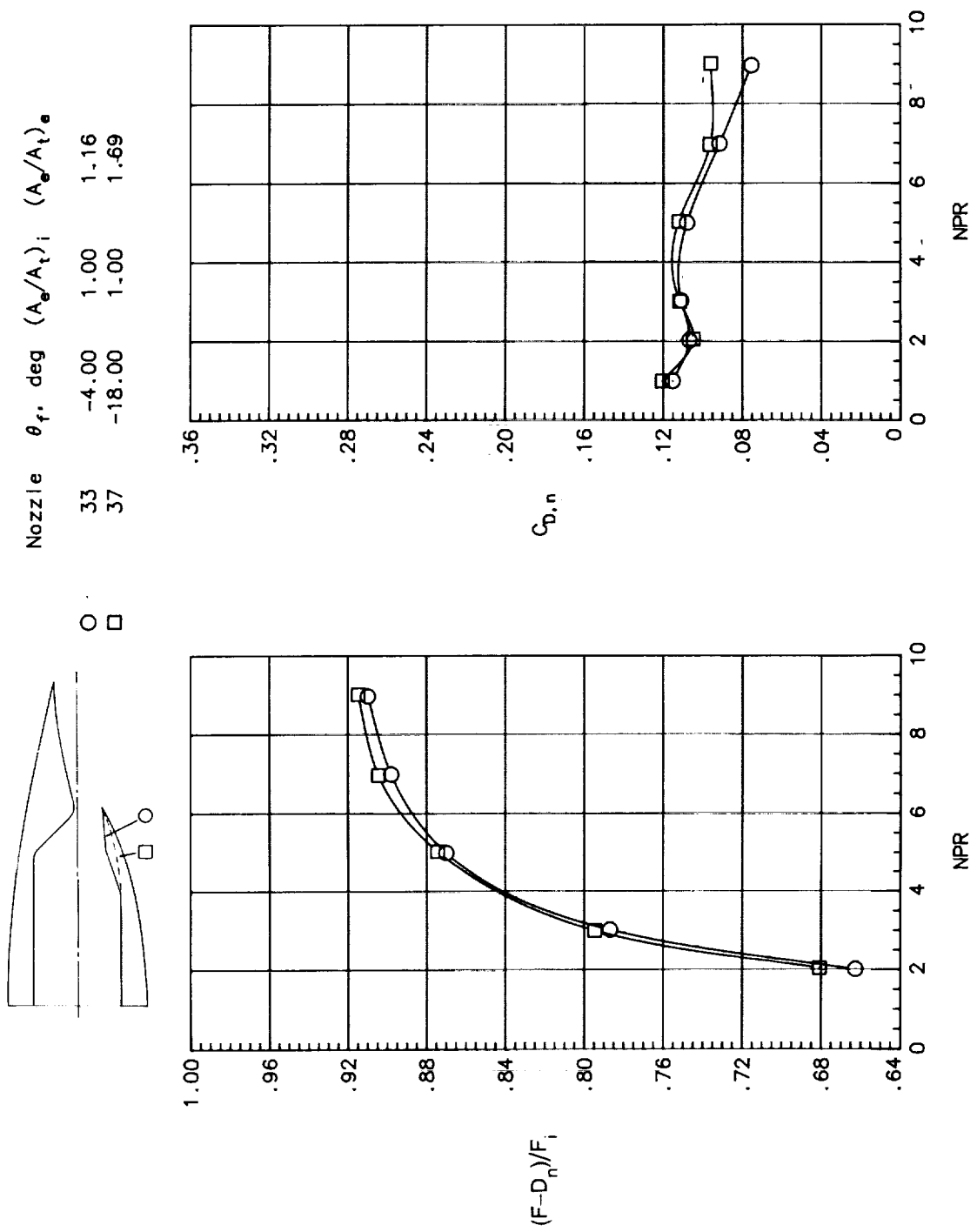
(c)  $M = 0.80$ .

Figure 45. Continued.



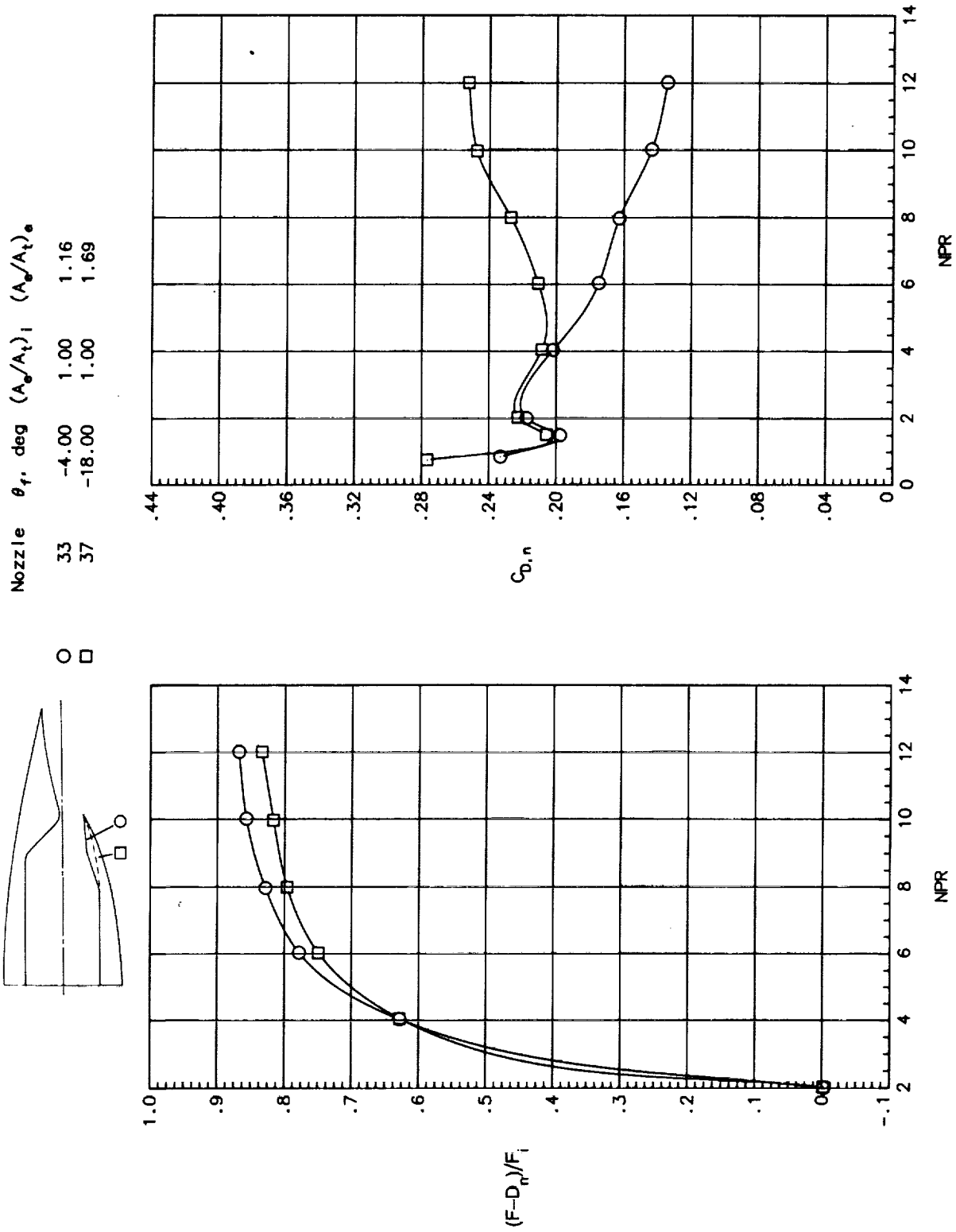
(d)  $M = 0.90$ .

Figure 45. Continued.



(e)  $M = 0.95$ .

Figure 45. Continued.



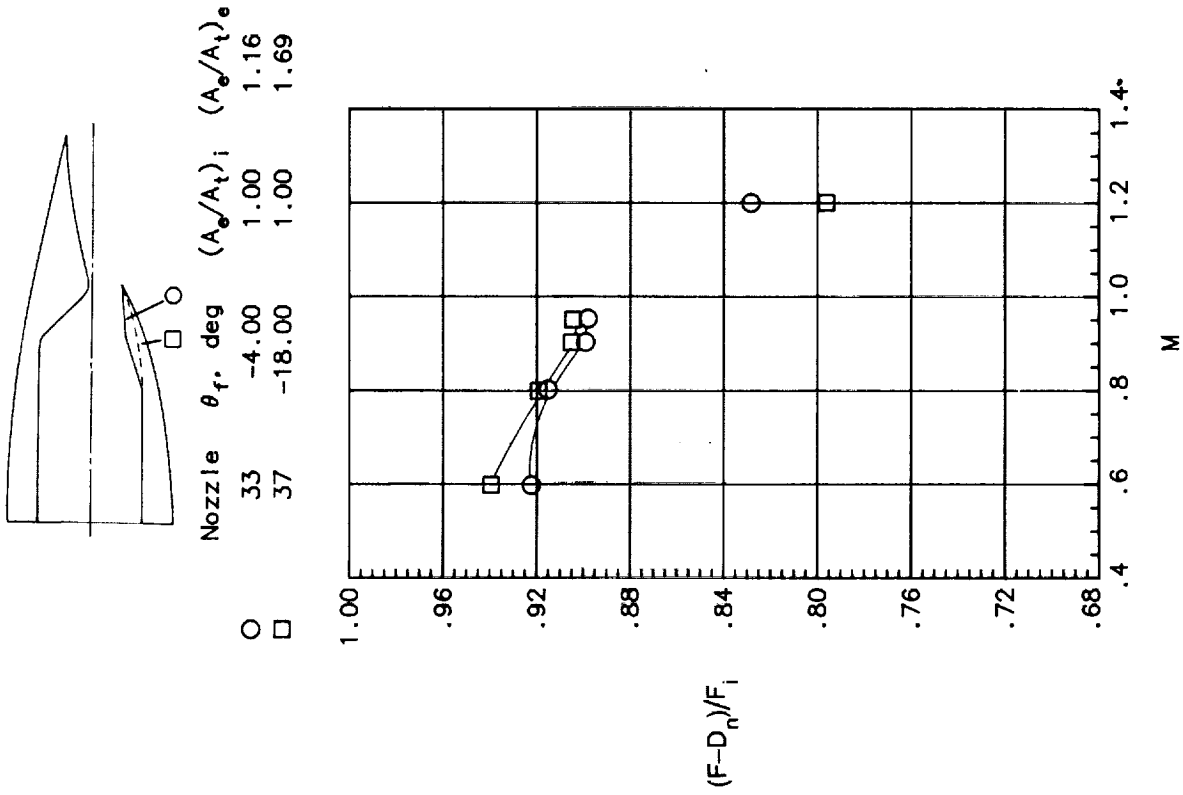


Figure 46. Effect of lower flap angle of convergent nozzles on aerodynamic performance at scheduled NPR.  $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $\beta_r = 8.15^\circ$ ;  $l_f/h_{t,n} = 0$ ;  $\beta_f = 12.63^\circ$ ;  $x_t/h_{t,n} = 7.25$ ;  $y_t/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .

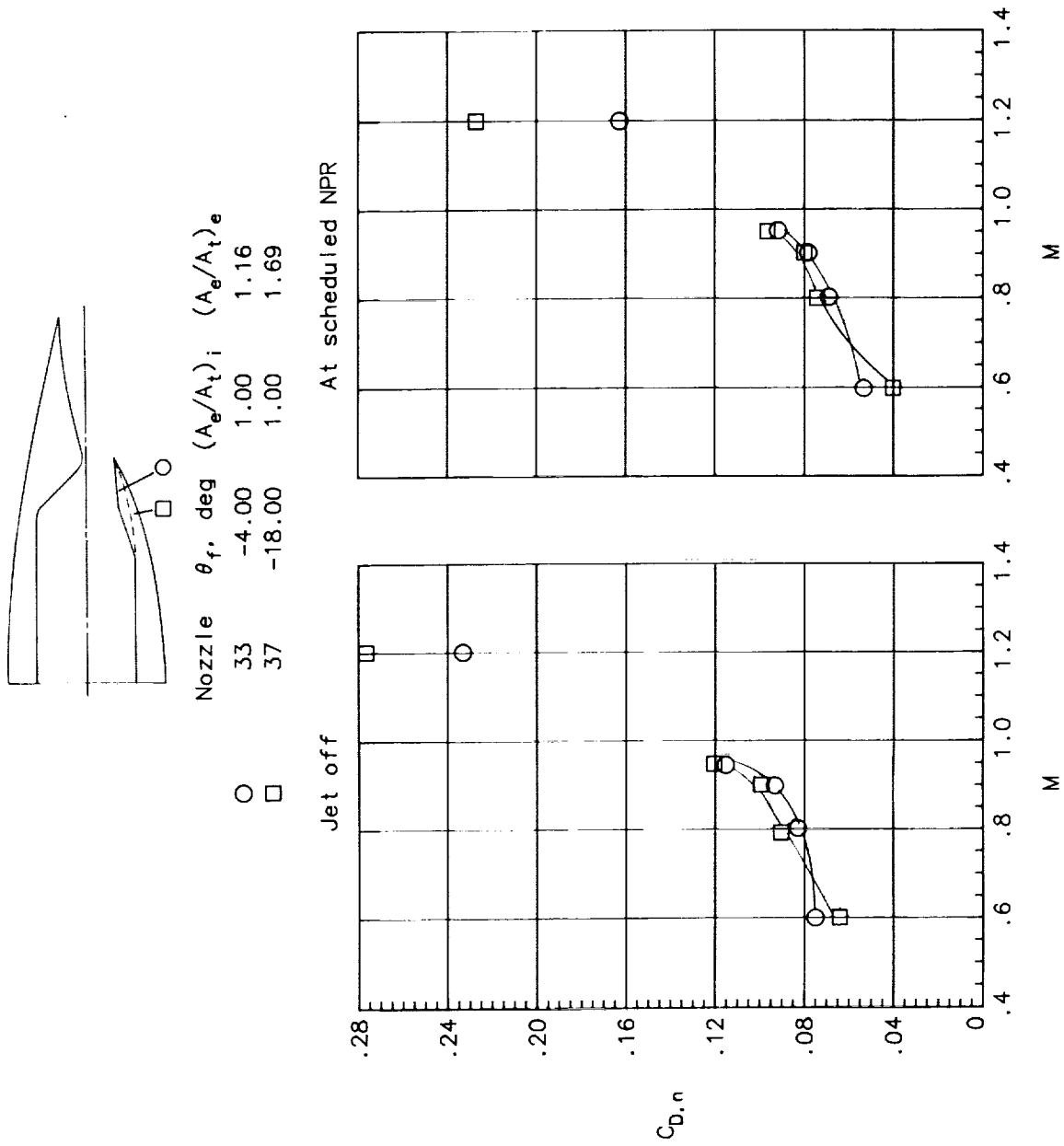
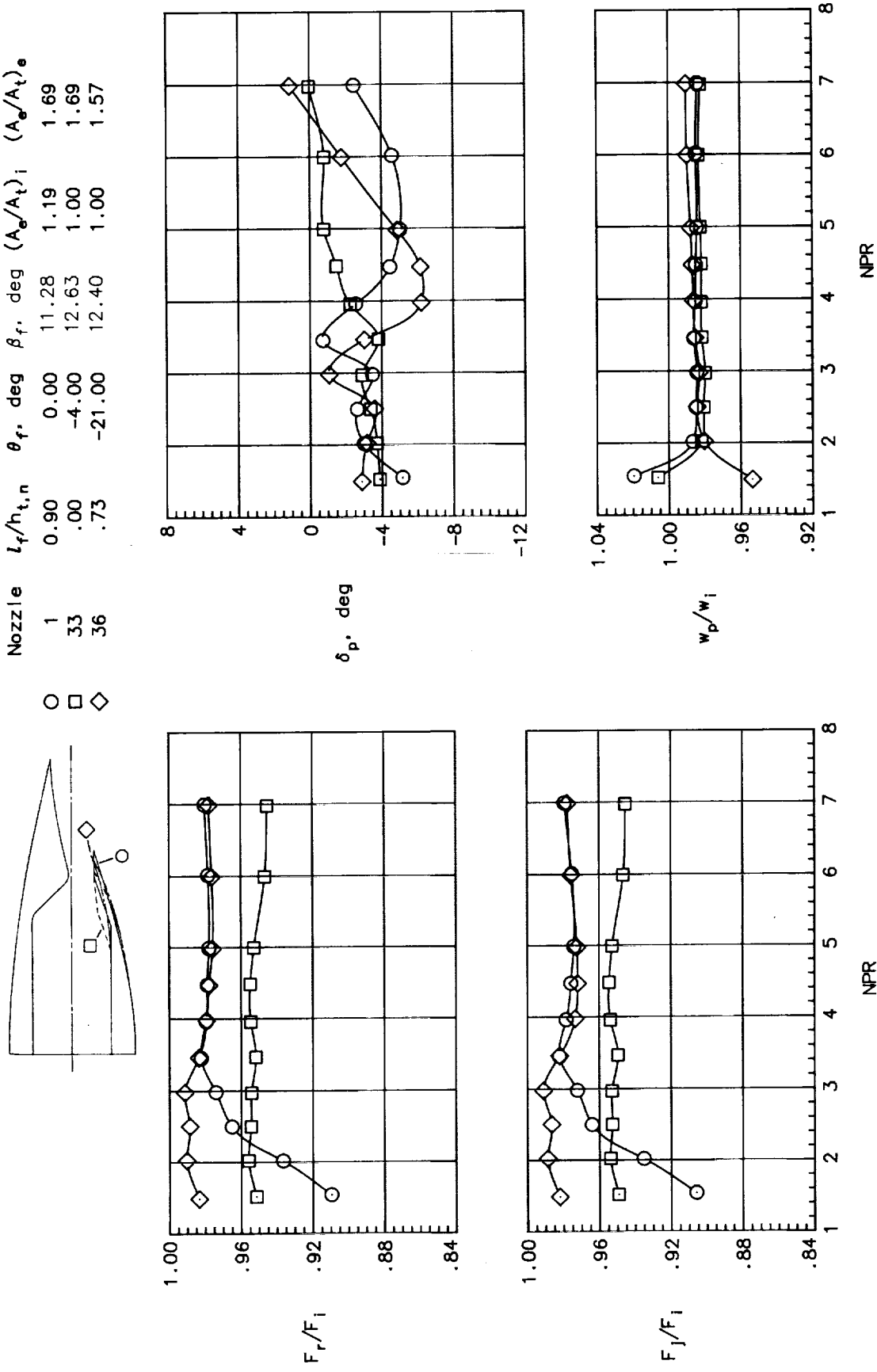
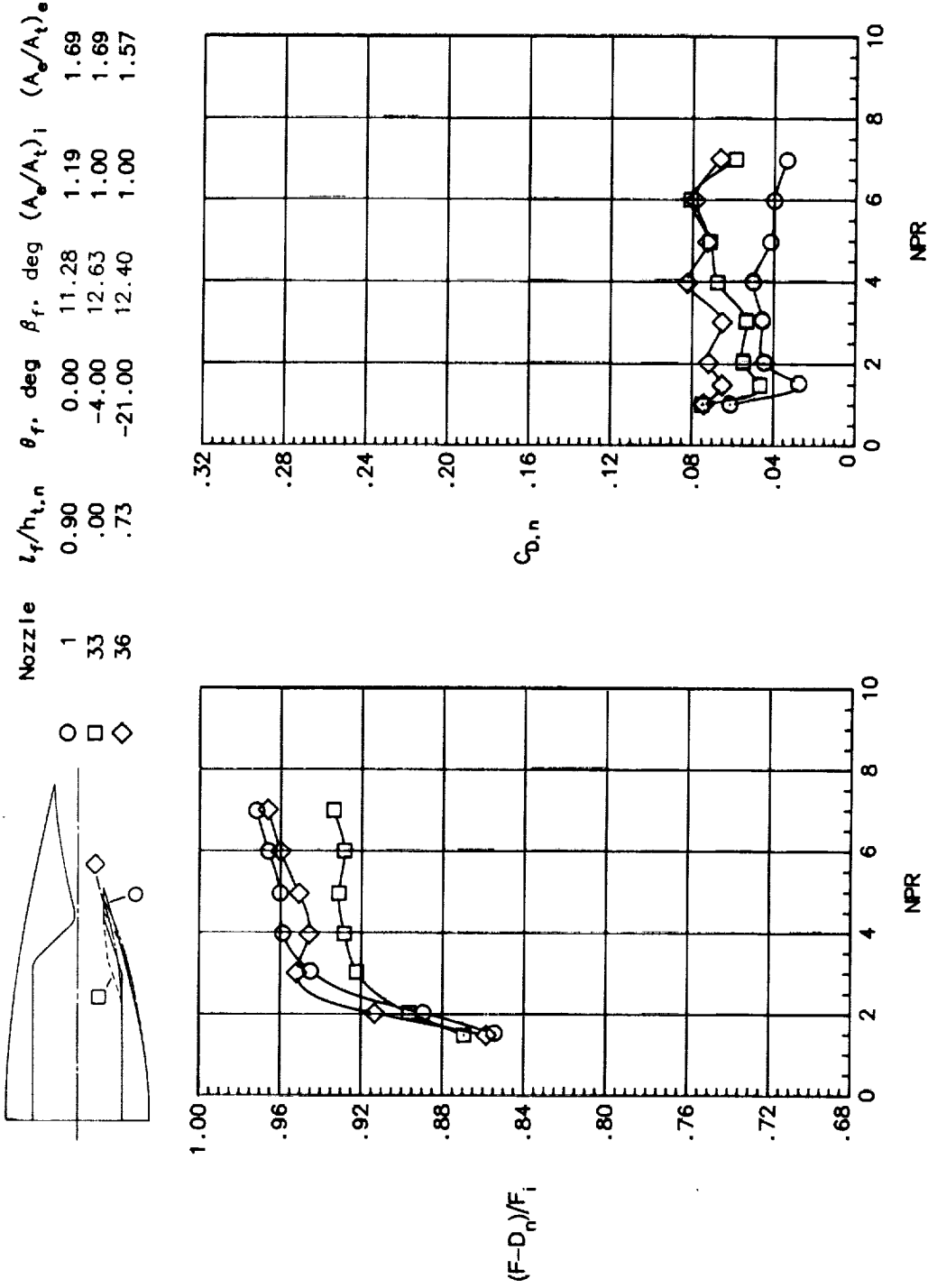


Figure 47. Effect of lower flap angle of convergent nozzles on nozzle drag;  $l_r/h_{t,n} = 4.50$ ;  $\theta_r = 8.75^\circ$ ;  $\beta_r = 8.15^\circ$ ;  $l_f/h_{t,n} = 0$ ;  $\beta_f = 12.63^\circ$ ;  $x_l/h_{t,n} = 7.25$ ;  $y_l/h_{t,n} = 0.12$ ;  $\alpha = 0^\circ$ .



(a)  $M = 0$ .

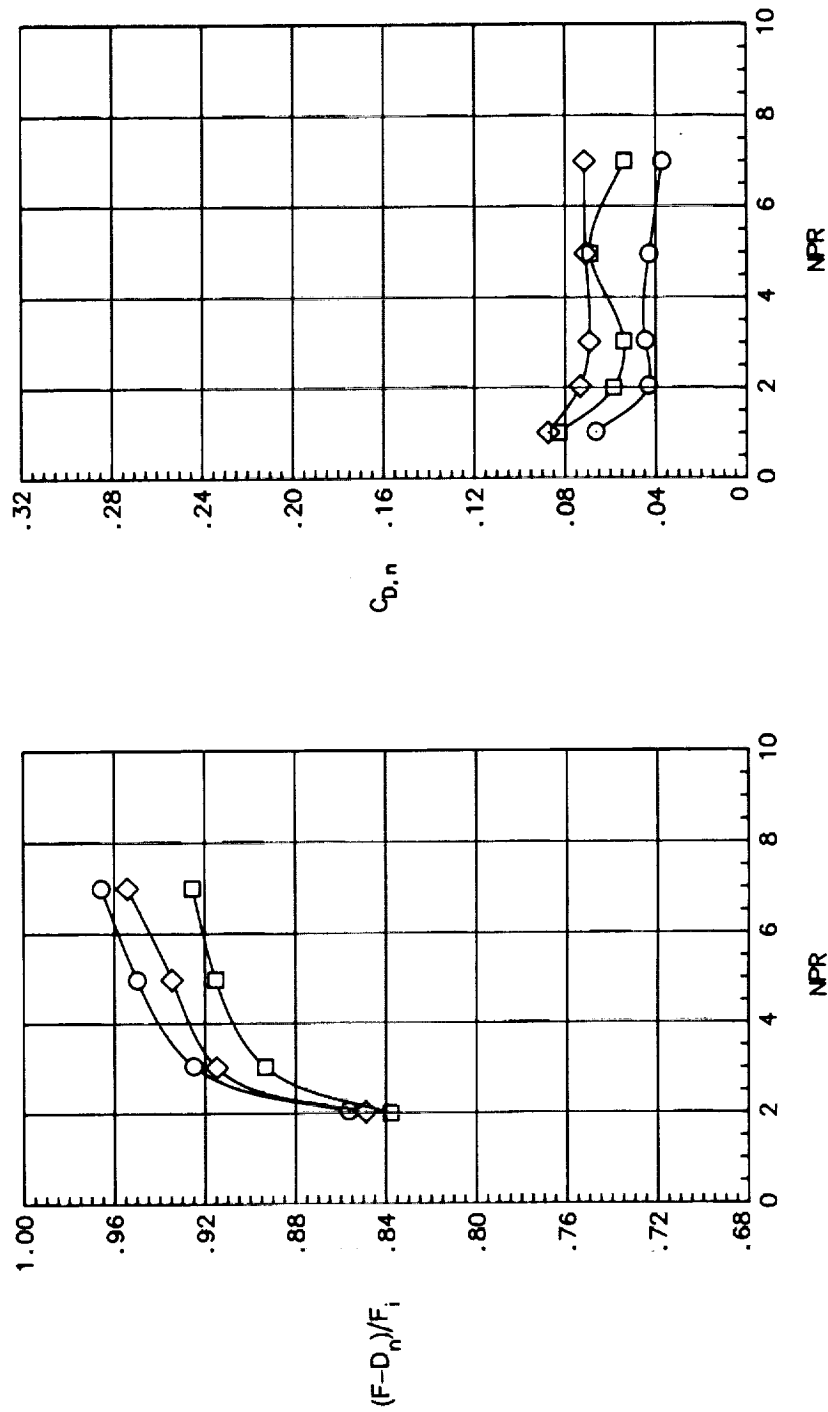
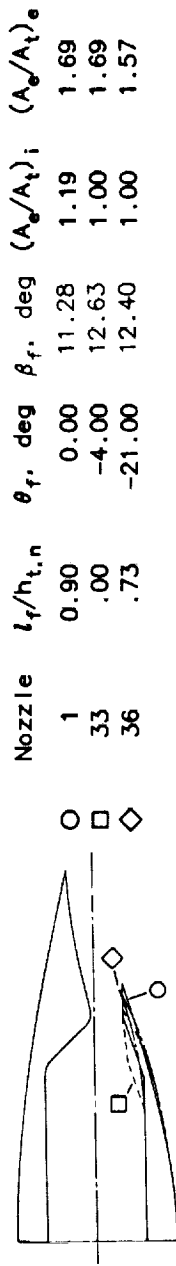
Figure 48. Comparison of aeropulsive performance between convergent-divergent and convergent nozzles.  
 $L_r/h_{t,n} = 4.50; \theta_r = 8.75^\circ; \beta_r = 8.15^\circ; x_t/h_{t,n} = 7.25; y_t/h_{t,n} = 0.12; \alpha = 0^\circ$ .



(b)  $M = 0.60$ .

Figure 48. Continued.

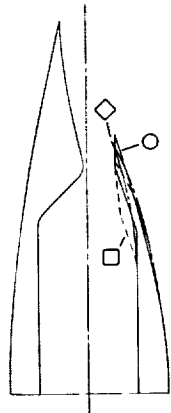




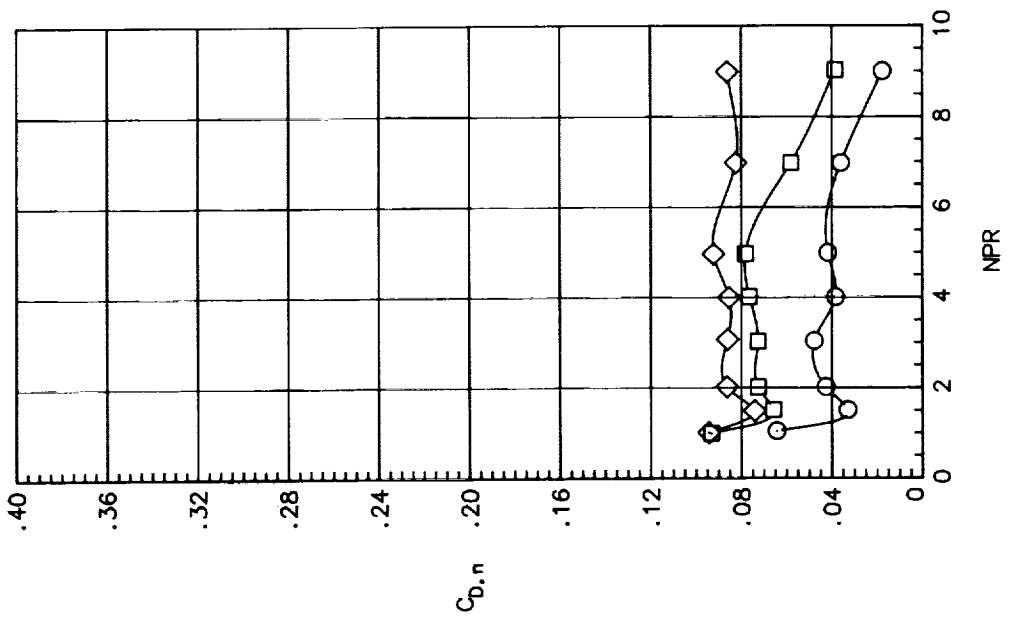
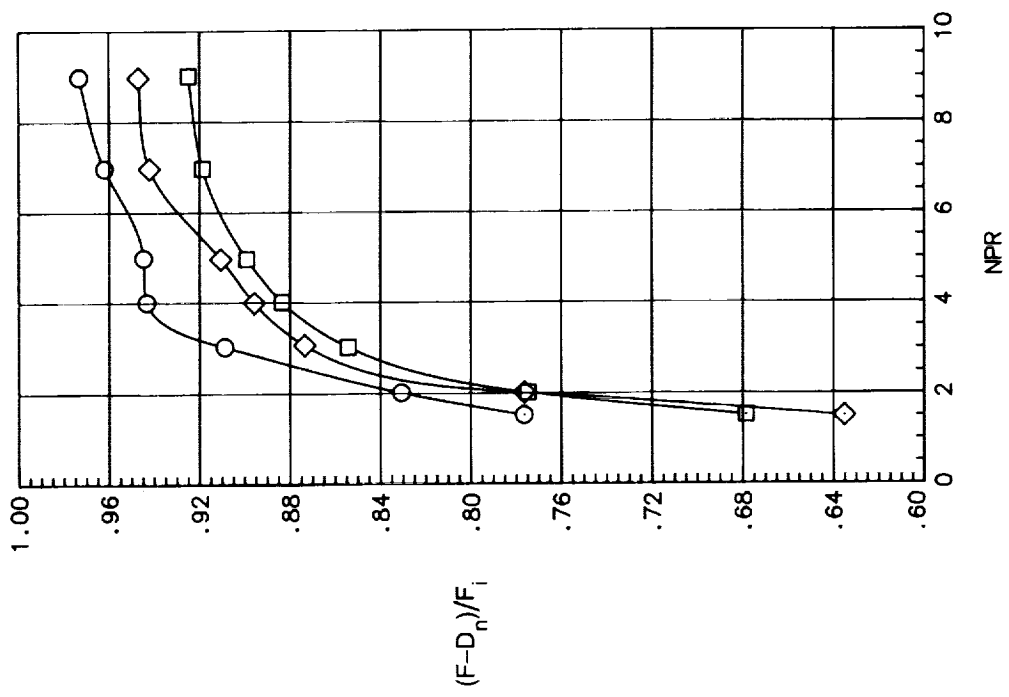
(c)  $M = 0.80$ .

Figure 48. Continued.

Nozzle	$l_f/h_{t,n}$	$\theta_f$ , deg	$\beta_f$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
1	0.90	0.00	11.28	1.19	1.69
33	.00	-4.00	12.63	1.00	1.69
36	.73	-21.00	12.40	1.00	1.57

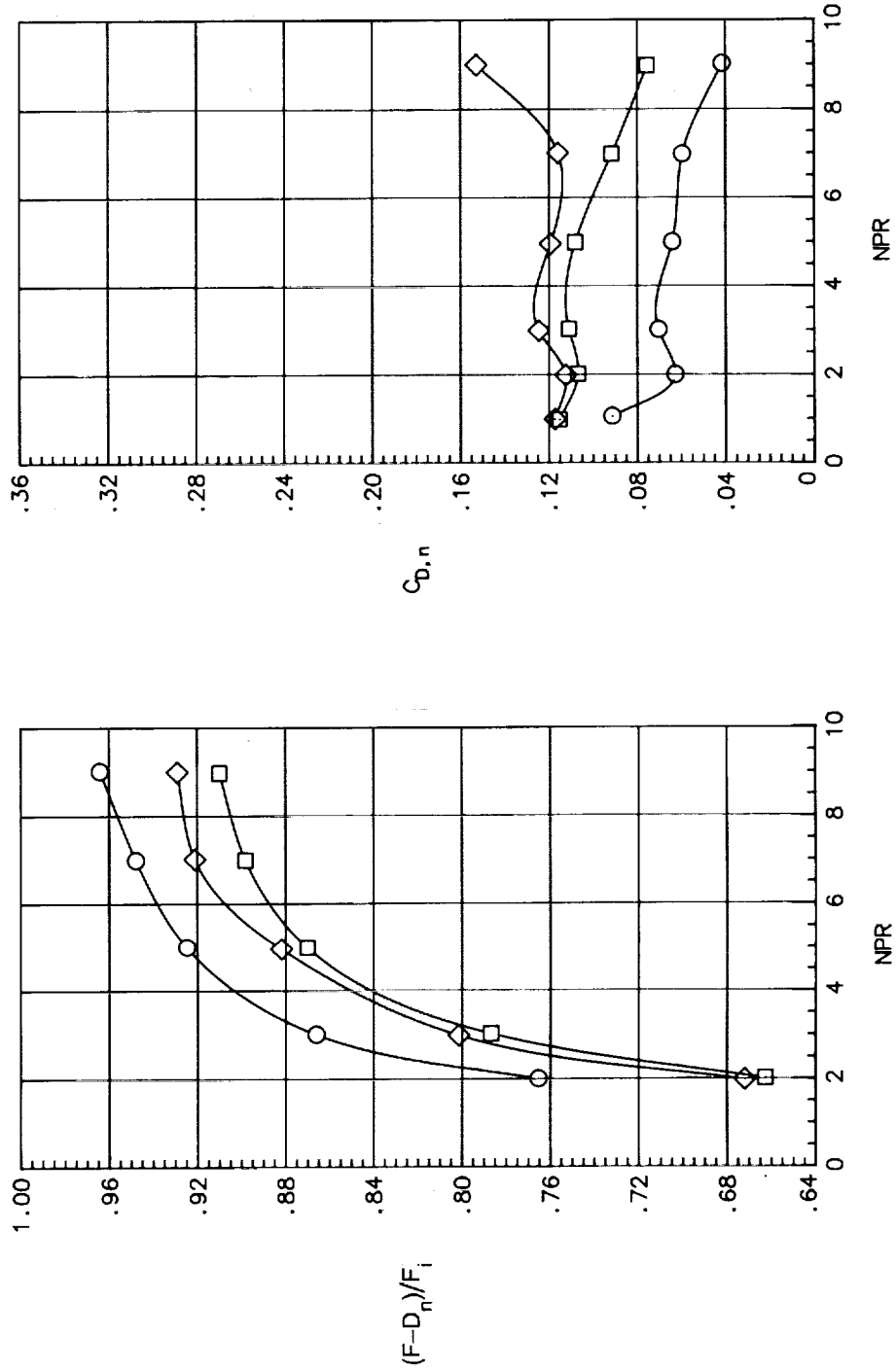
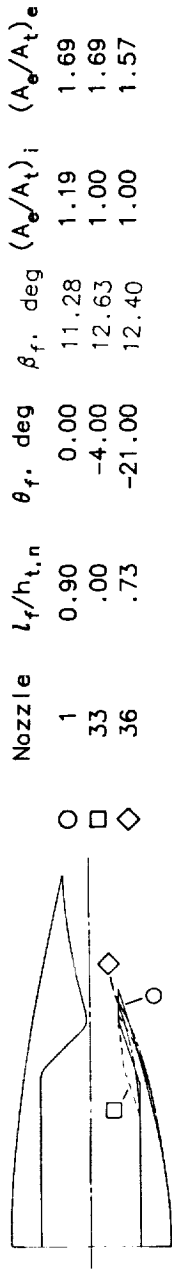


○ □ ◇



(d)  $M = 0.90$ .

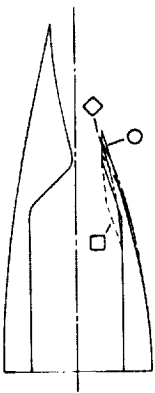
Figure 48. Continued.



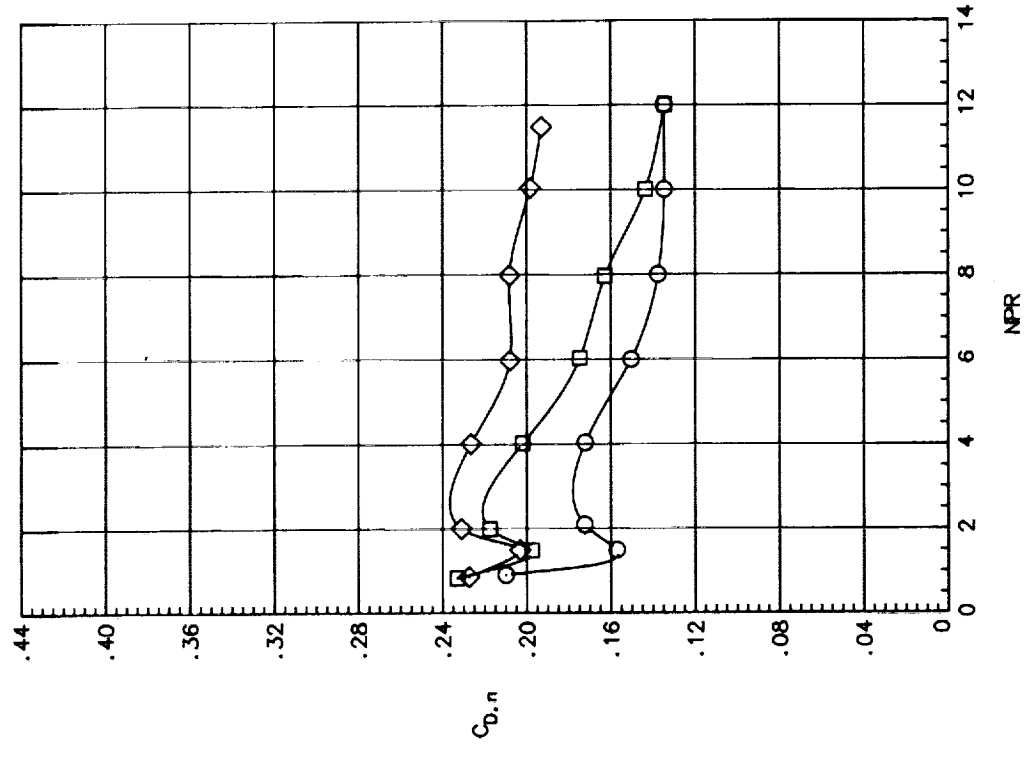
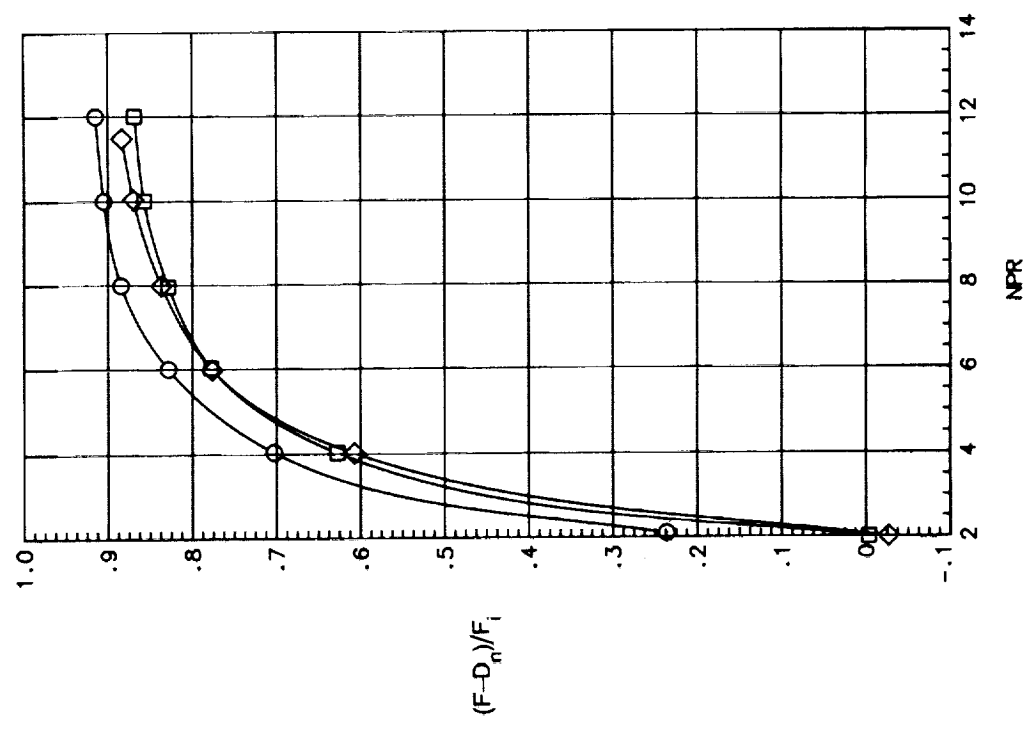
(e)  $M = 0.95$ .

Figure 48. Continued.

Nozzle	$l_f/h_{t,n}$	$\theta_f$ , deg	$\beta_f$ , deg	$(A_o/A_t)_i$	$(A_o/A_t)_e$
1	0.90	0.00	11.28	1.19	1.69
33	.00	-4.00	12.63	1.00	1.69
36	.73	-21.00	12.40	1.00	1.57

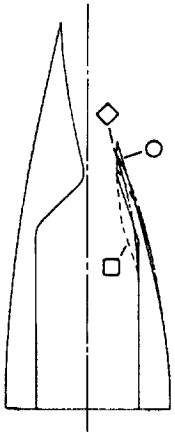


O □ ◇



(f)  $M = 1.20$ .

Figure 48. Concluded.



Nozzle	$l_f/h_{t,n}$	$\theta_f$ , deg	$\beta_f$ , deg	$(A_0/A_t)_i$	$(A_0/A_t)_e$	
○	1	0.90	0.00	11.28	1.19	1.69
□	33	.00	-4.00	12.63	1.00	1.69
◇	36	.73	-21.00	12.40	1.00	1.57

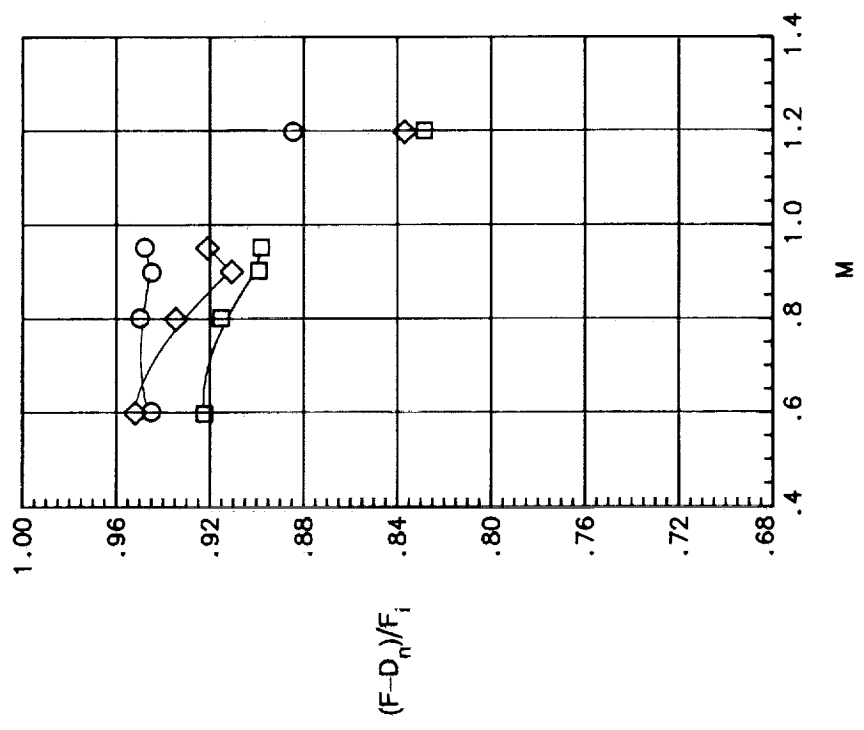
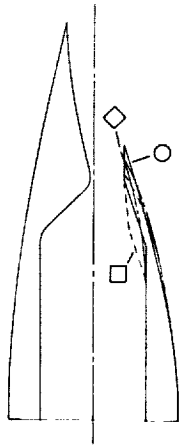


Figure 49. Comparison of aeropropulsive performance between convergent-divergent and convergent nozzles.  
 $l_f/h_{t,n} = 4.50; \theta_r = 8.75^\circ; \beta_r = 8.15^\circ; x_i/h_{t,n} = 7.25; y_i/h_{t,n} = 0.12; \alpha = 0^\circ$ .



Nozzle	$l_f/h_{t,n}$	$\theta_f$ , deg	$\beta_f$ , deg	$(A_e/A_t)_i$	$(A_e/A_t)_e$
○	1	0.00	11.28	1.19	1.69
□	33	-4.00	12.63	1.00	1.69
◇	36	-21.00	12.40	1.00	1.57

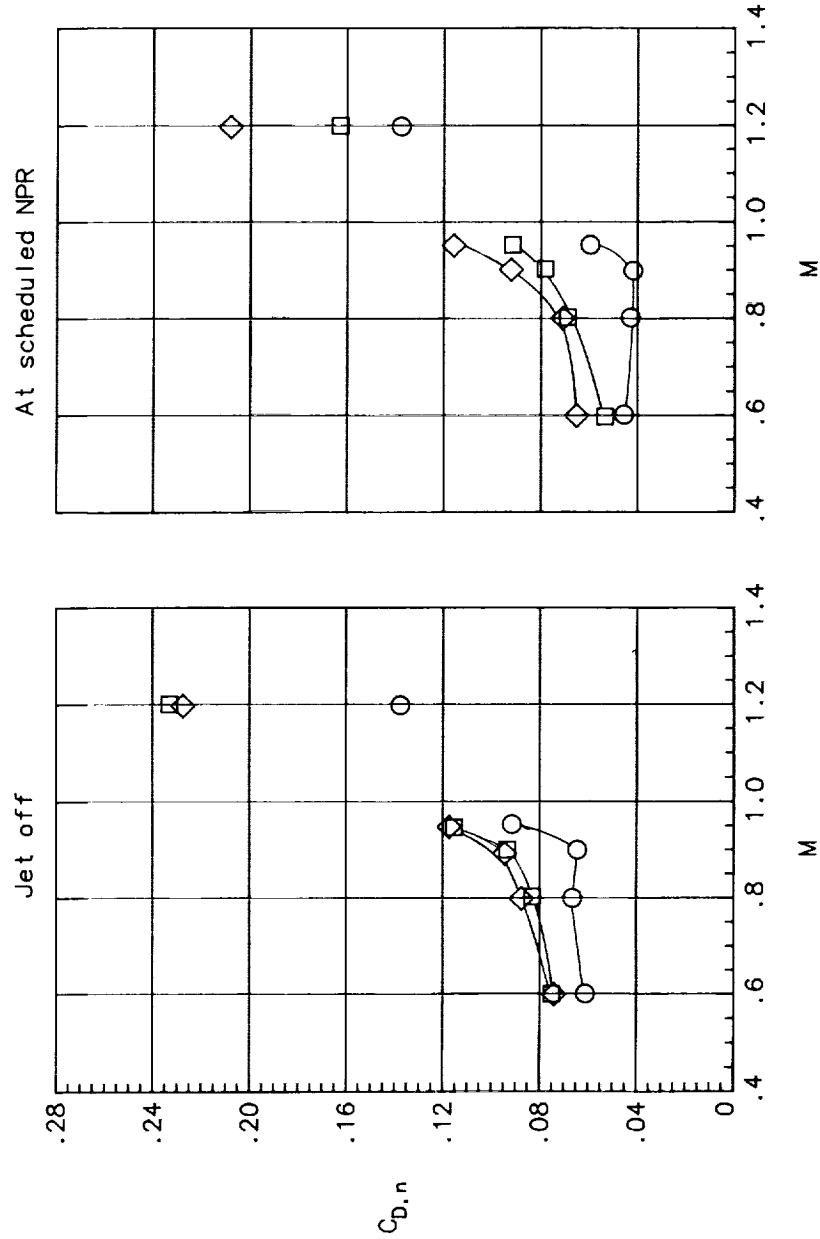
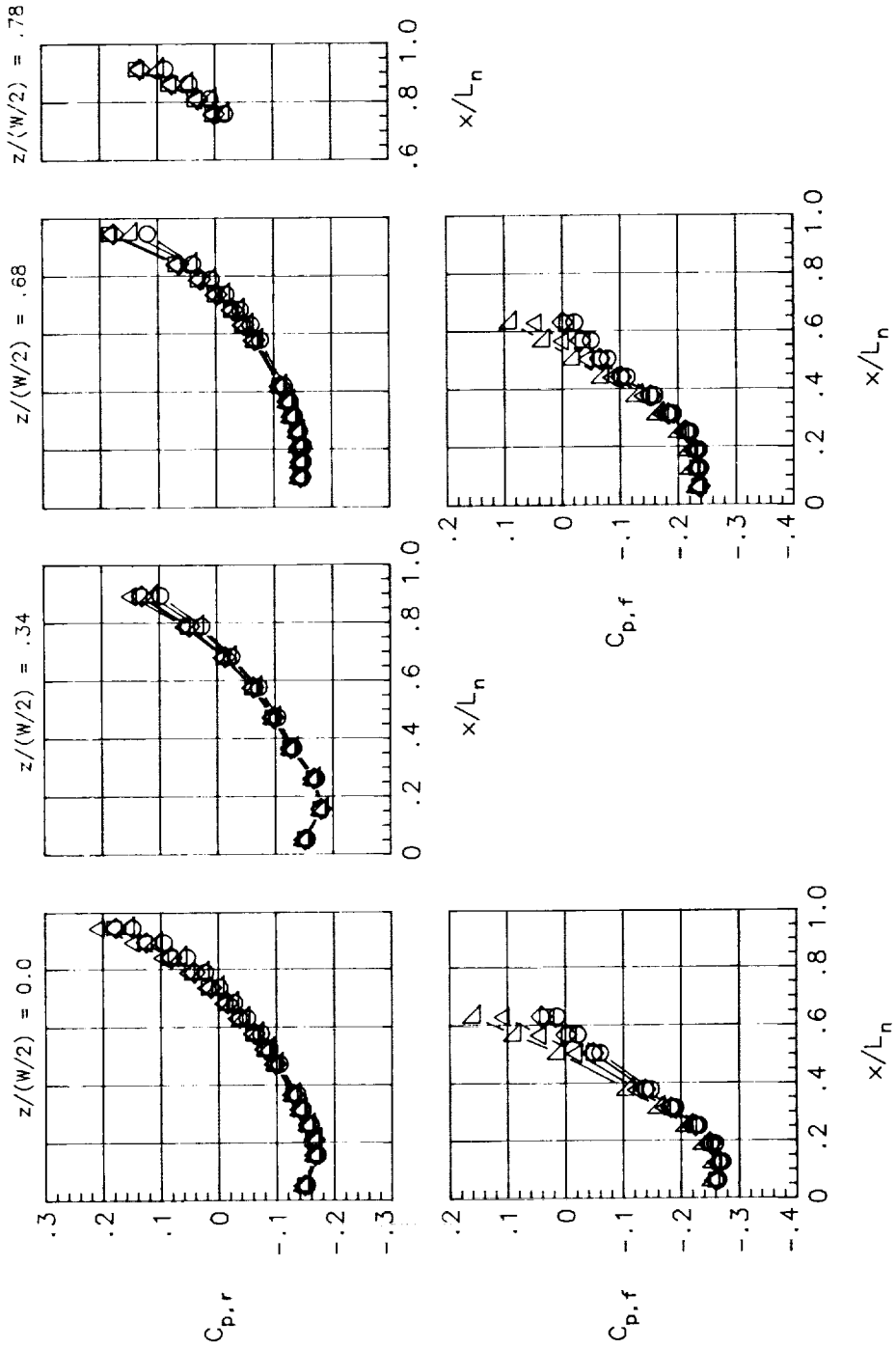


Figure 50. Comparison of nozzle drag between convergent-divergent and convergent nozzles.  
 $l_r/h_{t,n} = 4.50; \theta_r = 8.75^\circ; \beta_r = 8.15^\circ; x_t/h_{t,n} = 7.25; y_t/h_{t,n} = 0.12; \alpha = 0^\circ$ .

NPR

- 1.01
- 2.05
- ◇ 3.04
- △ 5.04
- ▽ 7.04

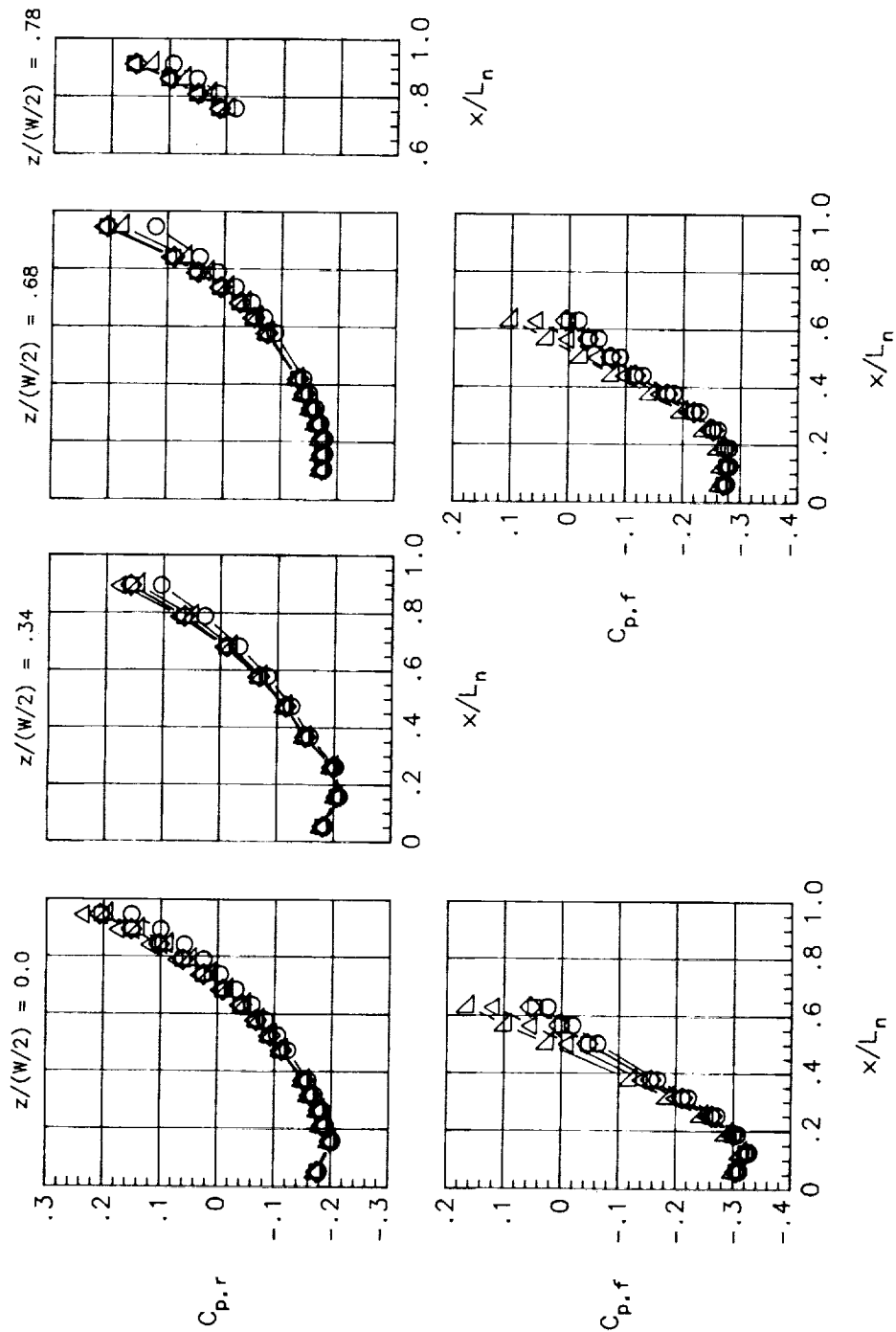


(a)  $M = 0.60$ .

Figure 51. External pressure distributions for nozzle 1 at  $\alpha = 0^\circ$ .

NPR

- 1.03
- 2.05
- ◇ 3.02
- △ 5.06
- ▴ 7.03



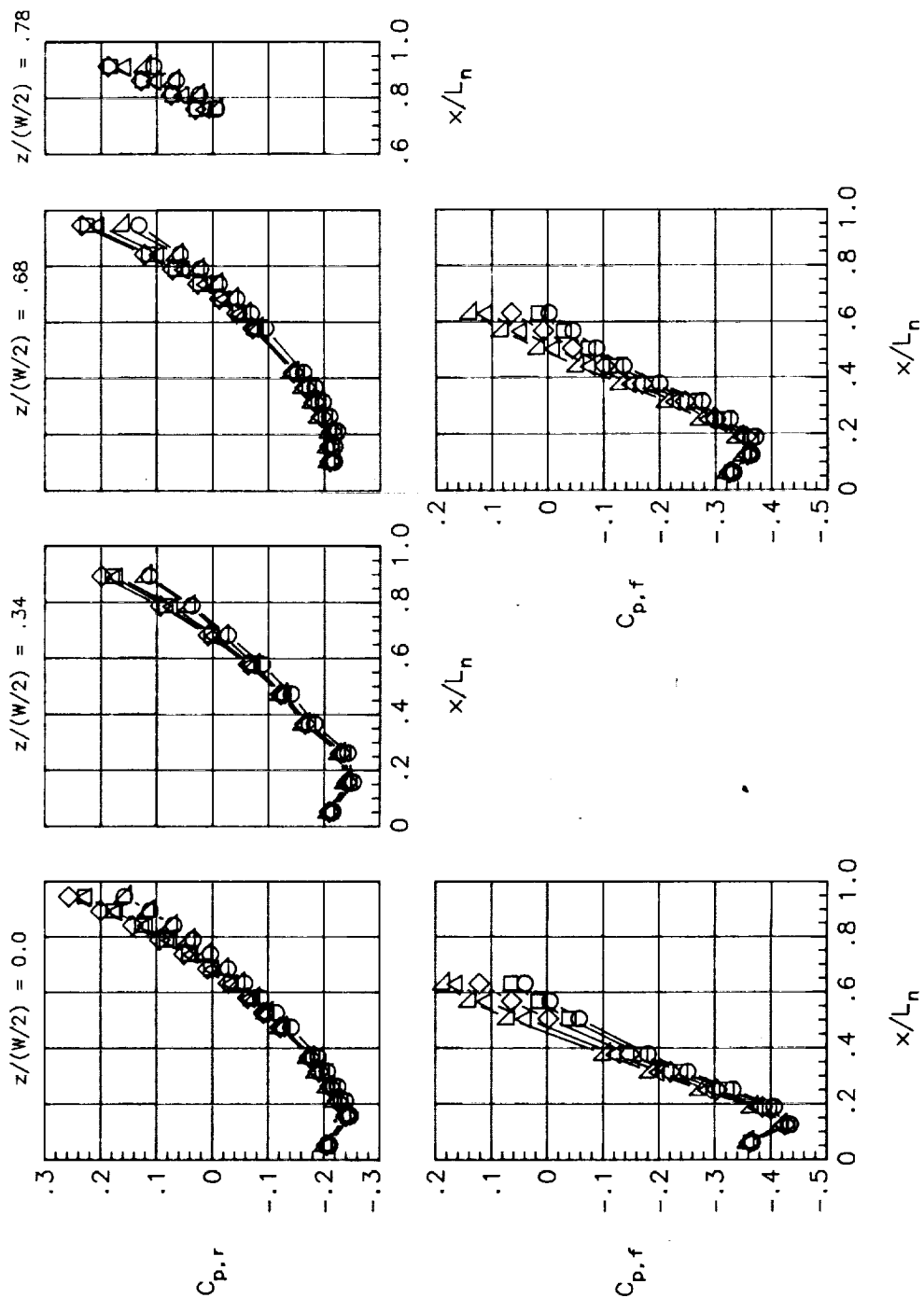
(b)  $M = 0.80$ .

Figure 51. Continued.



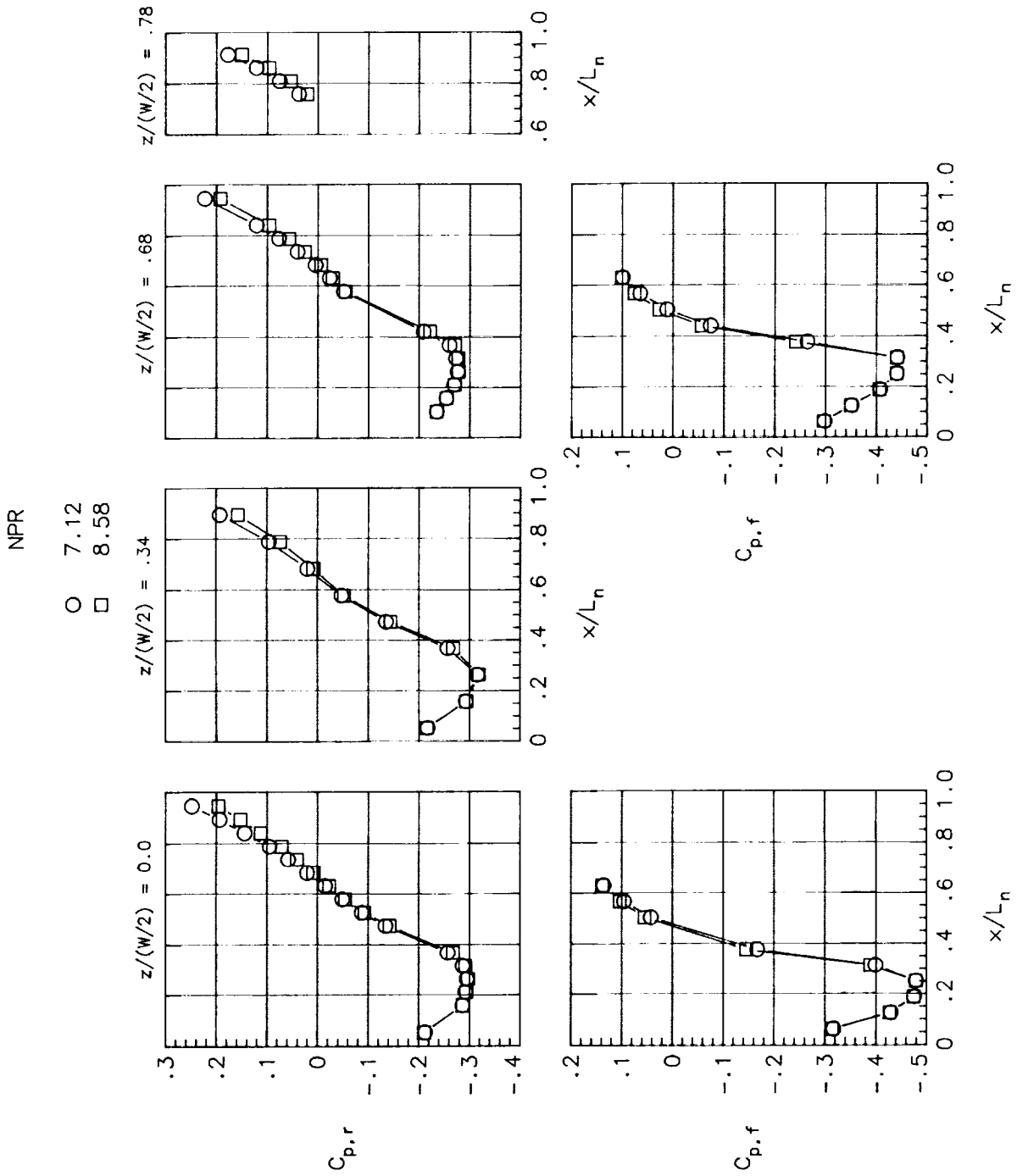
NPR

- 1.05
- 3.10
- ◇ 5.09
- △ 7.07
- ▽ 9.07



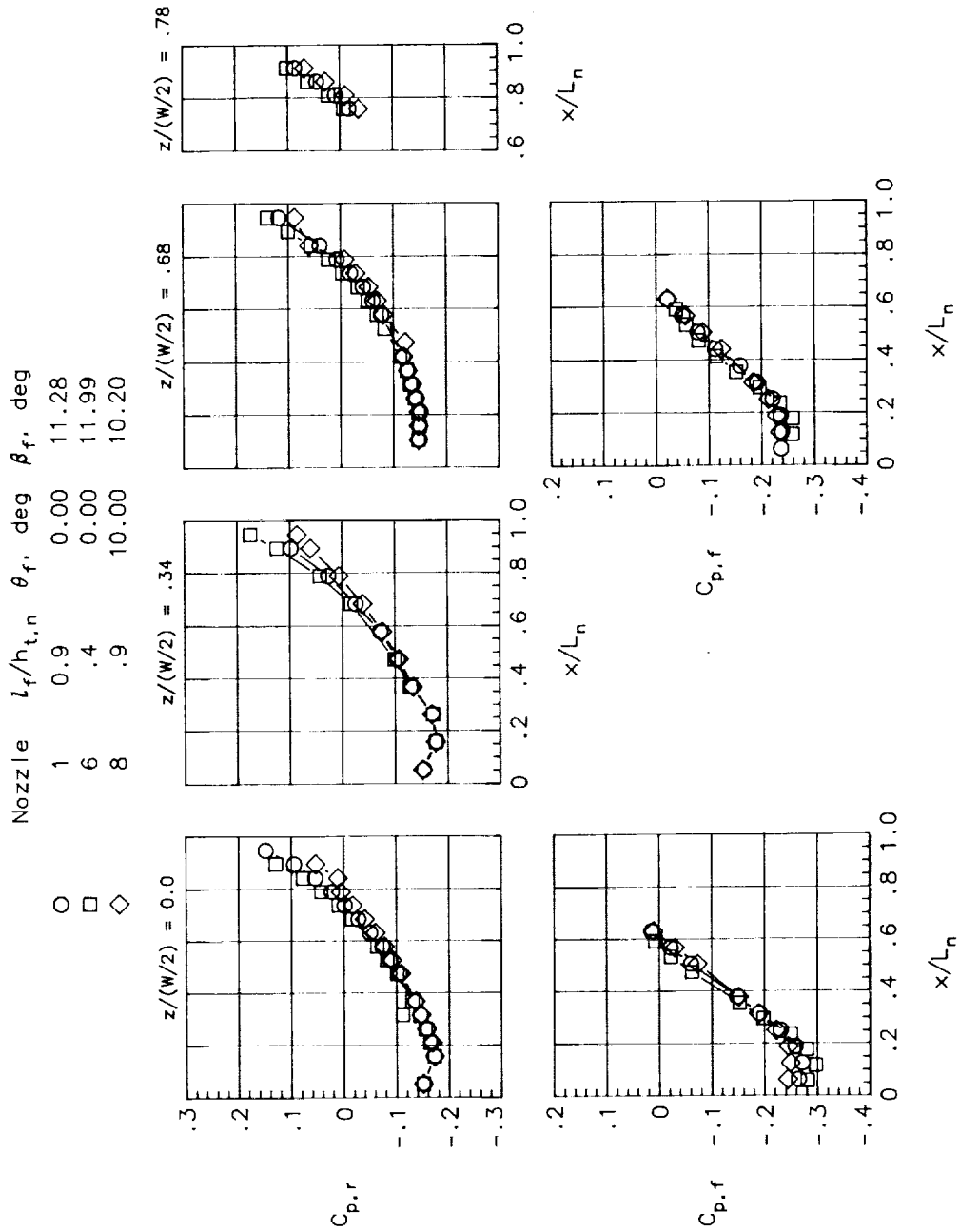
(c)  $M = 0.90$ .

Figure 51. Continued.



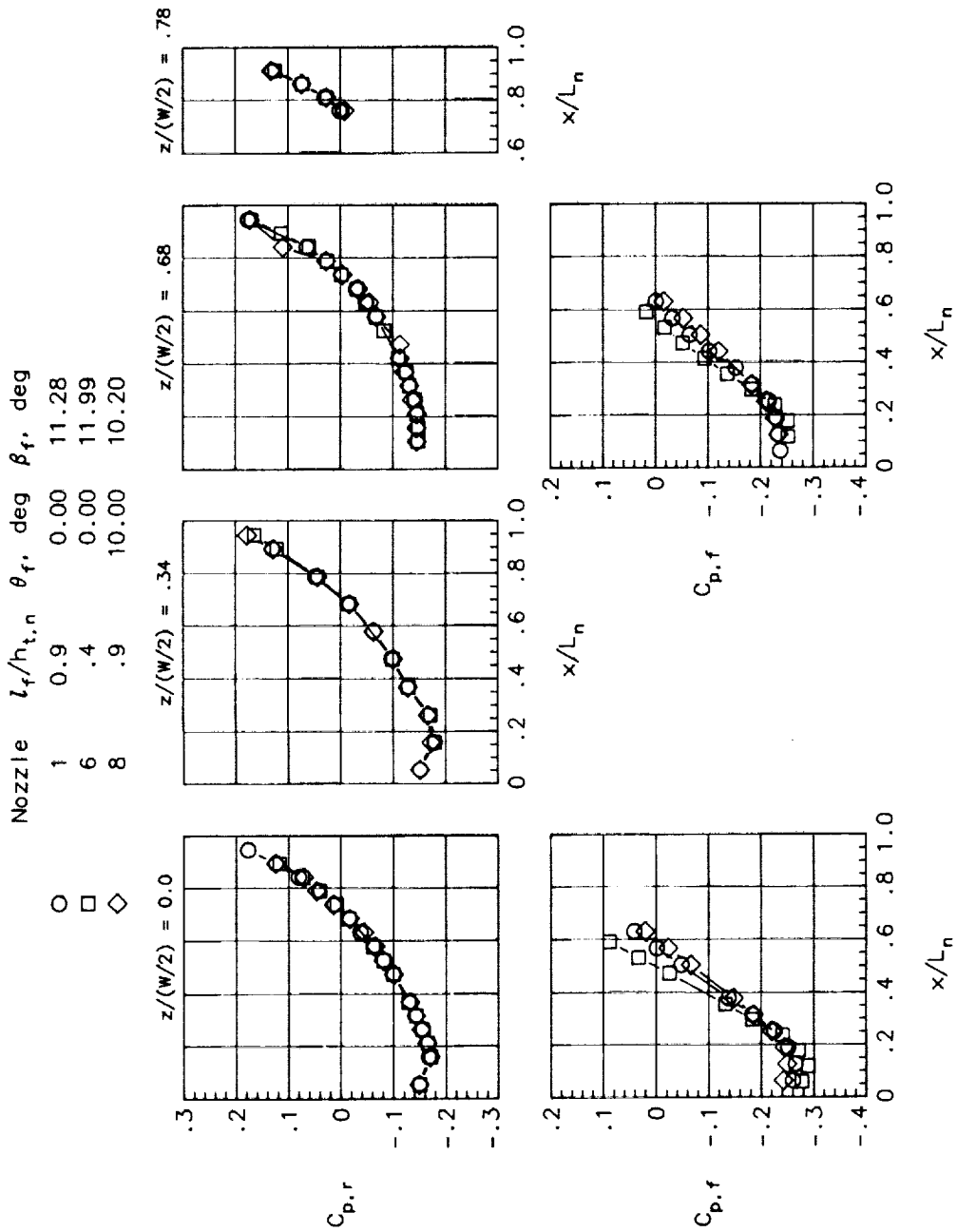
(d)  $M = 0.95$ .

Figure 51. Concluded.



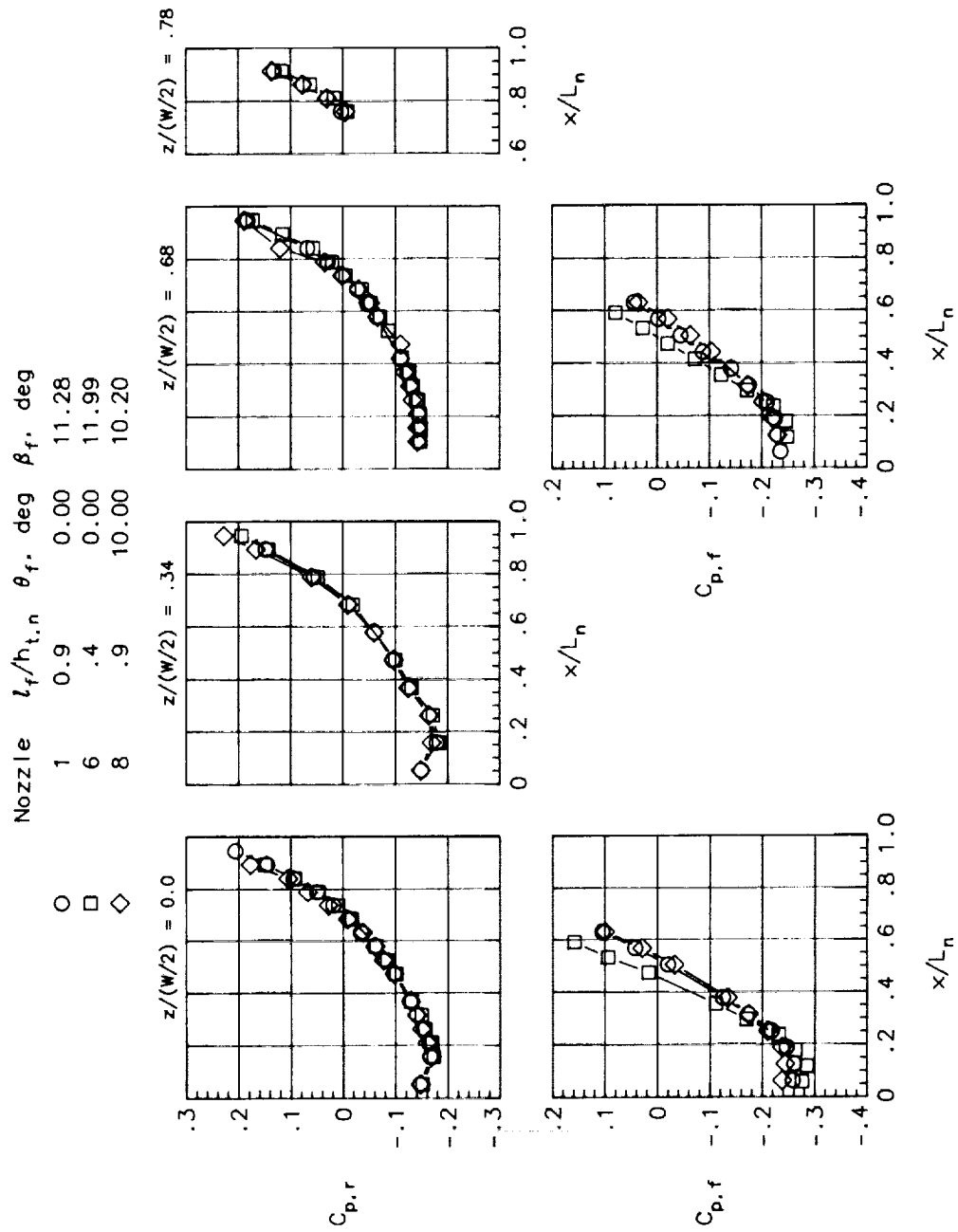
(a)  $M = 0.60$ ;  $NPR = 1$ .

Figure 52. Comparison of external pressure distributions for nozzles 1, 6, and 8 at  $\alpha = 0^\circ$ .



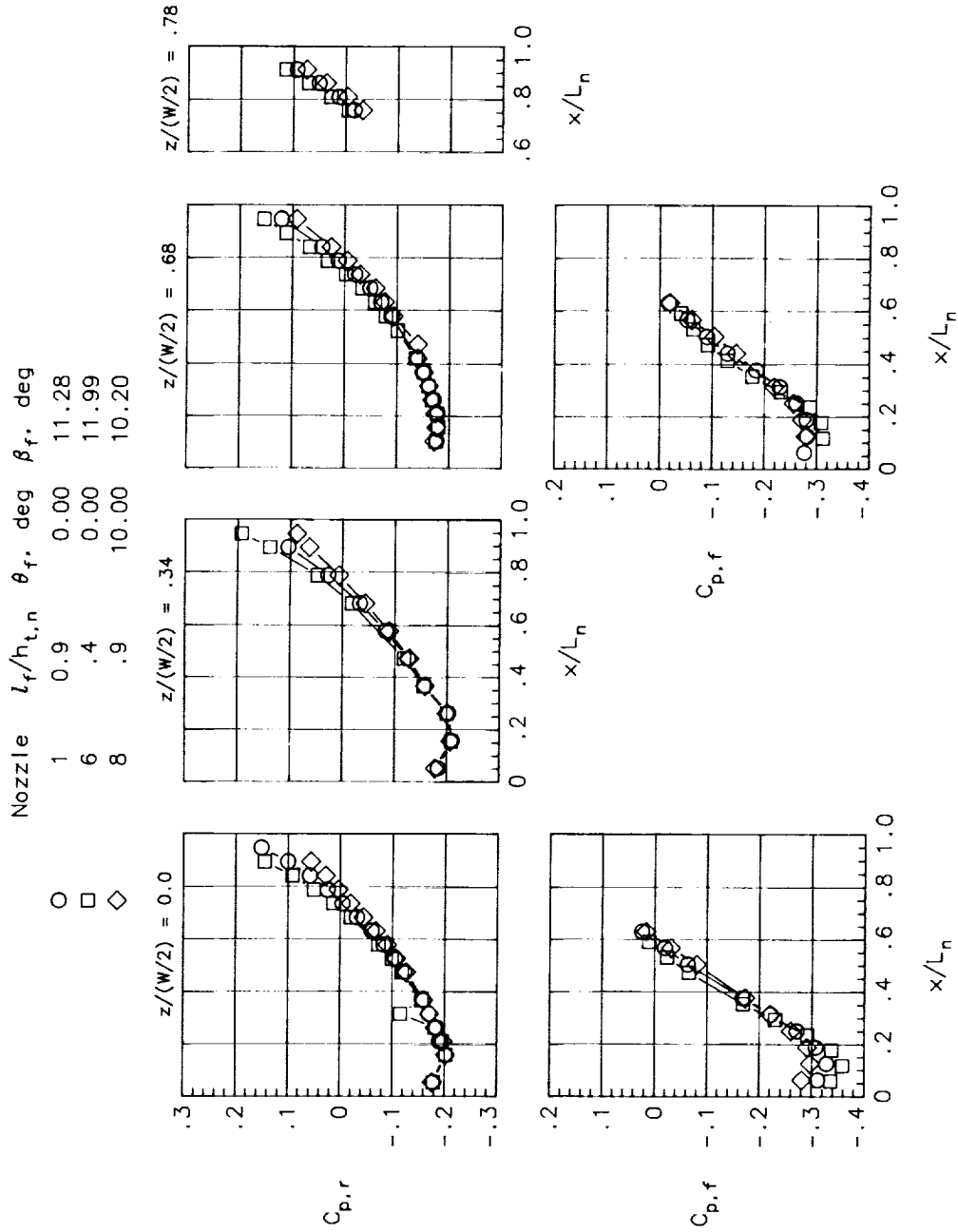
(b)  $M = 0.60$ ; NPR = 3.

Figure 52. Continued.



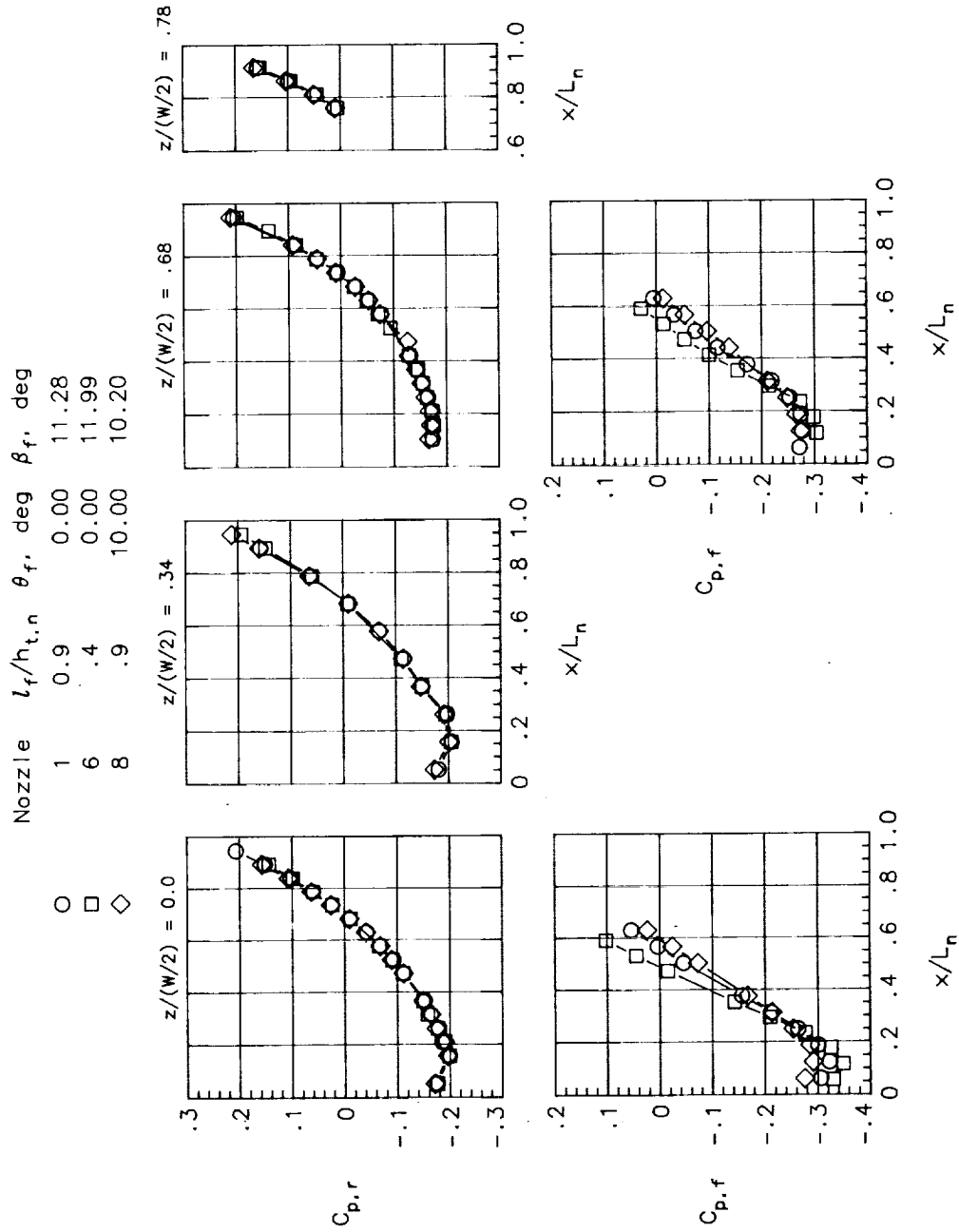
(c)  $M = 0.60$ ;  $NPR = 5$ .

Figure 52. Continued.



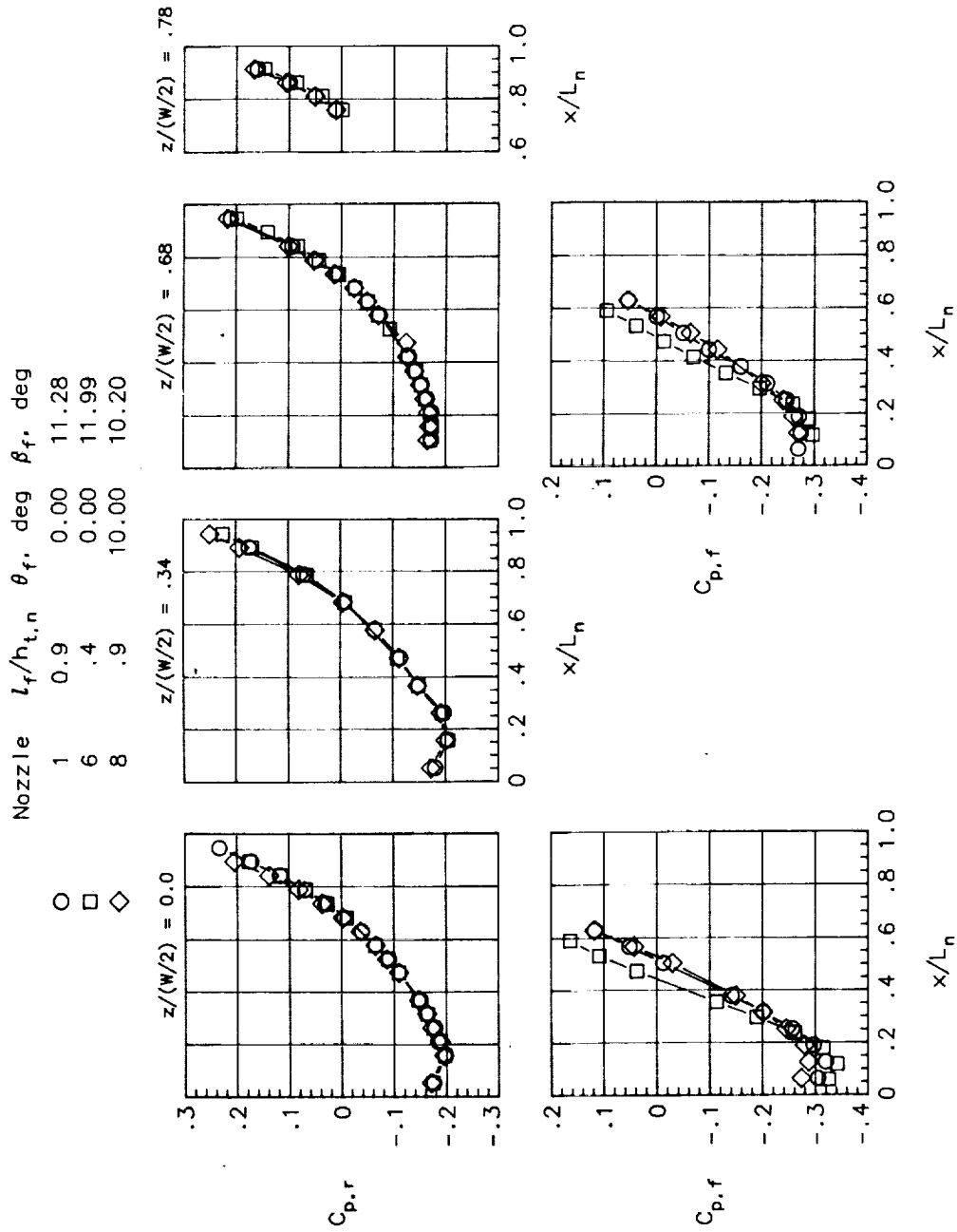
(d)  $M = 0.80$ ;  $NPR = 1$ .

Figure 52. Continued.



(e)  $M = 0.80$ ;  $NPR = 3$ .

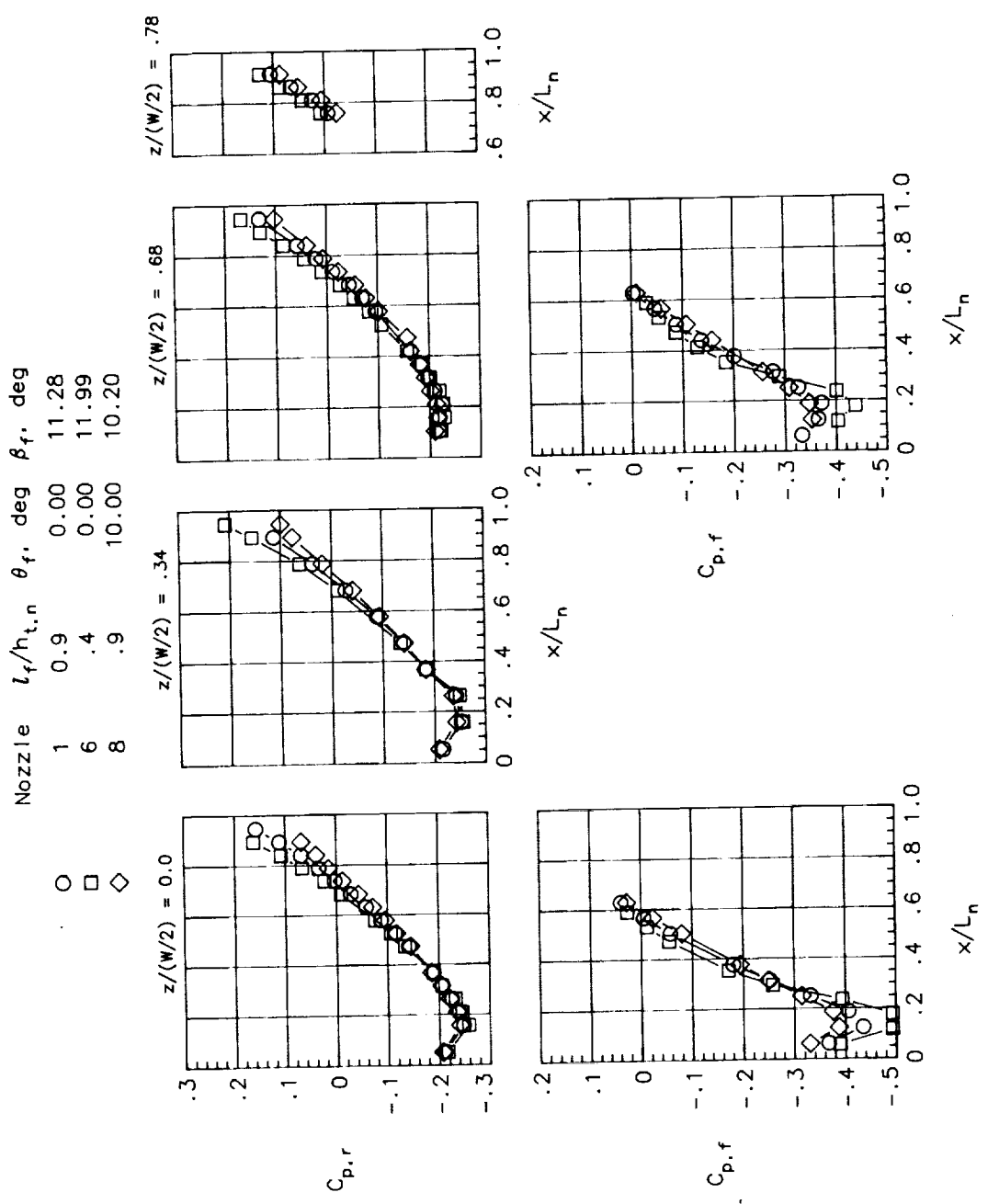
Figure 52. Continued.



(f)  $M = 0.80$ ;  $NPR = 5$ .

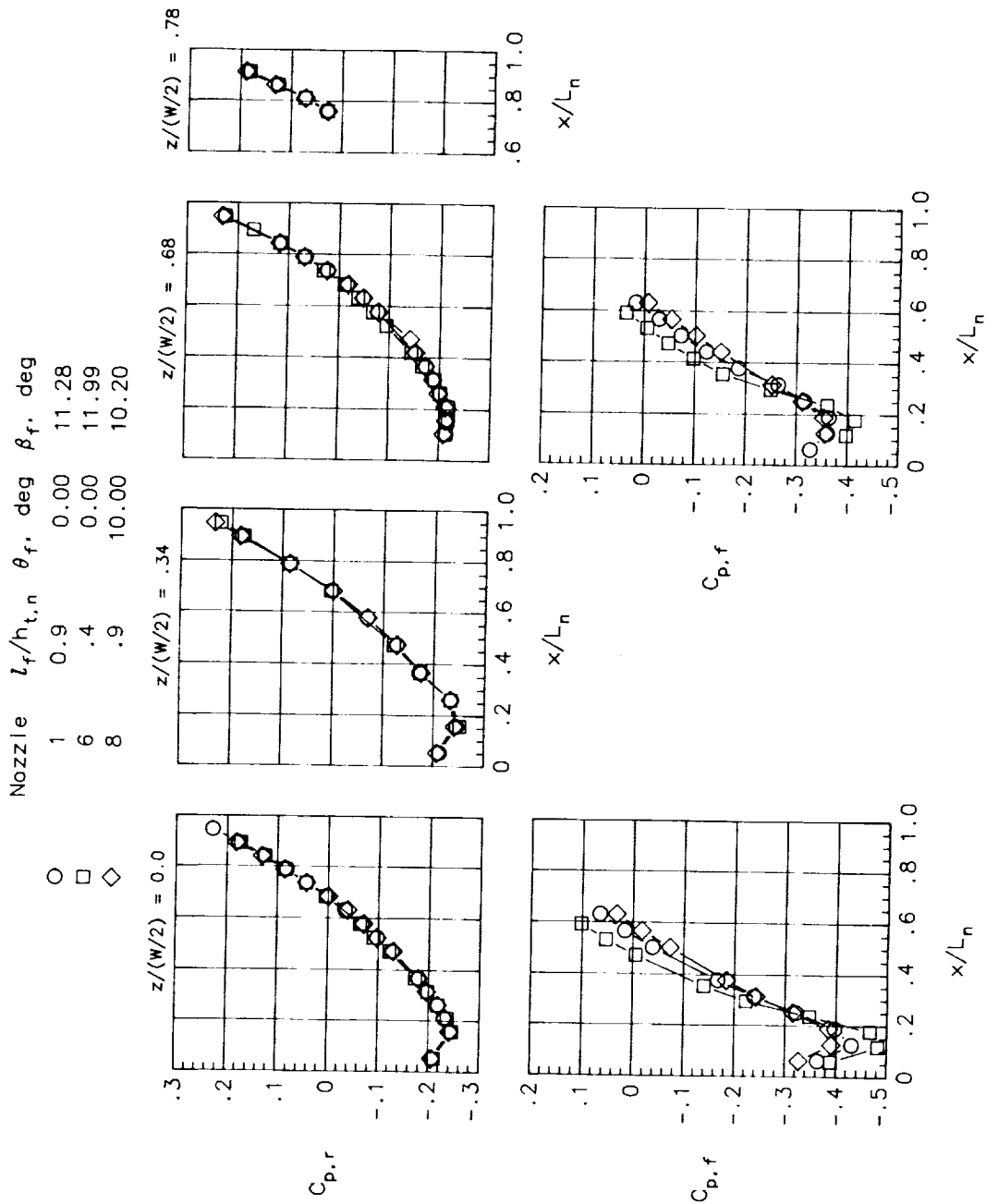
Figure 52. Continued.





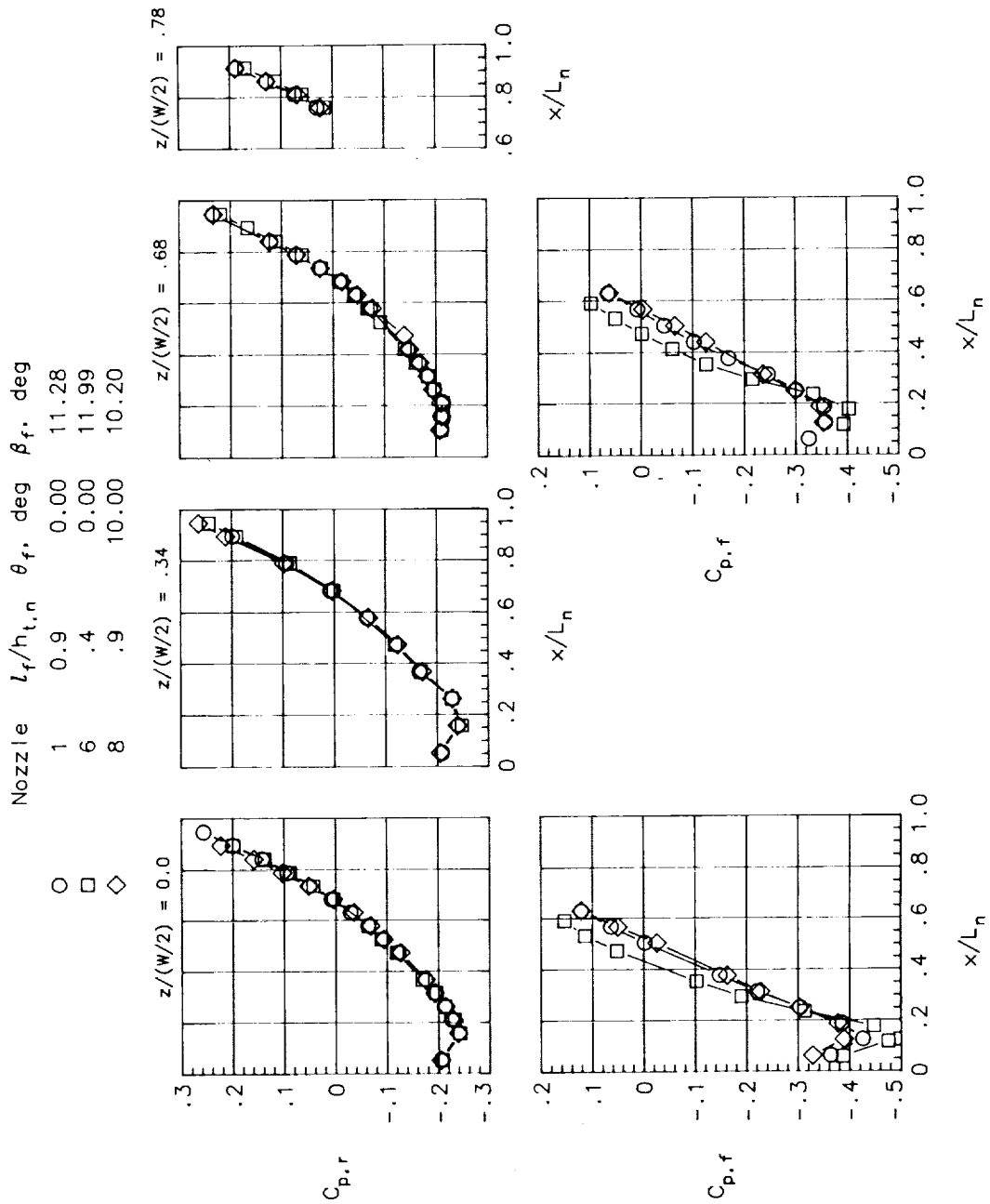
(g)  $M = 0.90$ ;  $NPR = 1$ .

Figure 52. Continued.



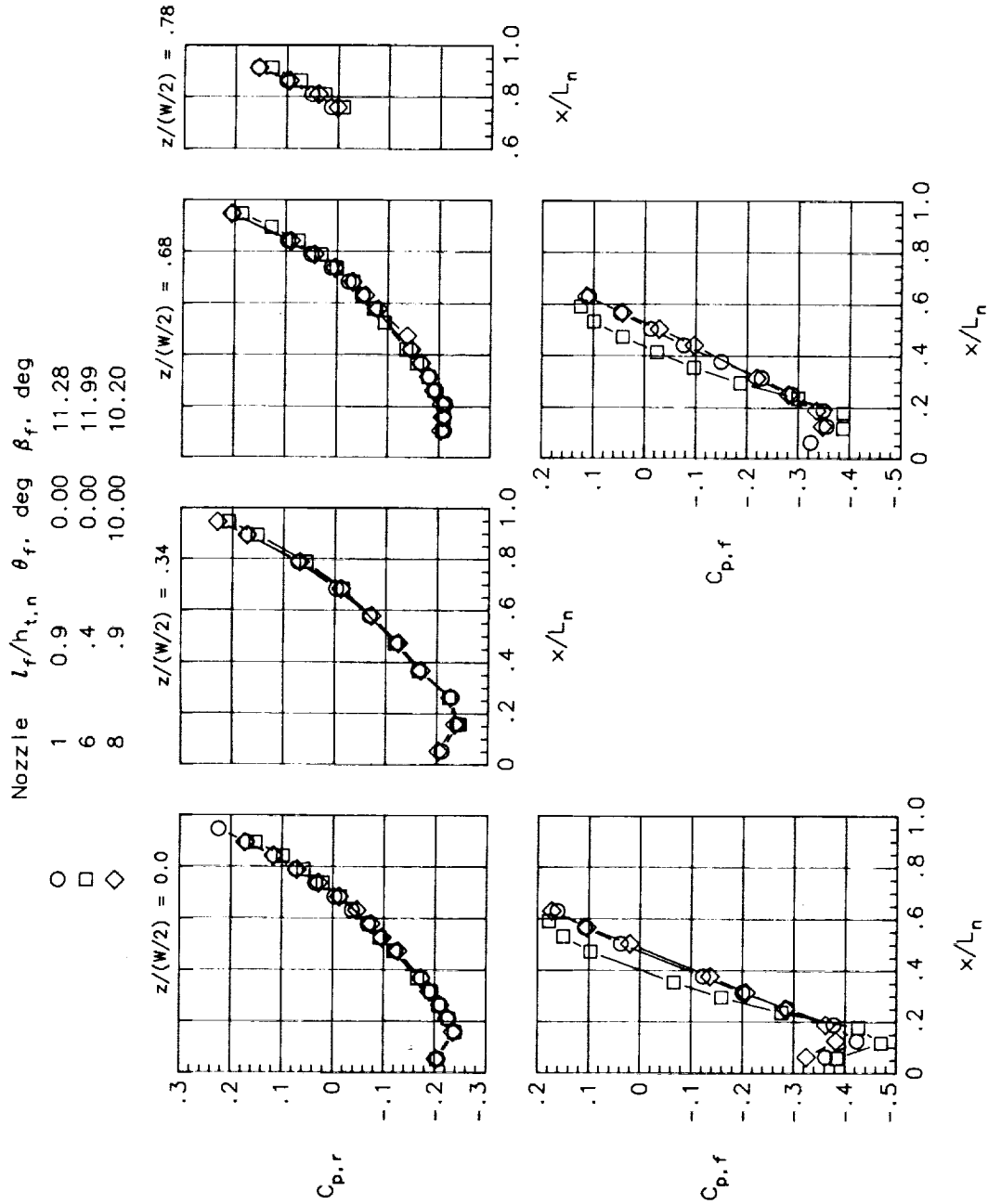
(h)  $M = 0.90$ ;  $NPR = 3$ .

Figure 52. Continued.



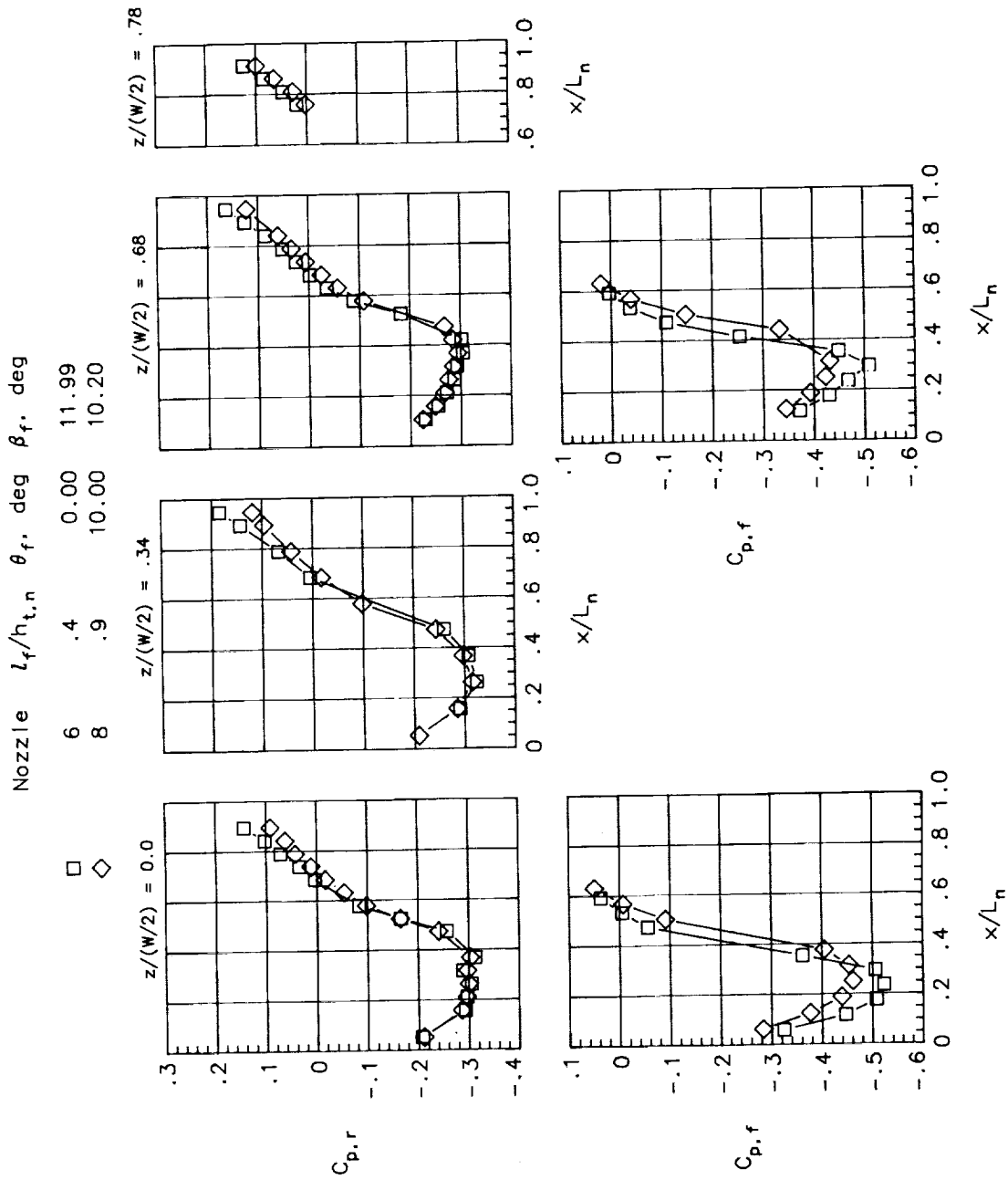
(i)  $M = 0.90$ ;  $NPR = 5$ .

Figure 52. Continued.



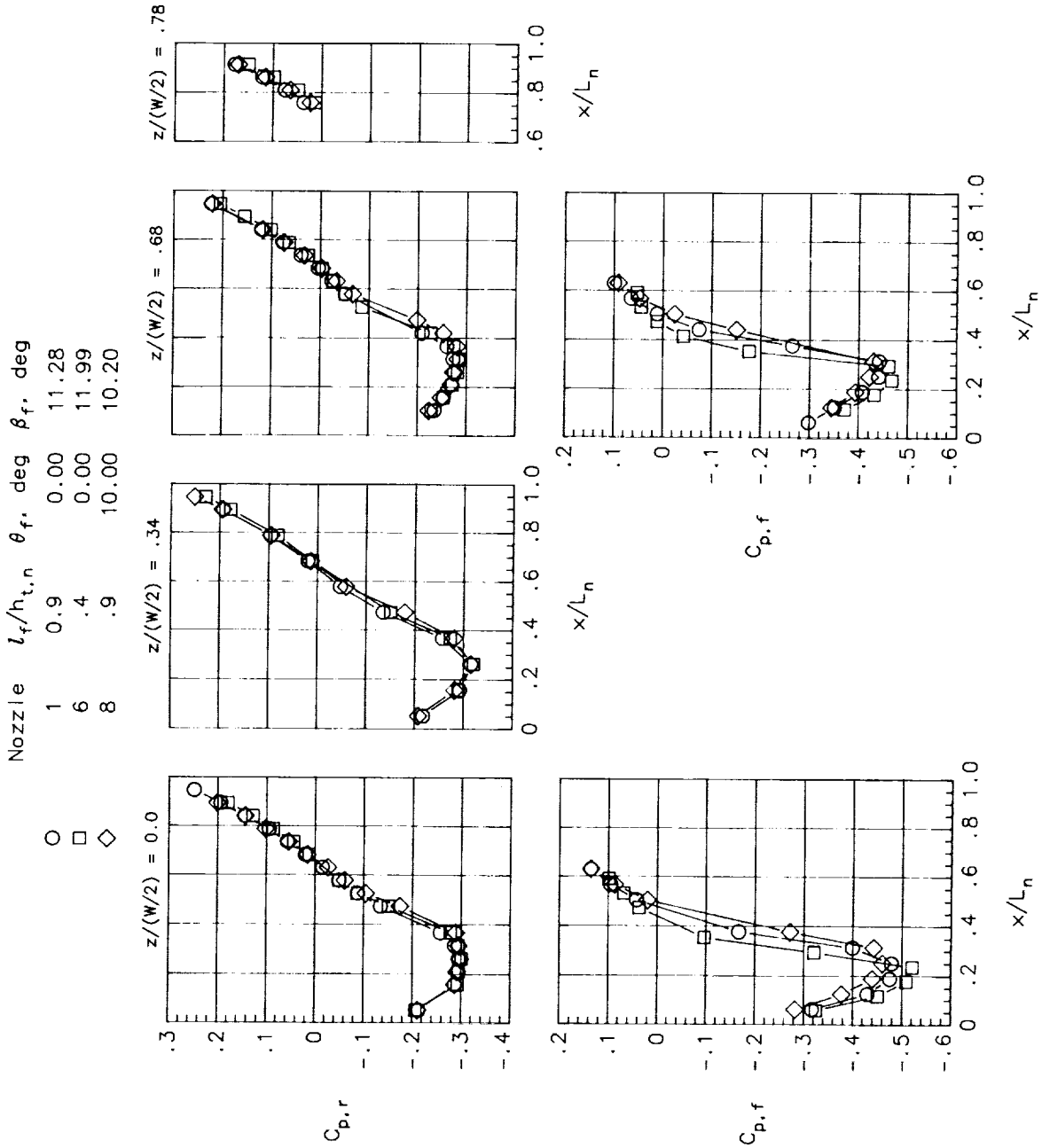
(j)  $M = 0.90$ ;  $NPR = 7$ .

Figure 52. Continued.



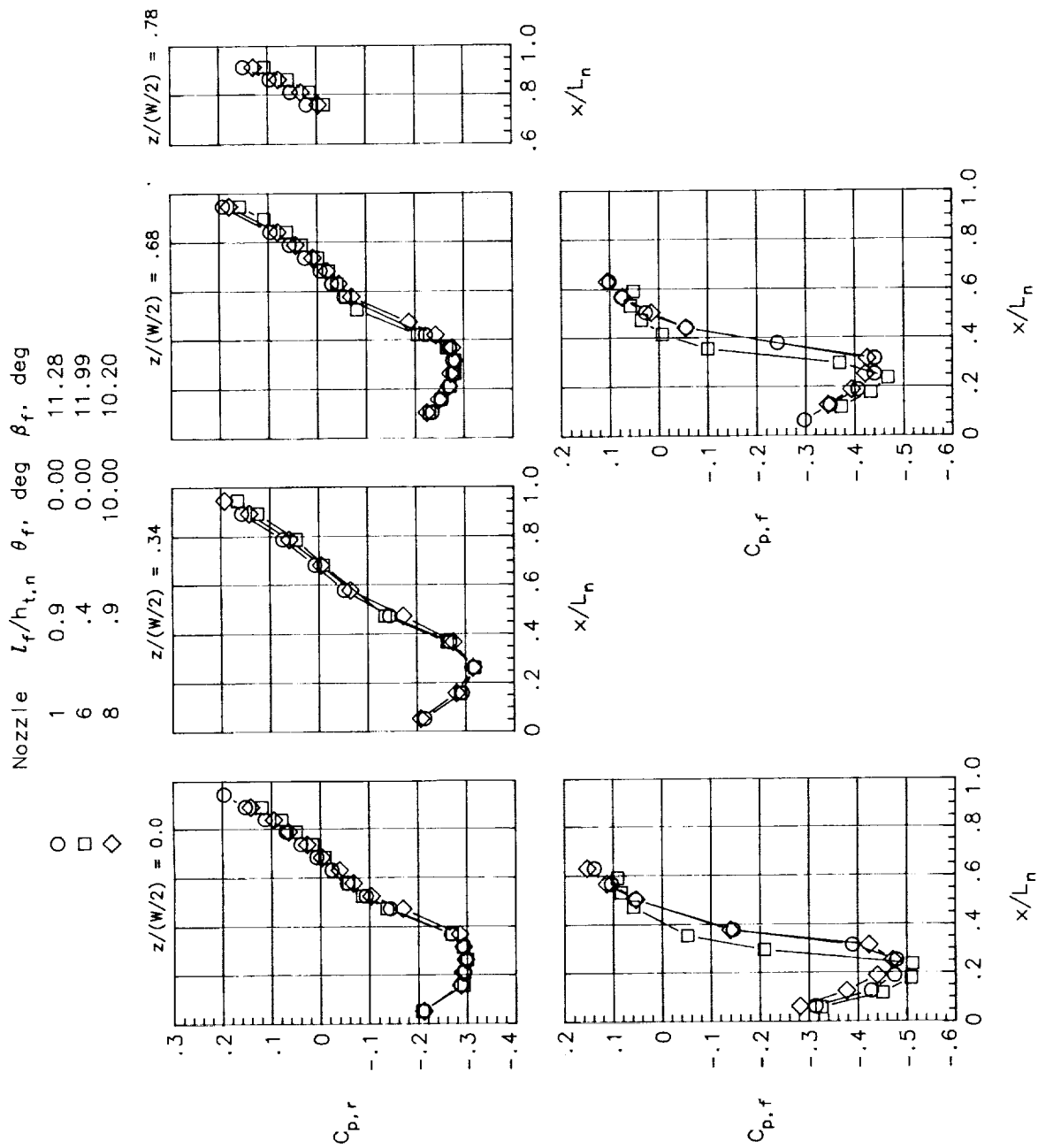
(k)  $M = 0.95$ ; NPR = 1.

Figure 52. Continued.



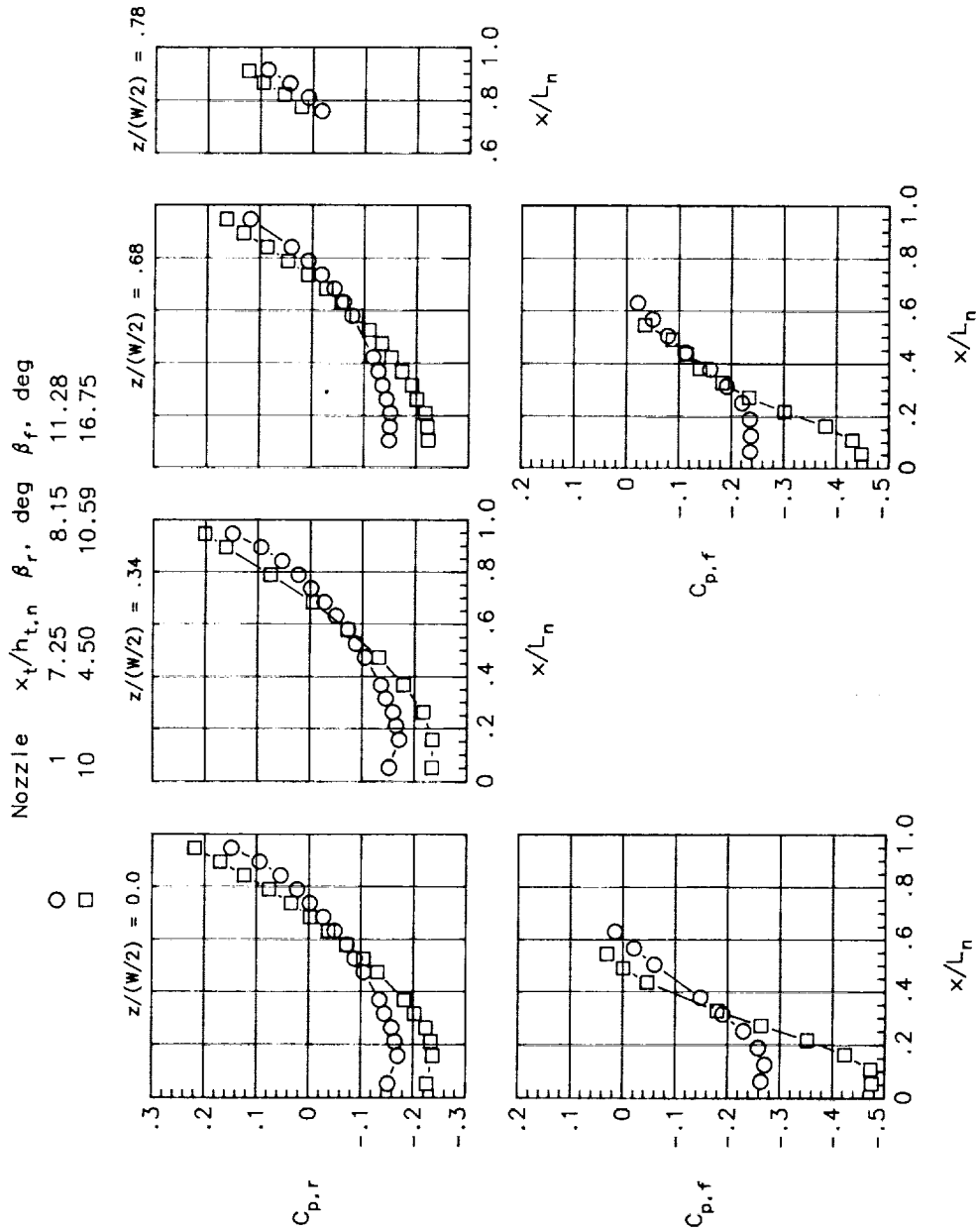
(1)  $M = 0.95$ ; NPR = 7.

Figure 52. Continued.



(m)  $M = 0.95$ ; NPR = 9.

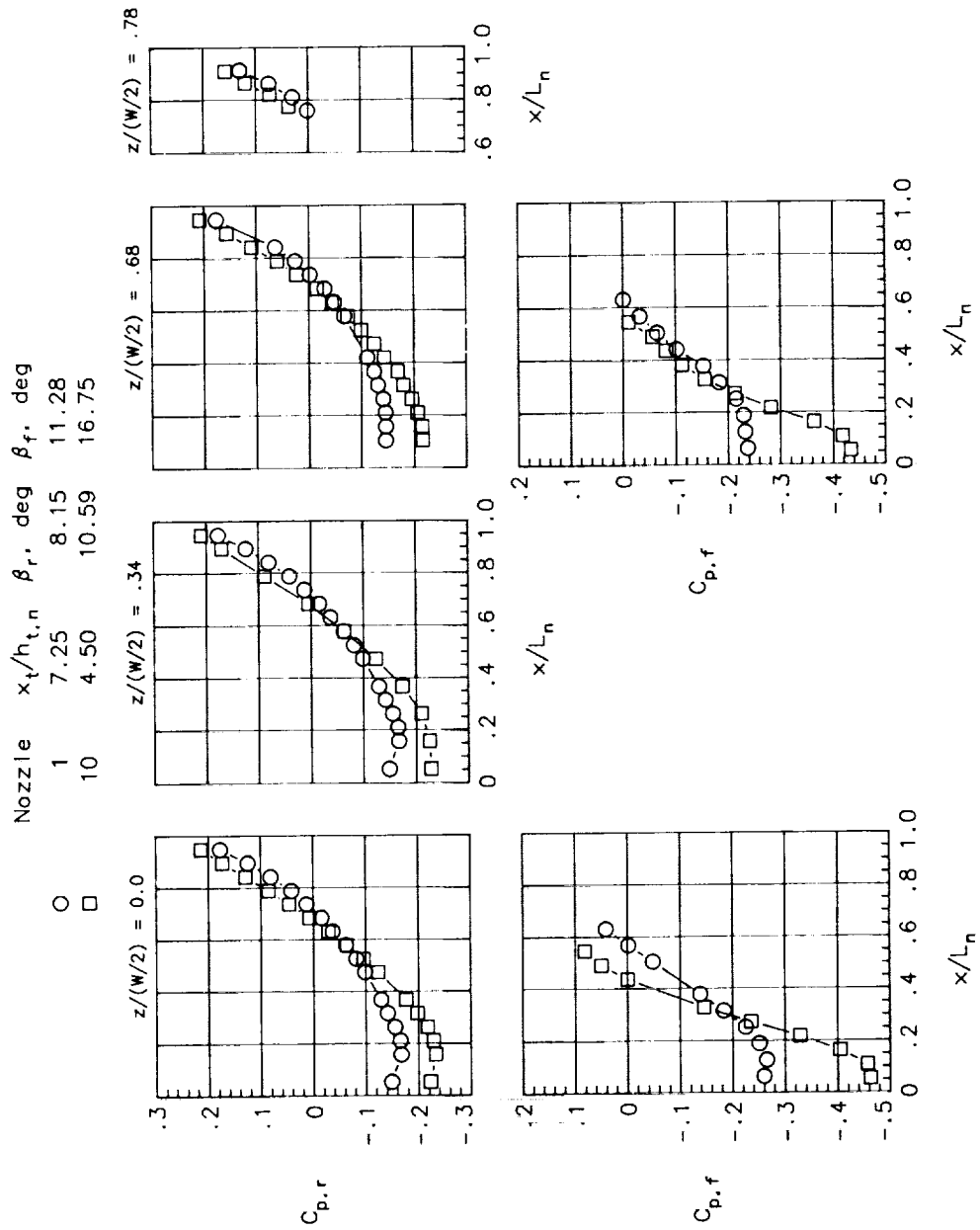
Figure 52. Concluded.



(a)  $M = 0.60$ ;  $NPR = 1$ .

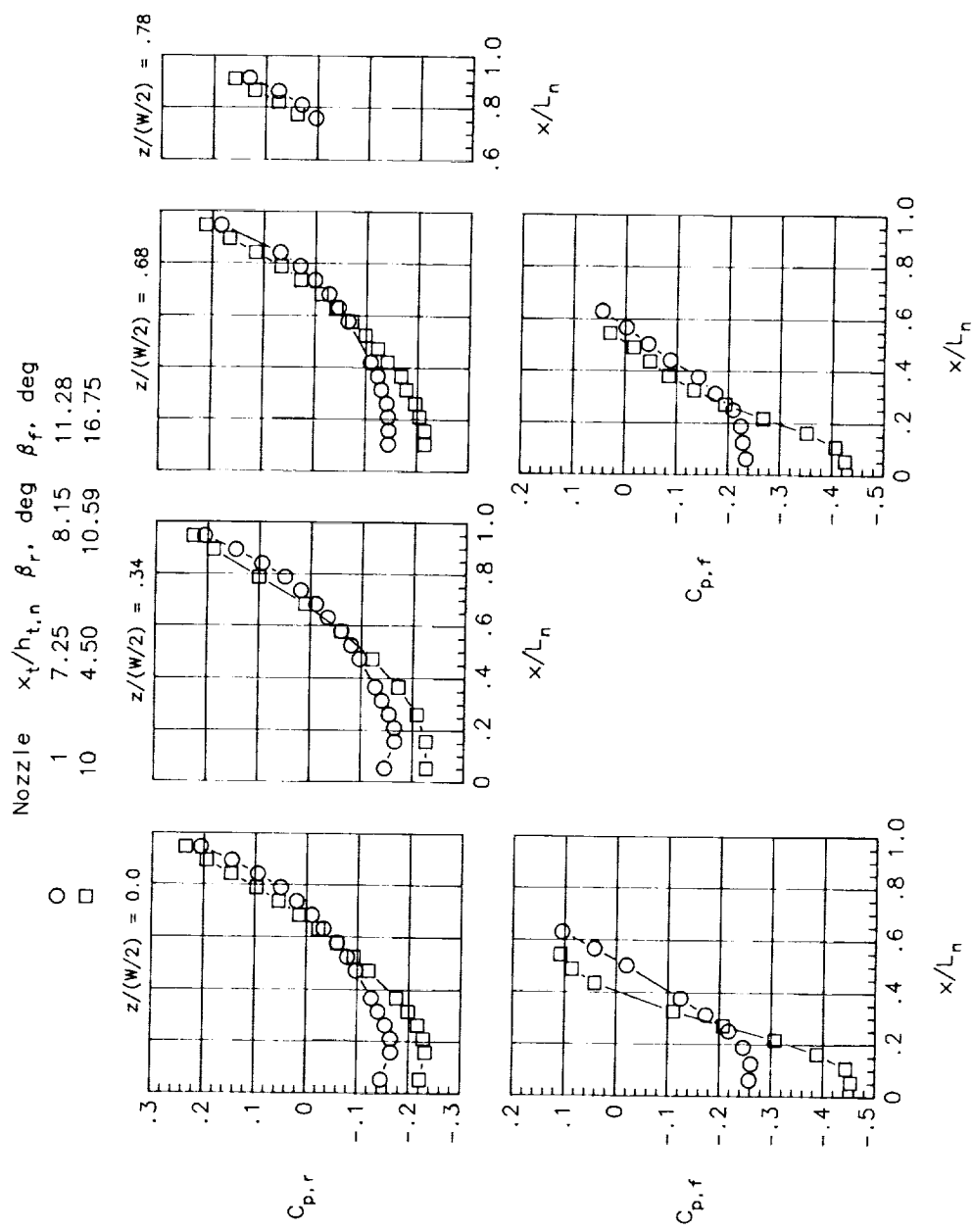
Figure 53. Comparison of external pressure distributions for nozzles 1 and 10 at  $\alpha = 0^\circ$ .





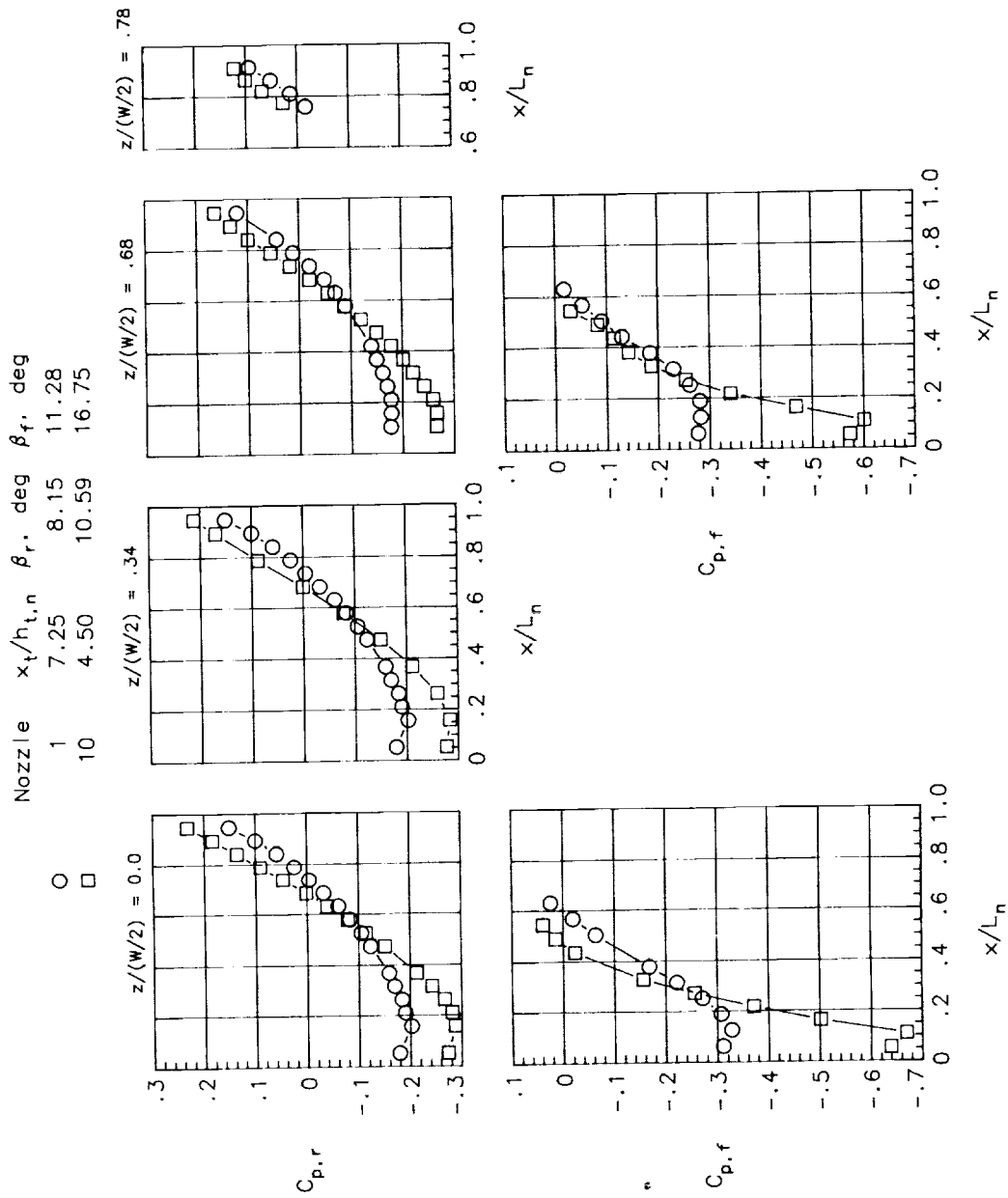
(b)  $M = 0.60$ ;  $NPR = 3$ .

Figure 53. Continued.



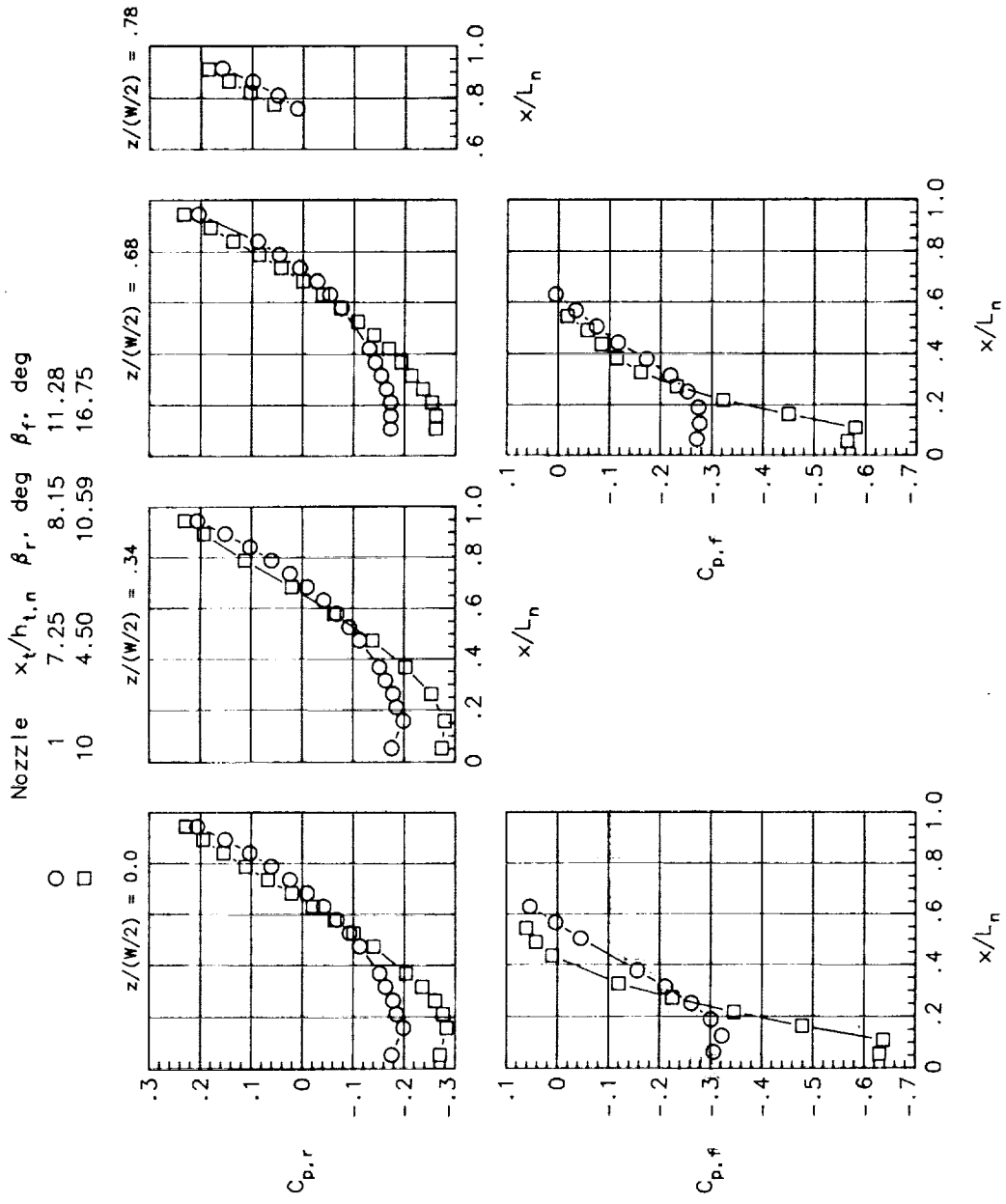
(c)  $M = 0.60$ ; NPR = 5.

Figure 53. Continued.



(d)  $M = 0.80$ ;  $NPR = 1$ .

Figure 53. Continued.

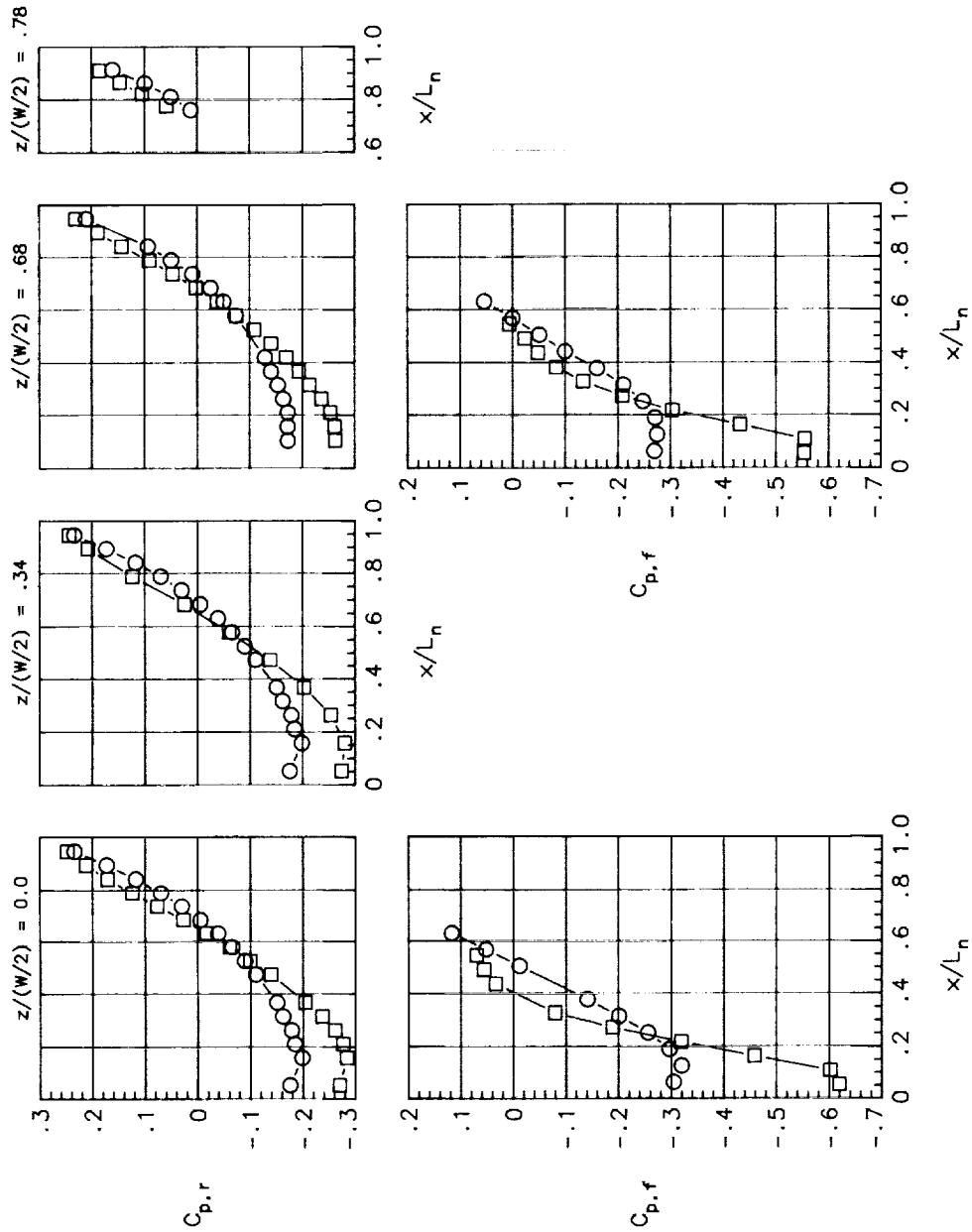


(c)  $M = 0.80$ ; NPR = 3.

Figure 53. Continued.

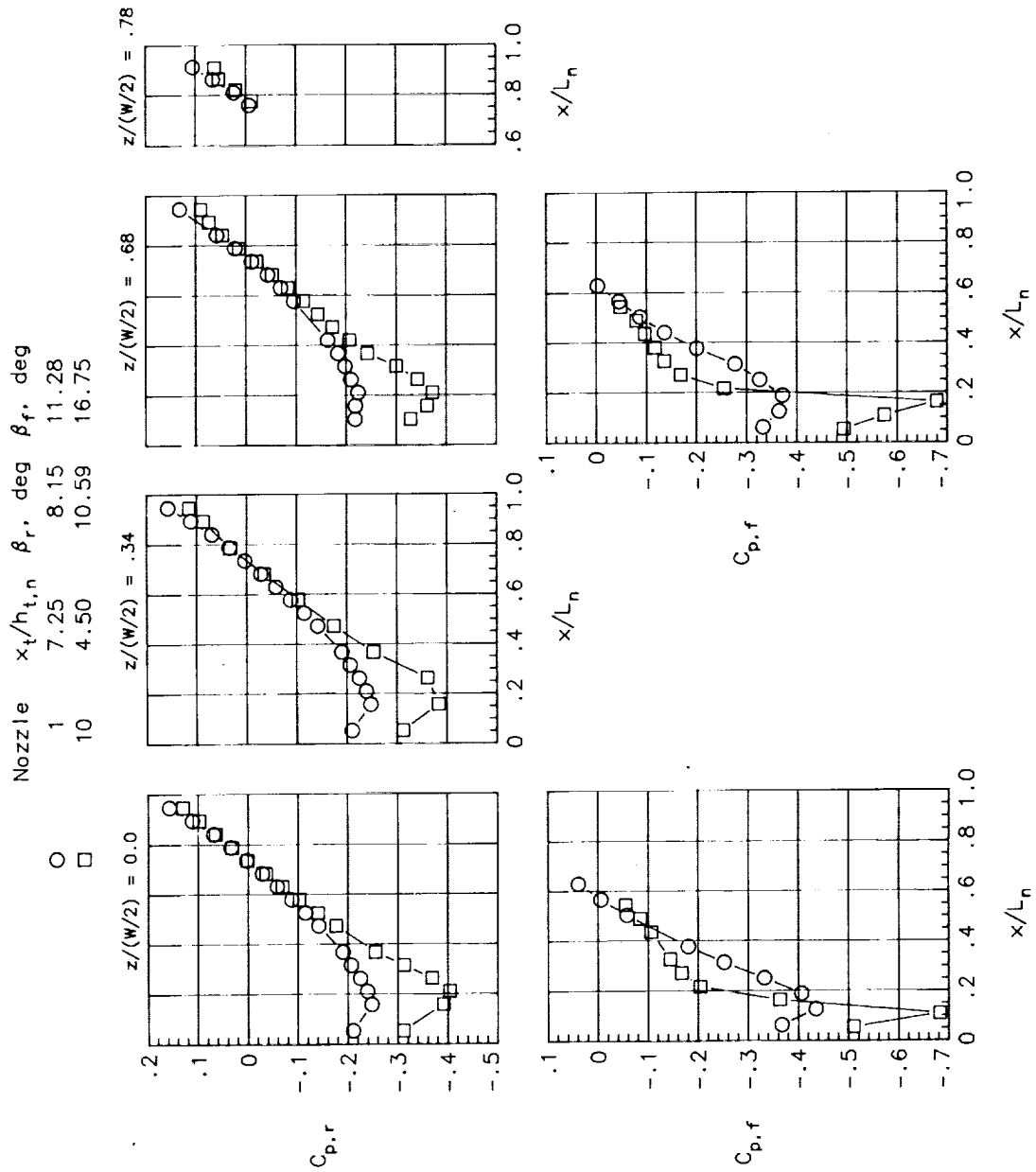
Nozzle  $x_t/h_{t,n}$   $\beta_r$ , deg  $\beta_f$ , deg

1	7.25	8.15	11.28
10	4.50	10.59	16.75



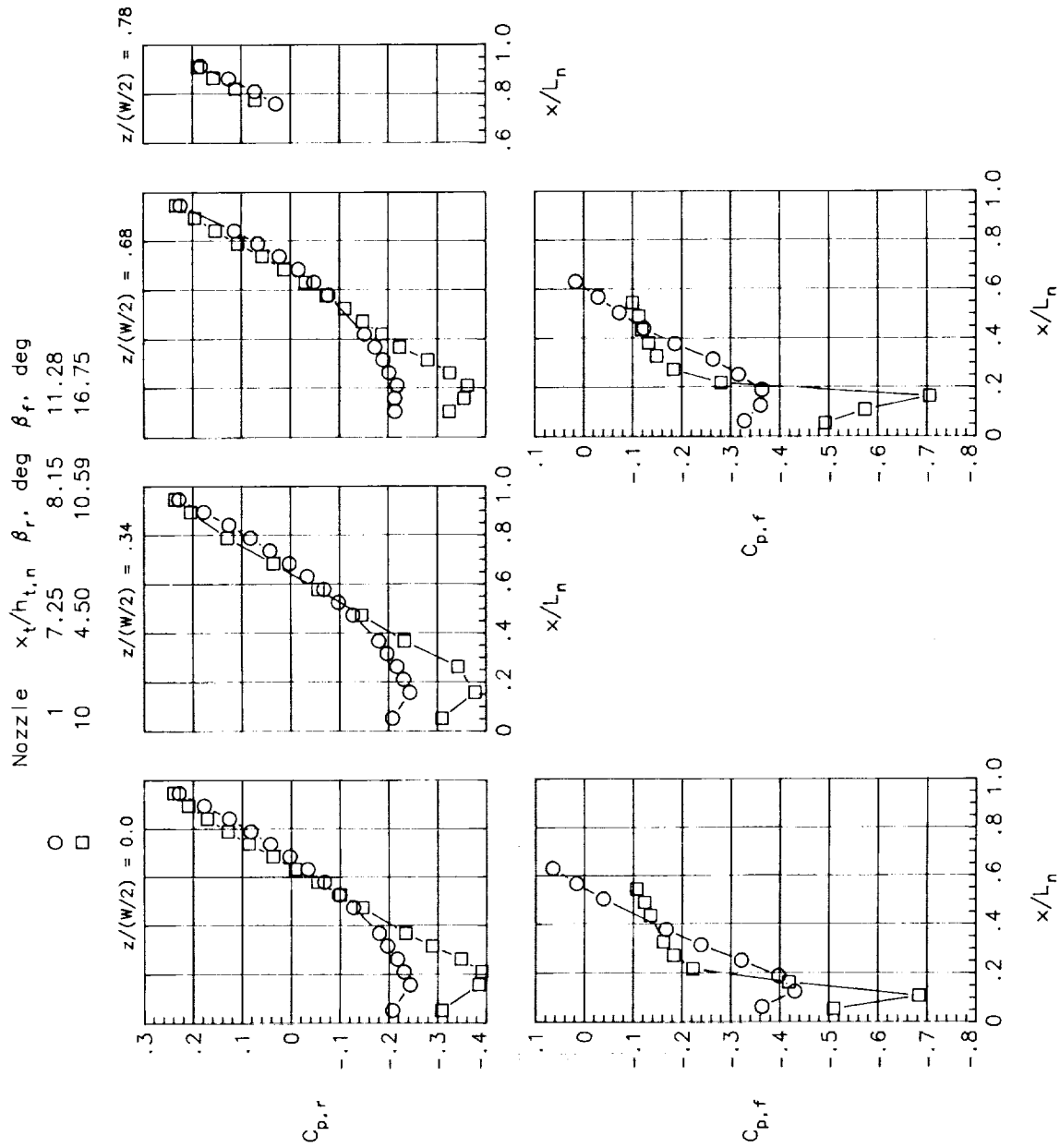
(f)  $M = 0.80$ ;  $NPR = 5$ .

Figure 53. Continued.



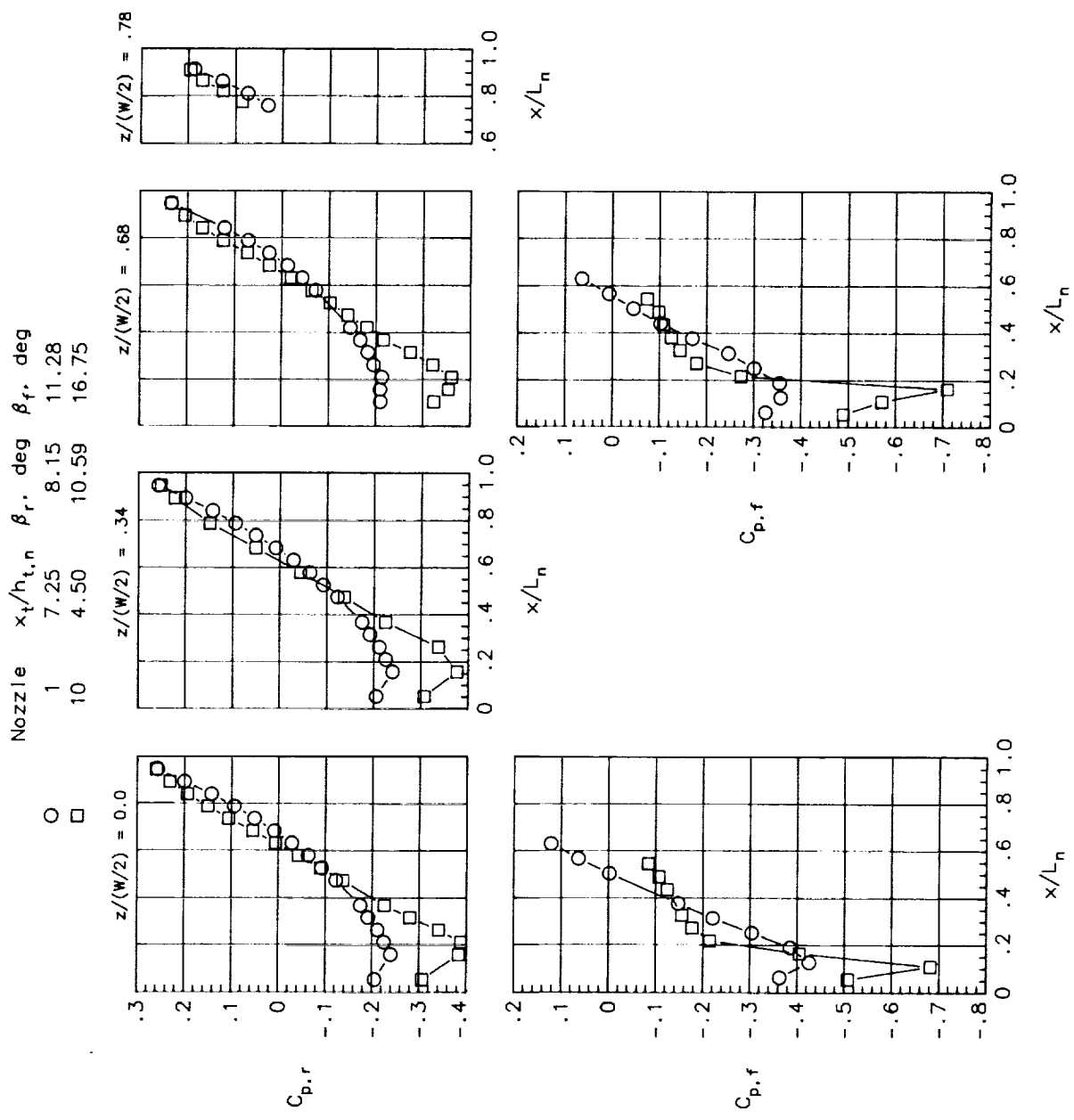
(g)  $M = 0.90$ ; NPR = 1.

Figure 53. Continued.



(h)  $M = 0.90$ ;  $NPR = 3$ .

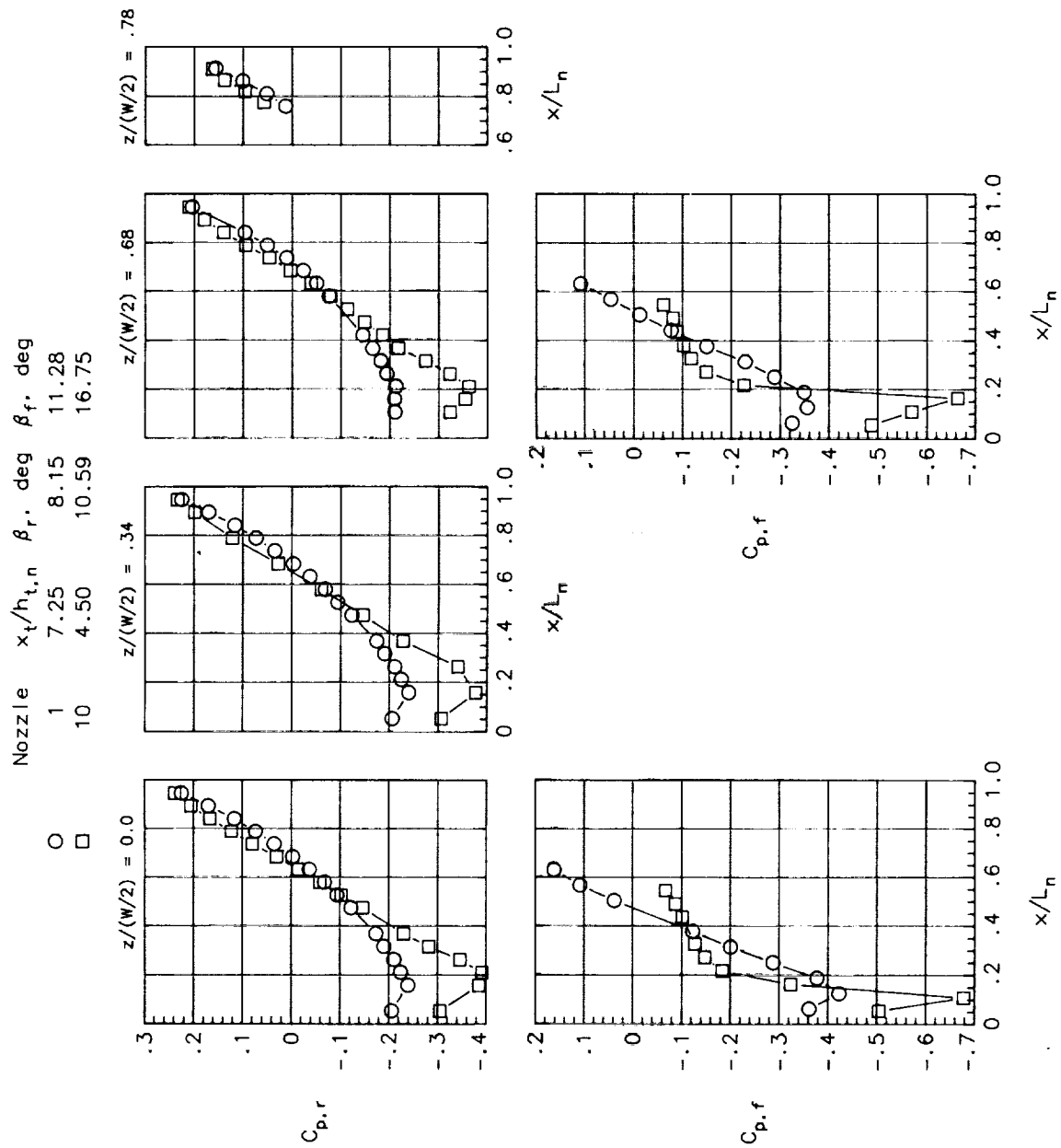
Figure 53. Continued.



(i)  $M = 0.90$ ; NPR = 5.

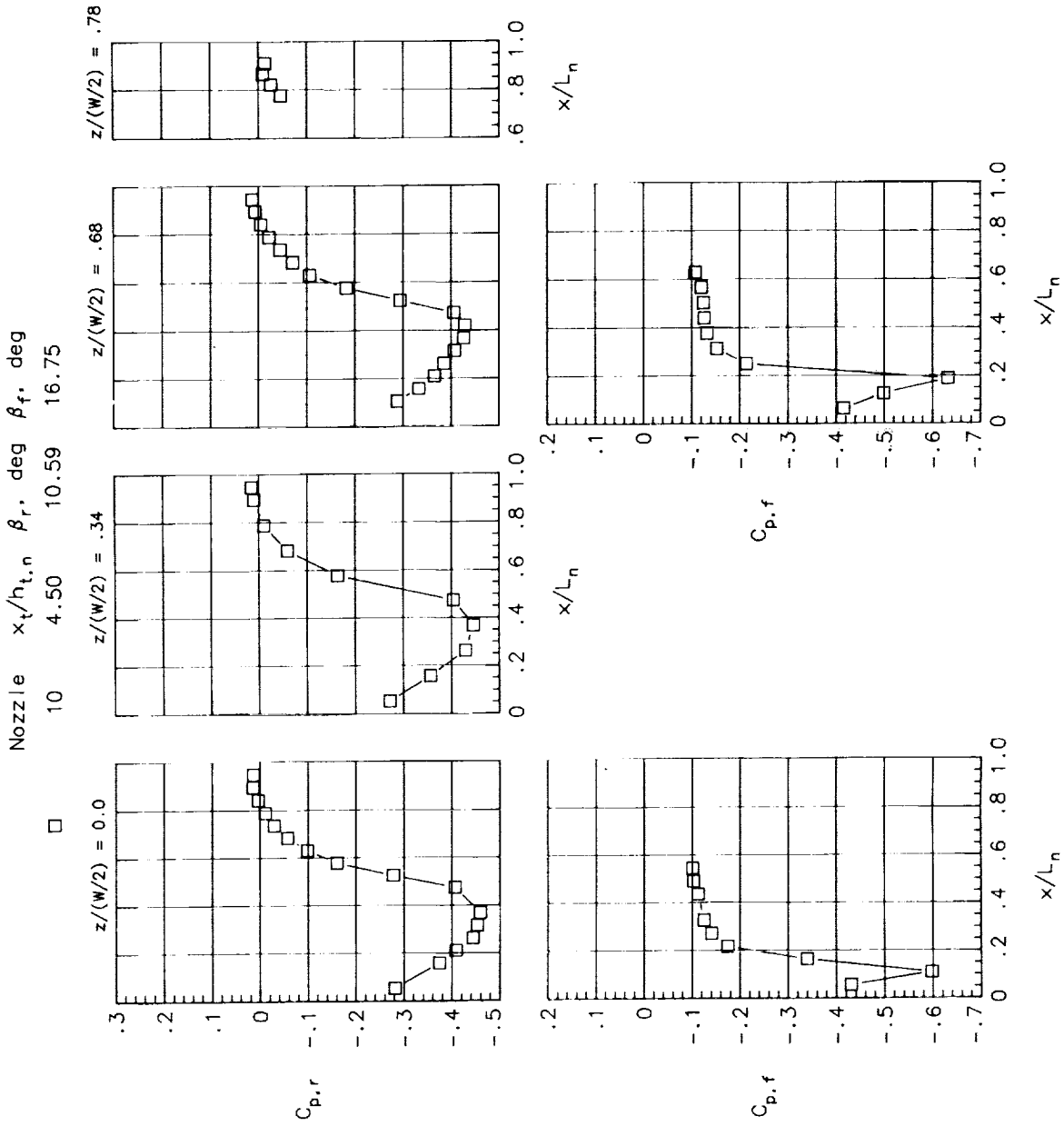
Figure 53. Continued.





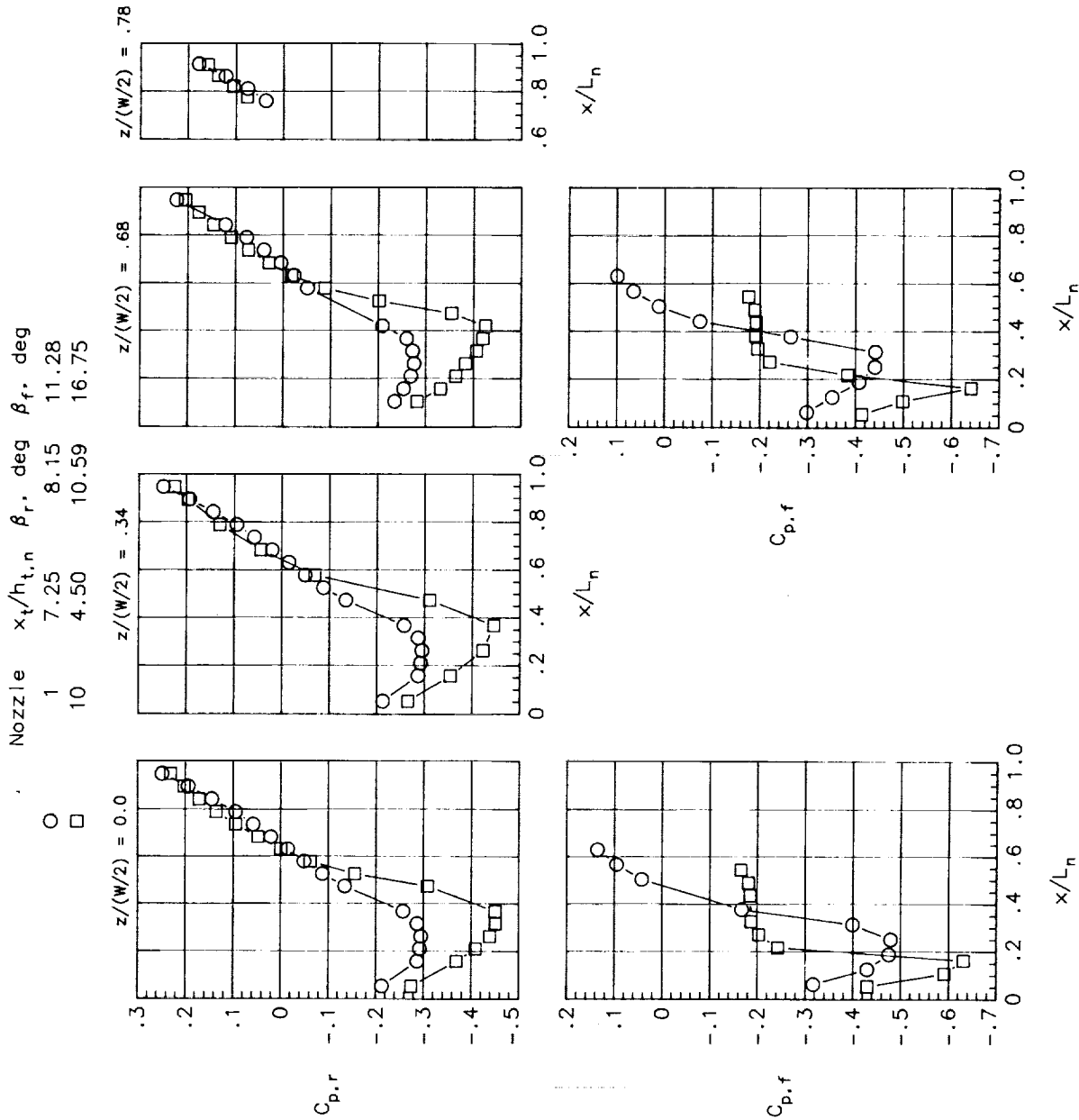
(j)  $M = 0.90$ ;  $NPR = 7$ .

Figure 53. Continued.



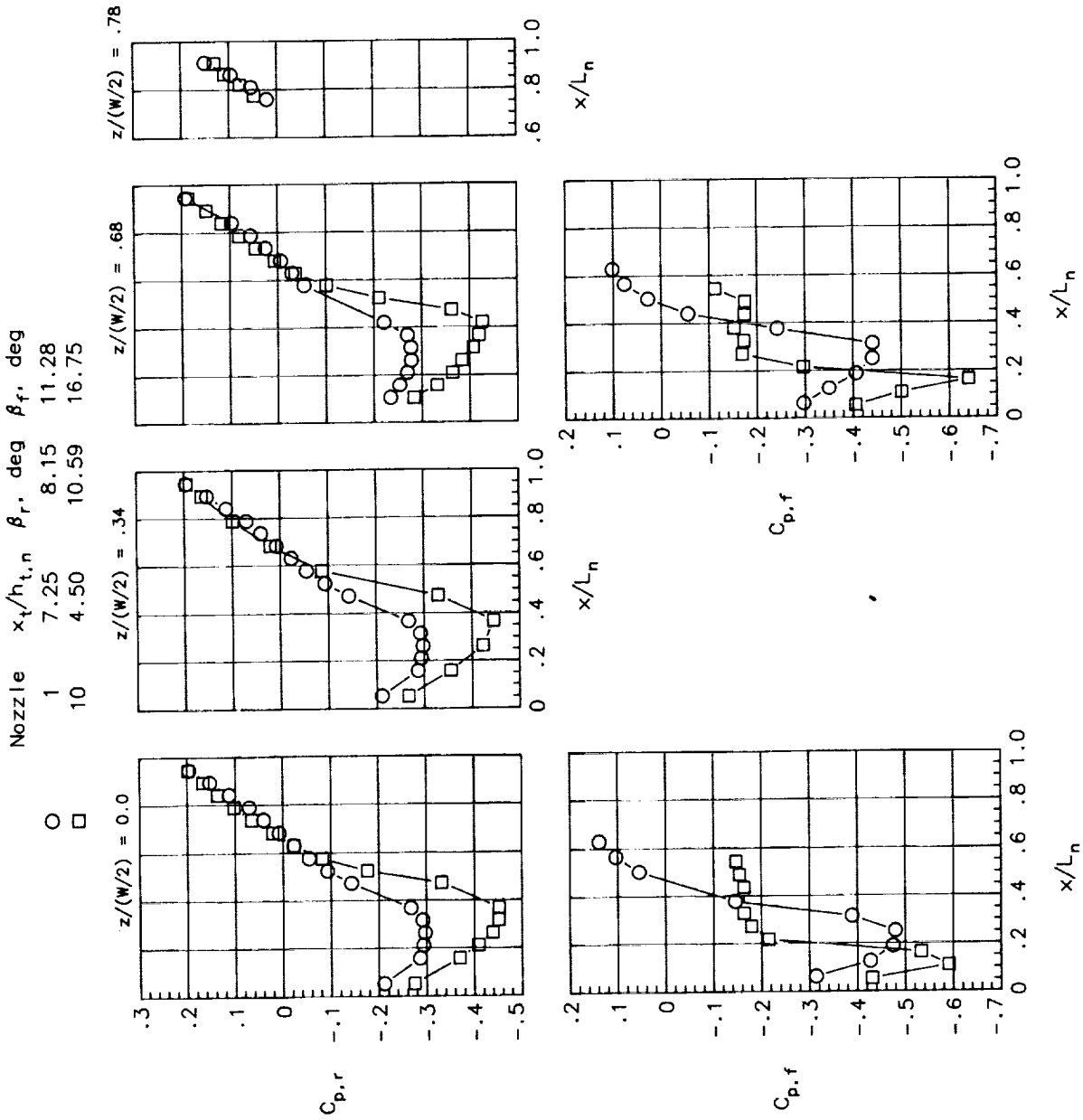
(k)  $M = 0.95$ ;  $NPR = 1$ .

Figure 53. Continued.



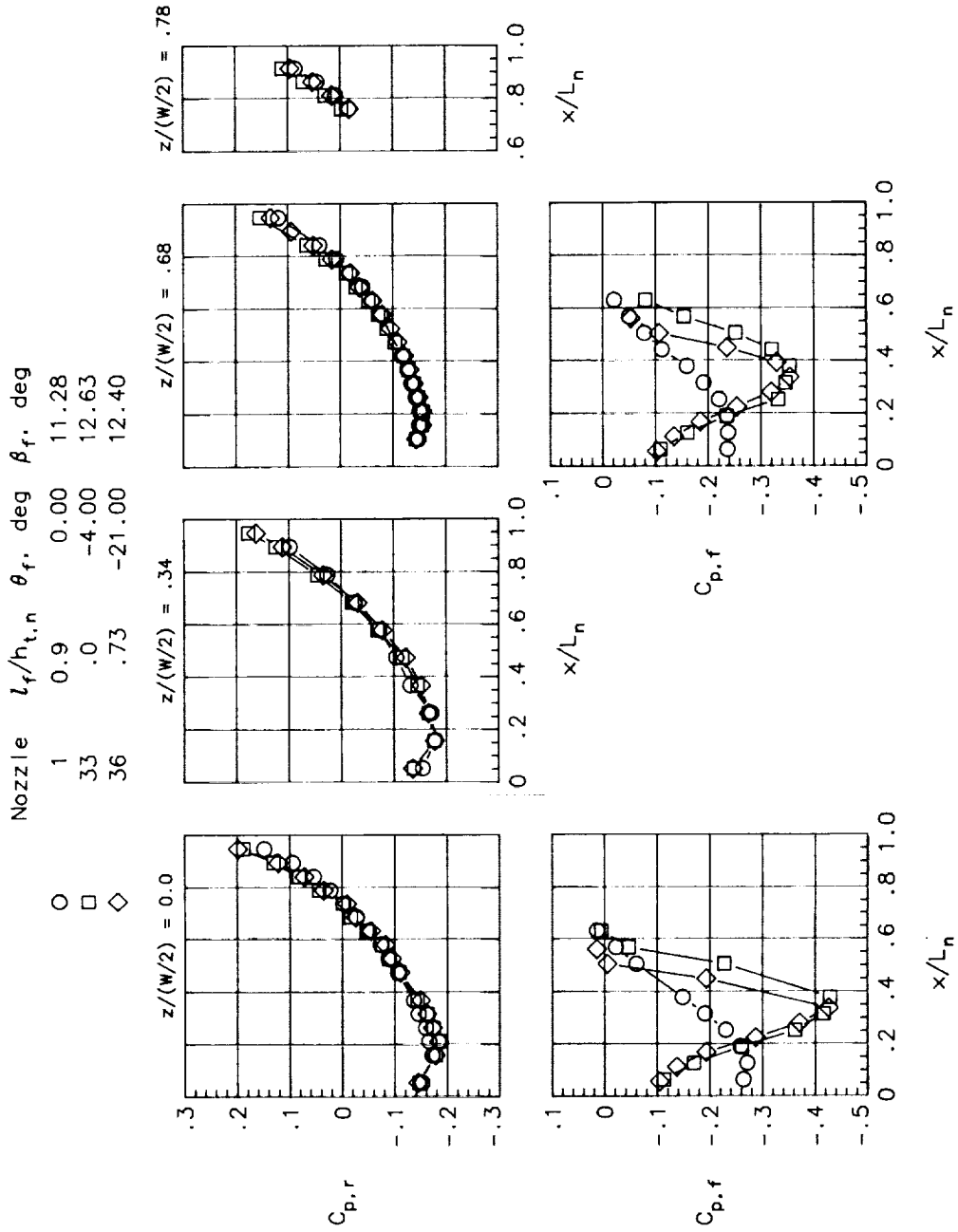
(1)  $M = 0.95$ ; NPR = 7.

Figure 53. Continued.



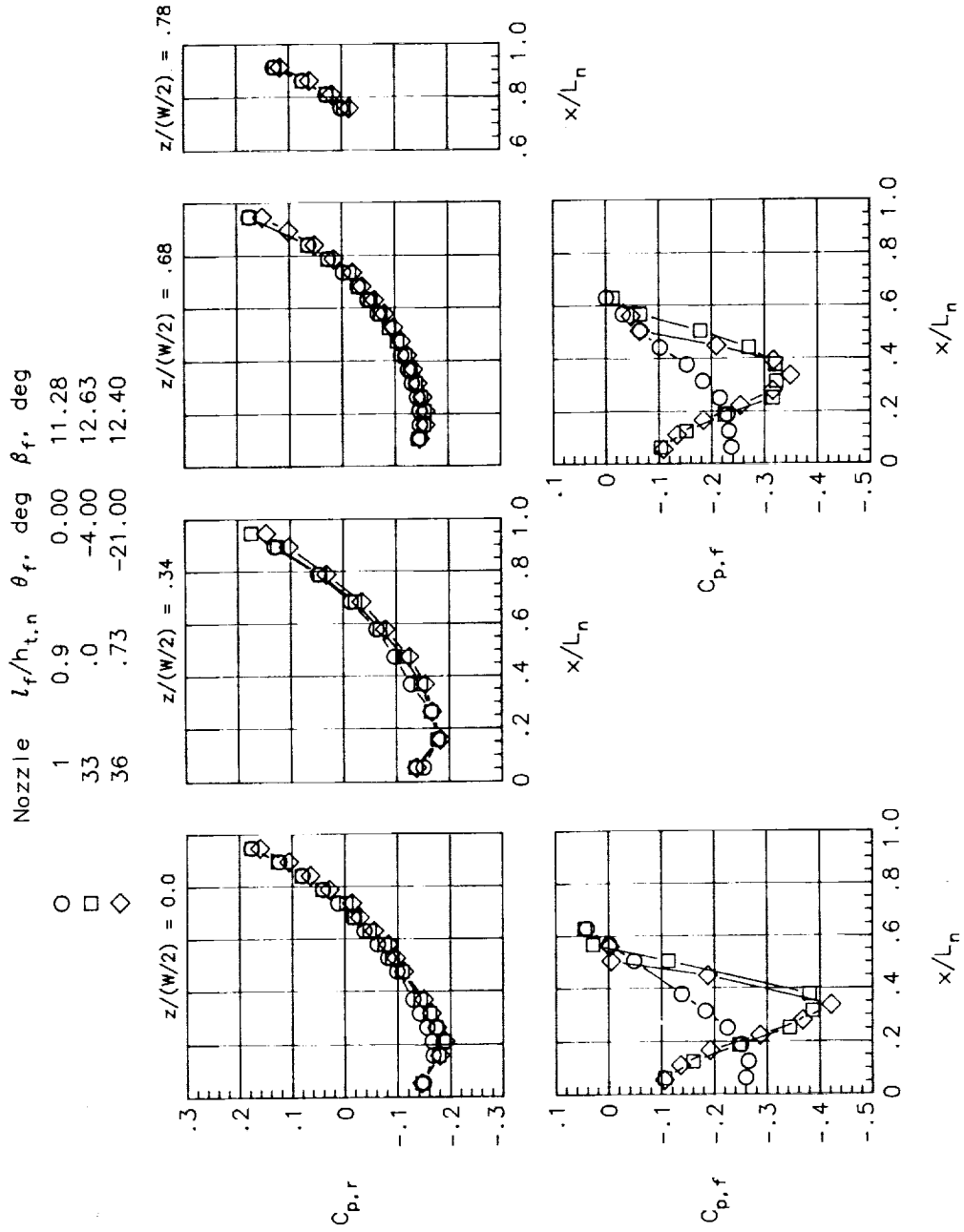
(m)  $M = 0.95$ ; NPR = 9.

Figure 53. Concluded.



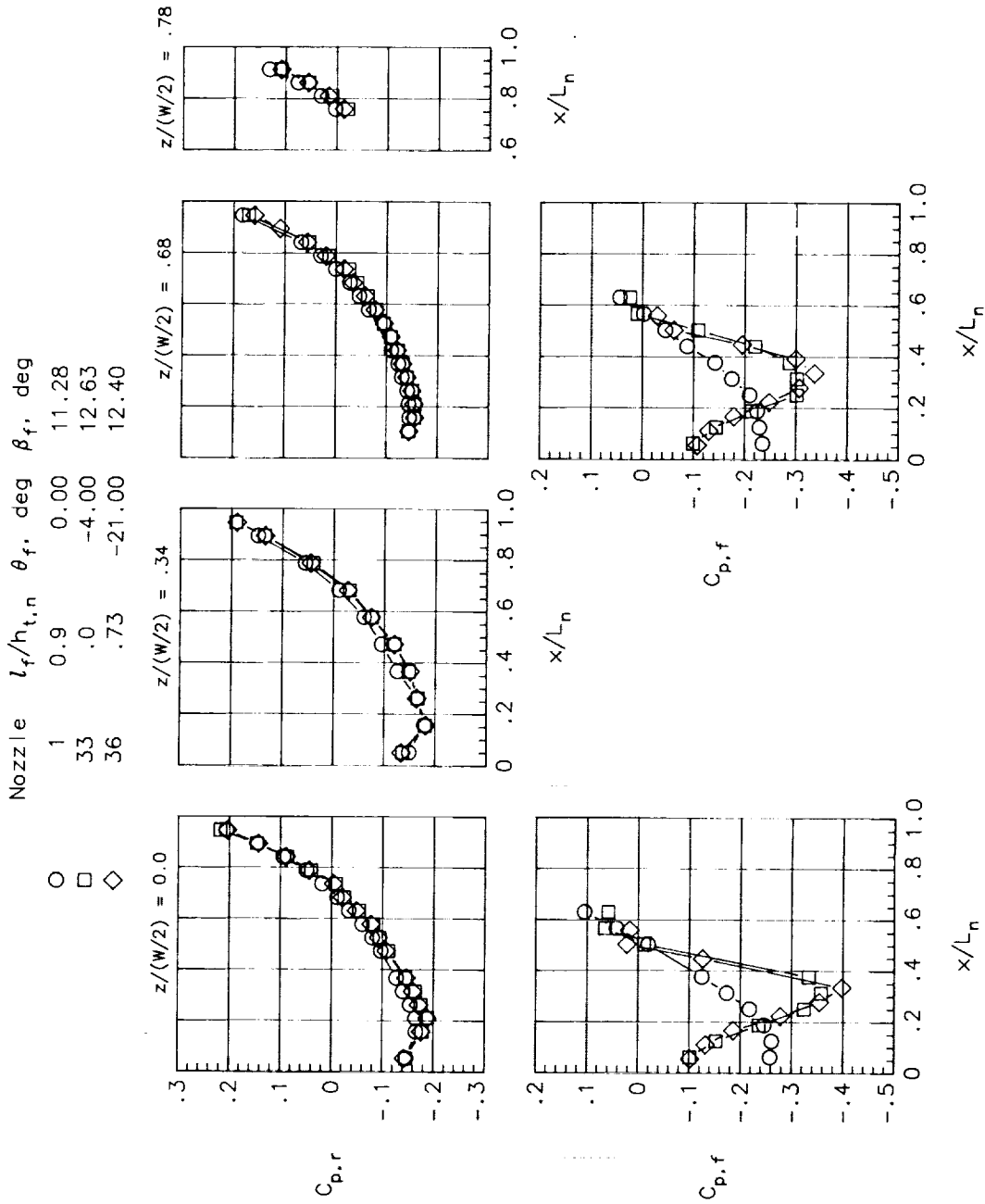
(a)  $M = 0.60$ ;  $NPR = 1$ .

Figure 54. Comparison of external pressure distributions for nozzles 1, 33, and 36 at  $\alpha = 0^\circ$ .



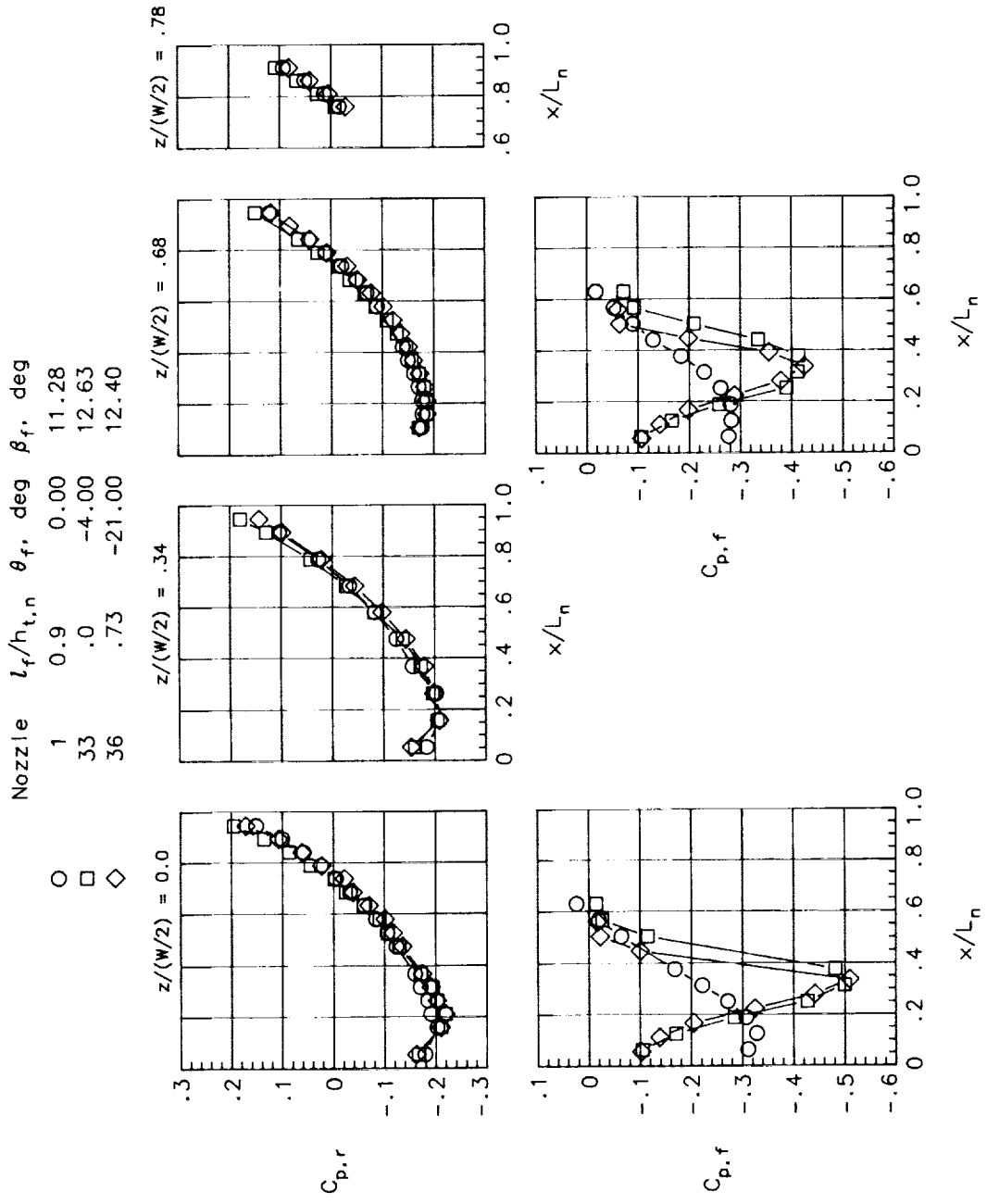
(b)  $M = 0.60$ ;  $NPR = 3$ .

Figure 54. Continued.



(c)  $M = 0.60$ ;  $NPR = 5$ .

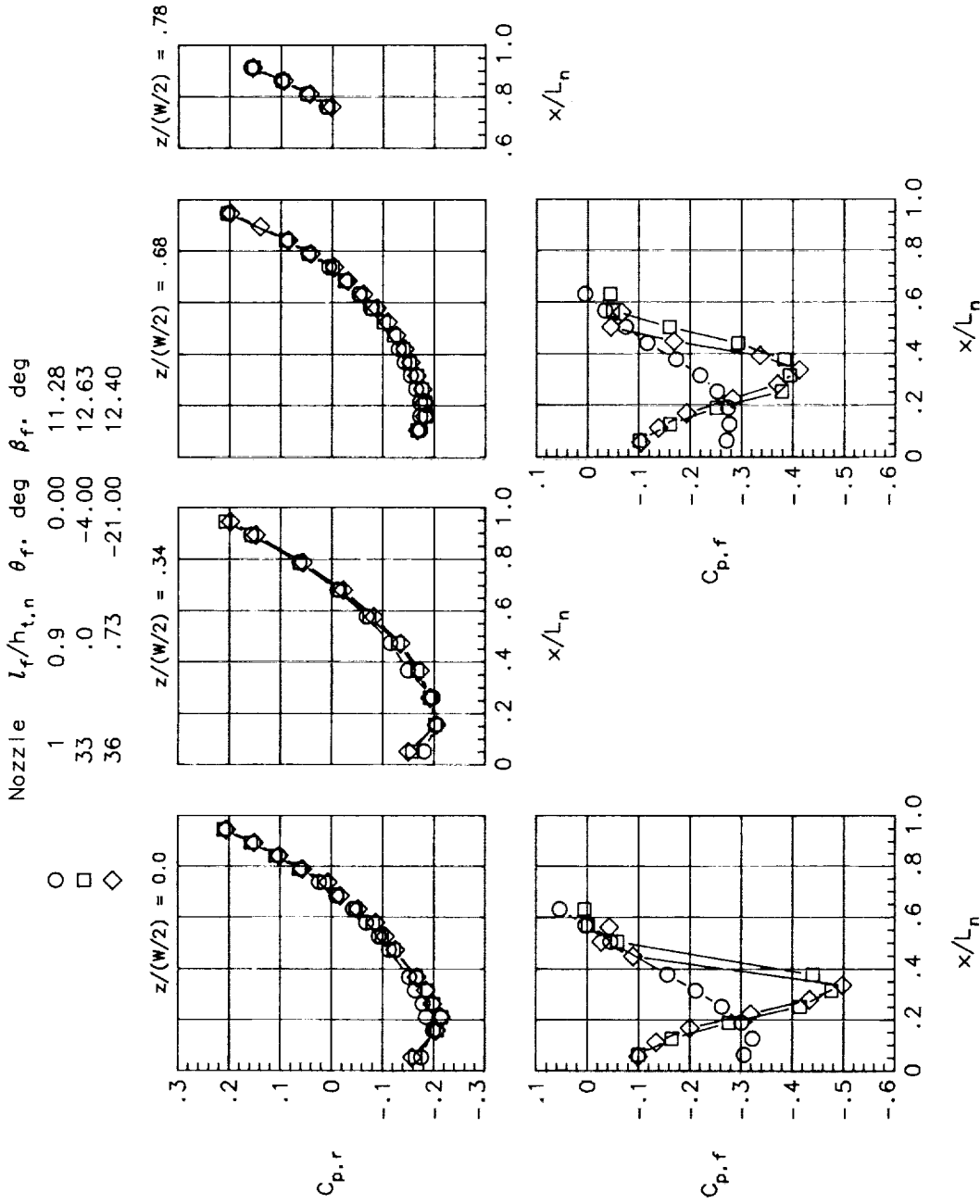
Figure 54. Continued.



(d)  $M = 0.80$ ; NPR = 1.

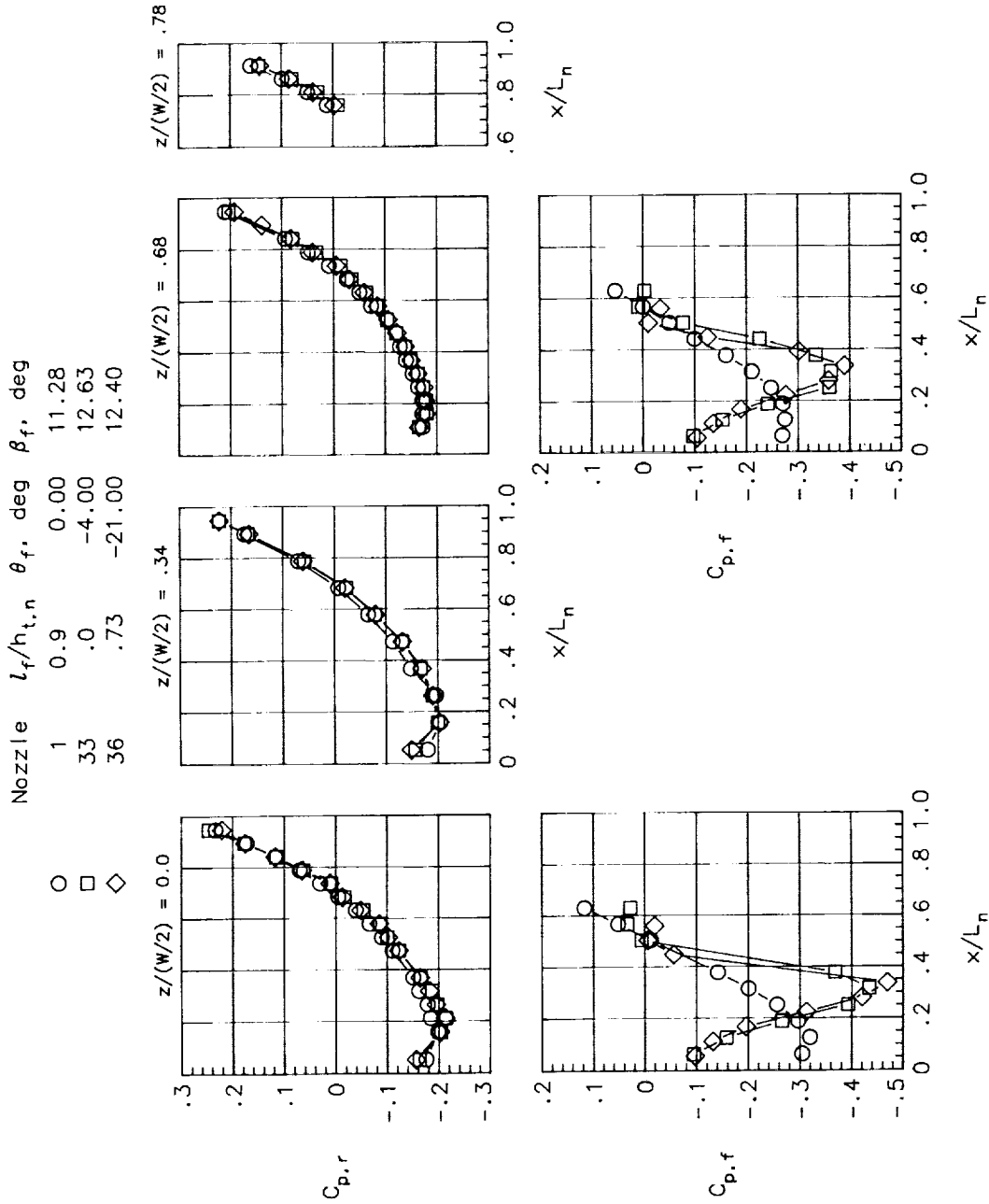
Figure 54. Continued.





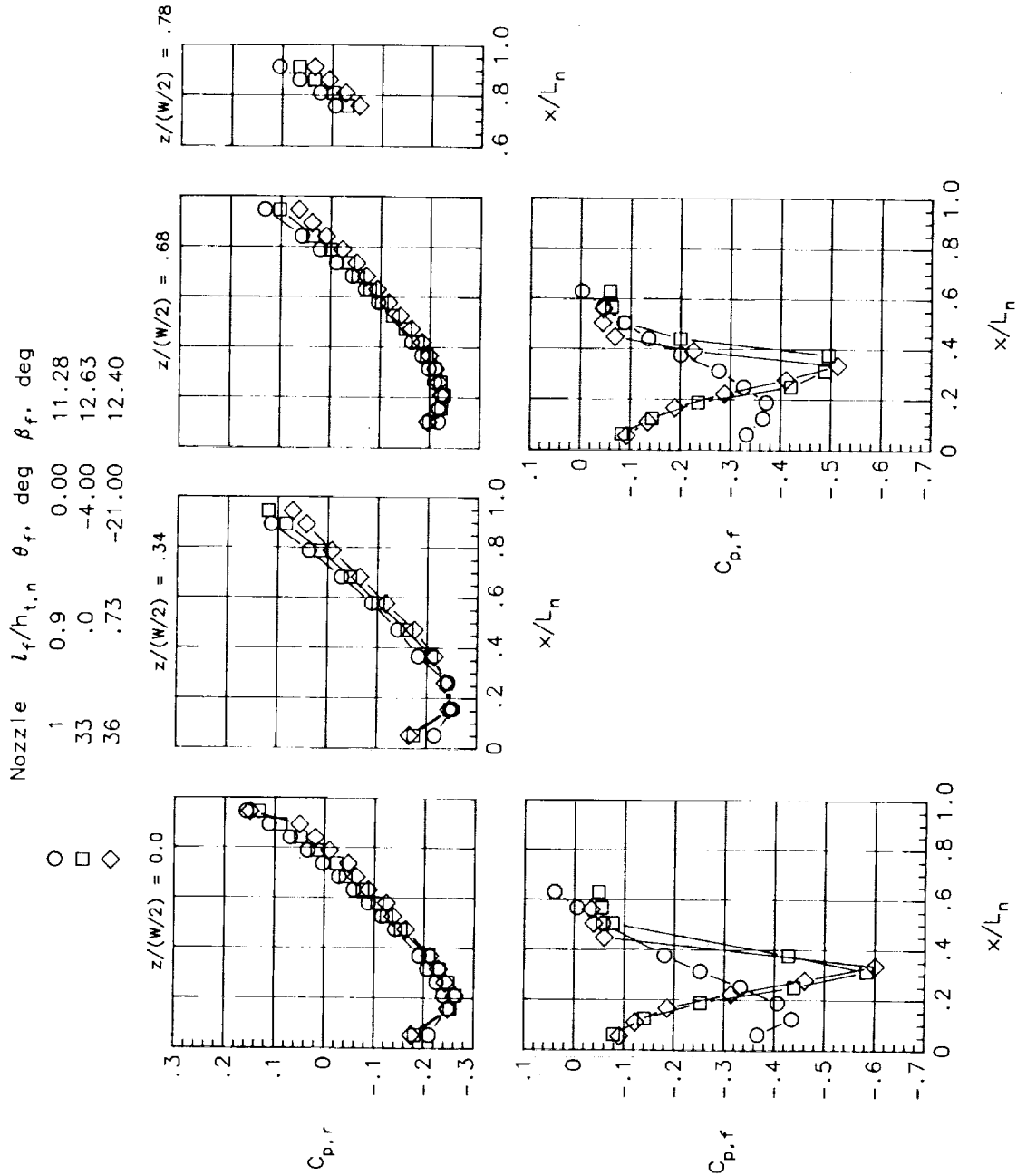
(e)  $M = 0.80$ ;  $NPR = 3$ .

Figure 54. Continued.



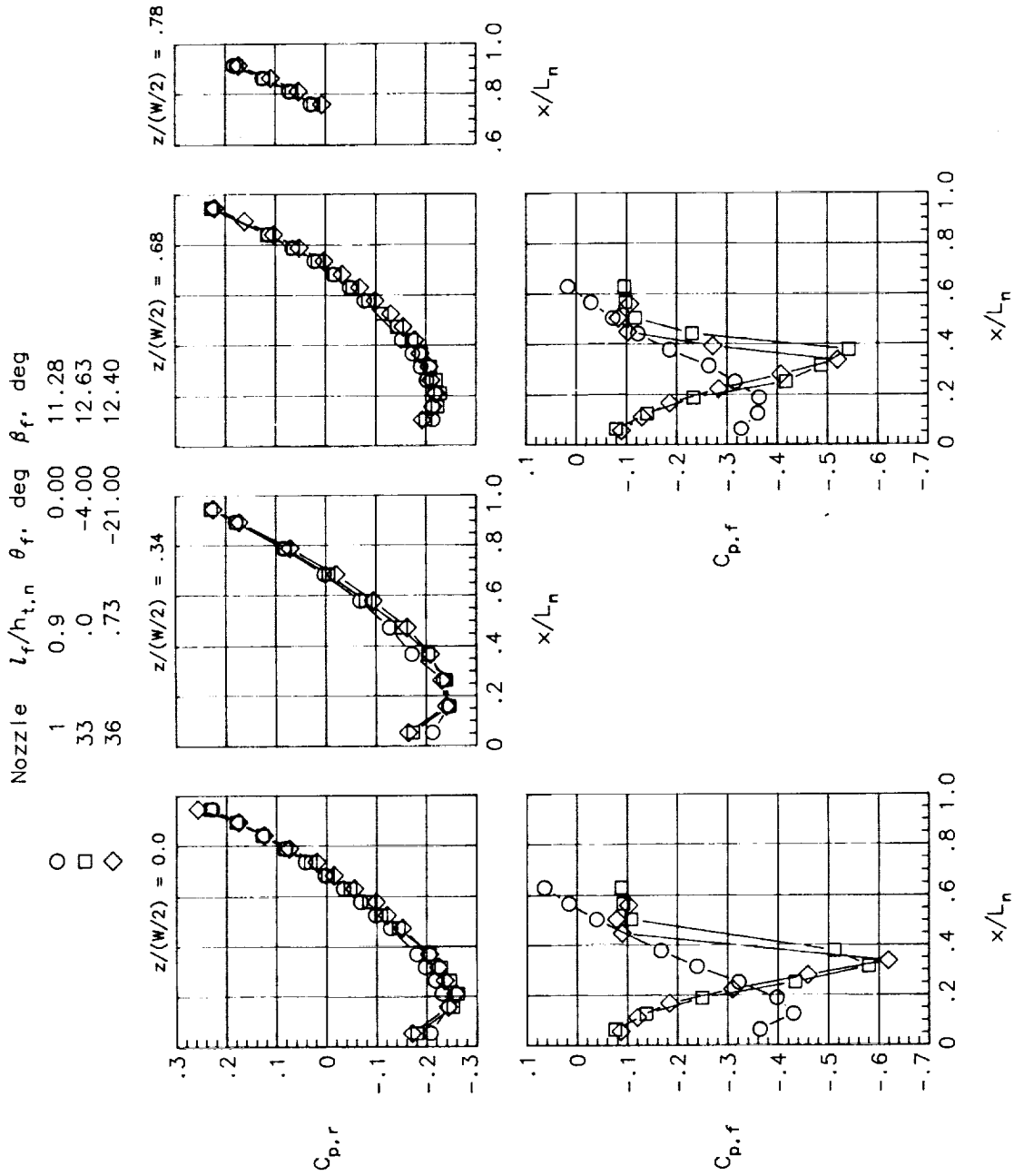
(f)  $M = 0.80$ ; NPR = 5.

Figure 54. Continued.



(g)  $M = 0.90$ ;  $NPR = 1$ .

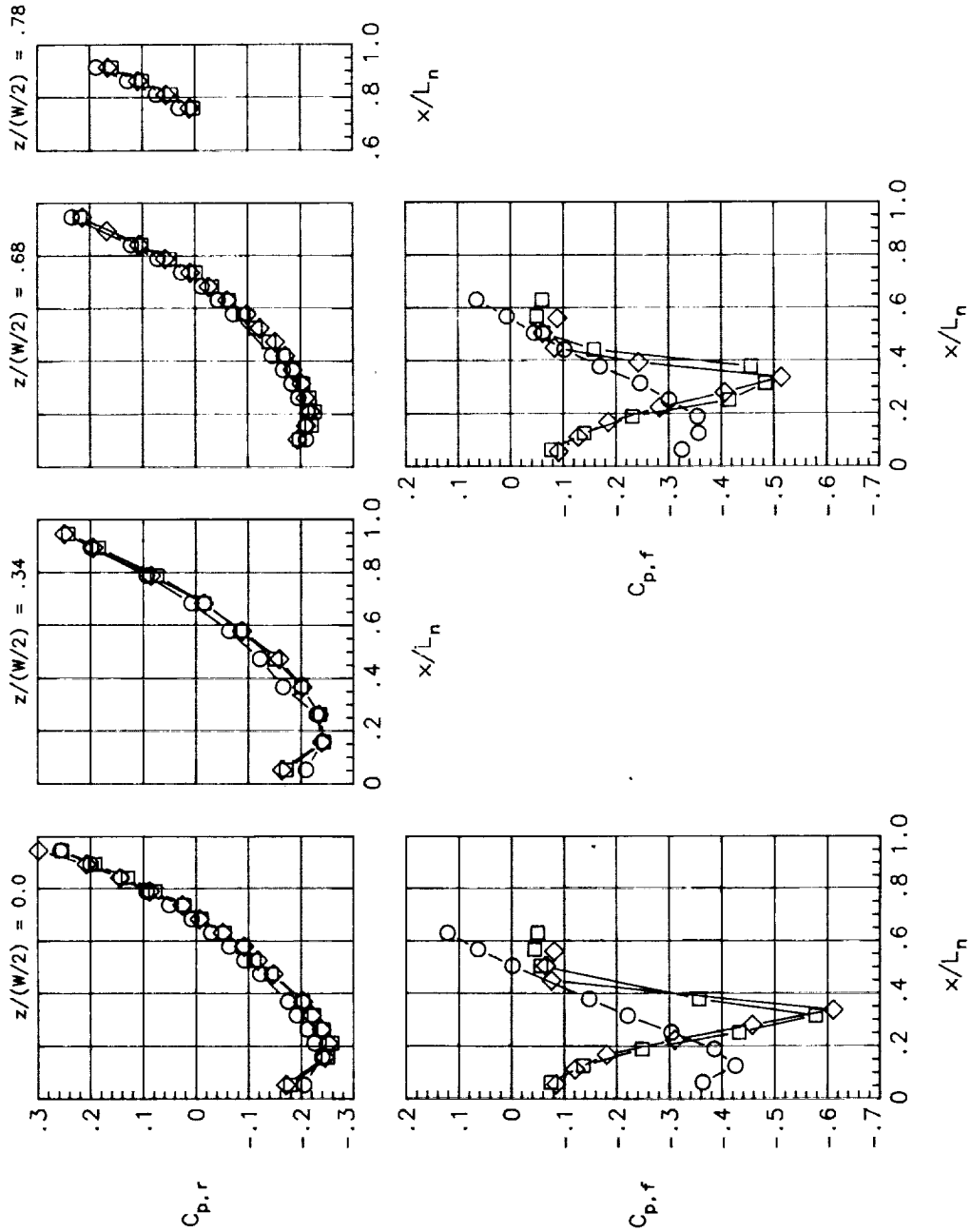
Figure 54. Continued.



(h)  $M = 0.90$ ; NPR = 3.

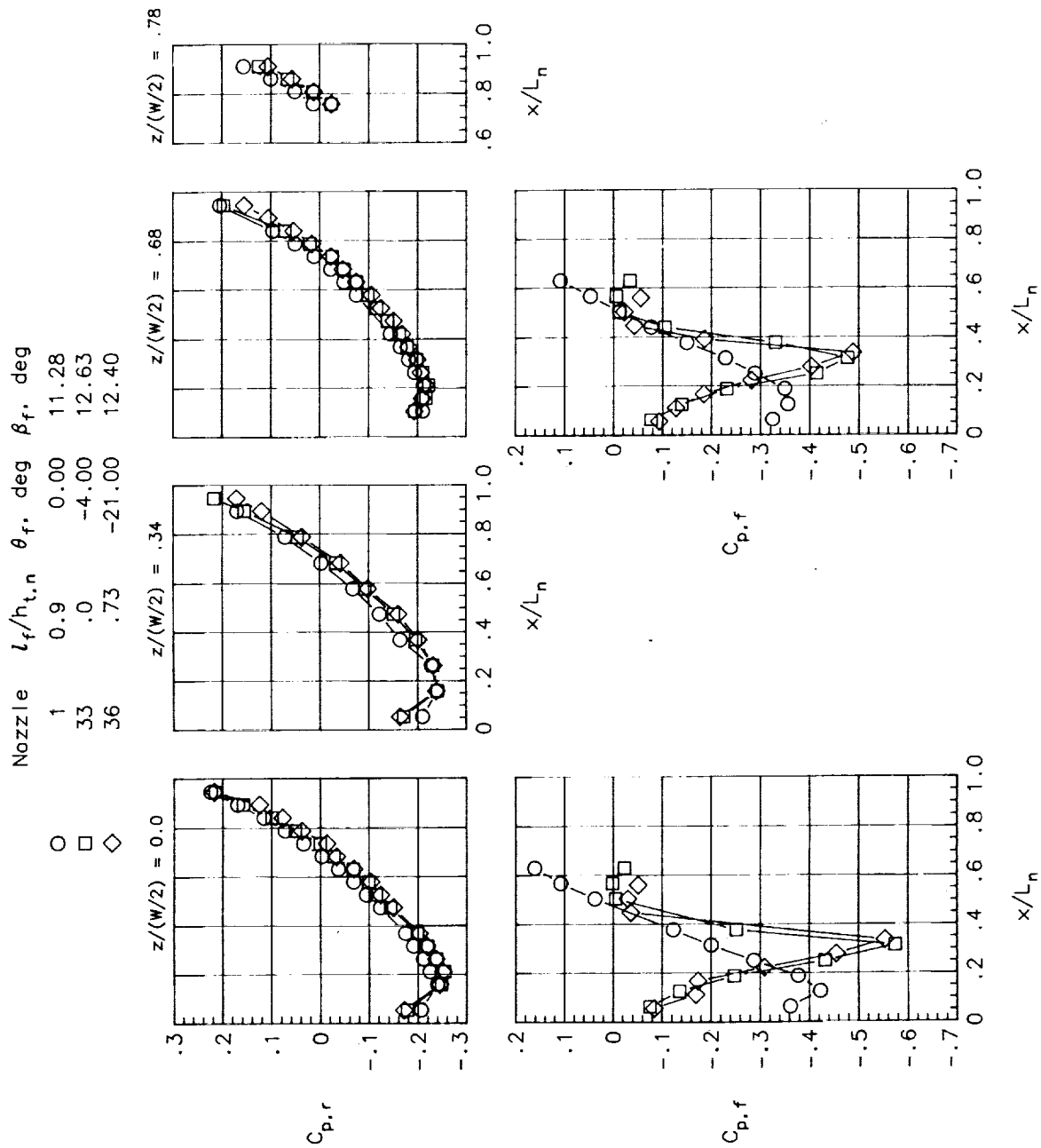
Figure 54. Continued.

Nozzle	$l_f/h_{t,n}$	$\theta_f$ , deg	$\beta_f$ , deg
1	0.9	0.00	11.28
33	.0	-4.00	12.63
36	.73	-21.00	12.40



(i)  $M = 0.90$ ; NPR = 5.

Figure 54. Continued.



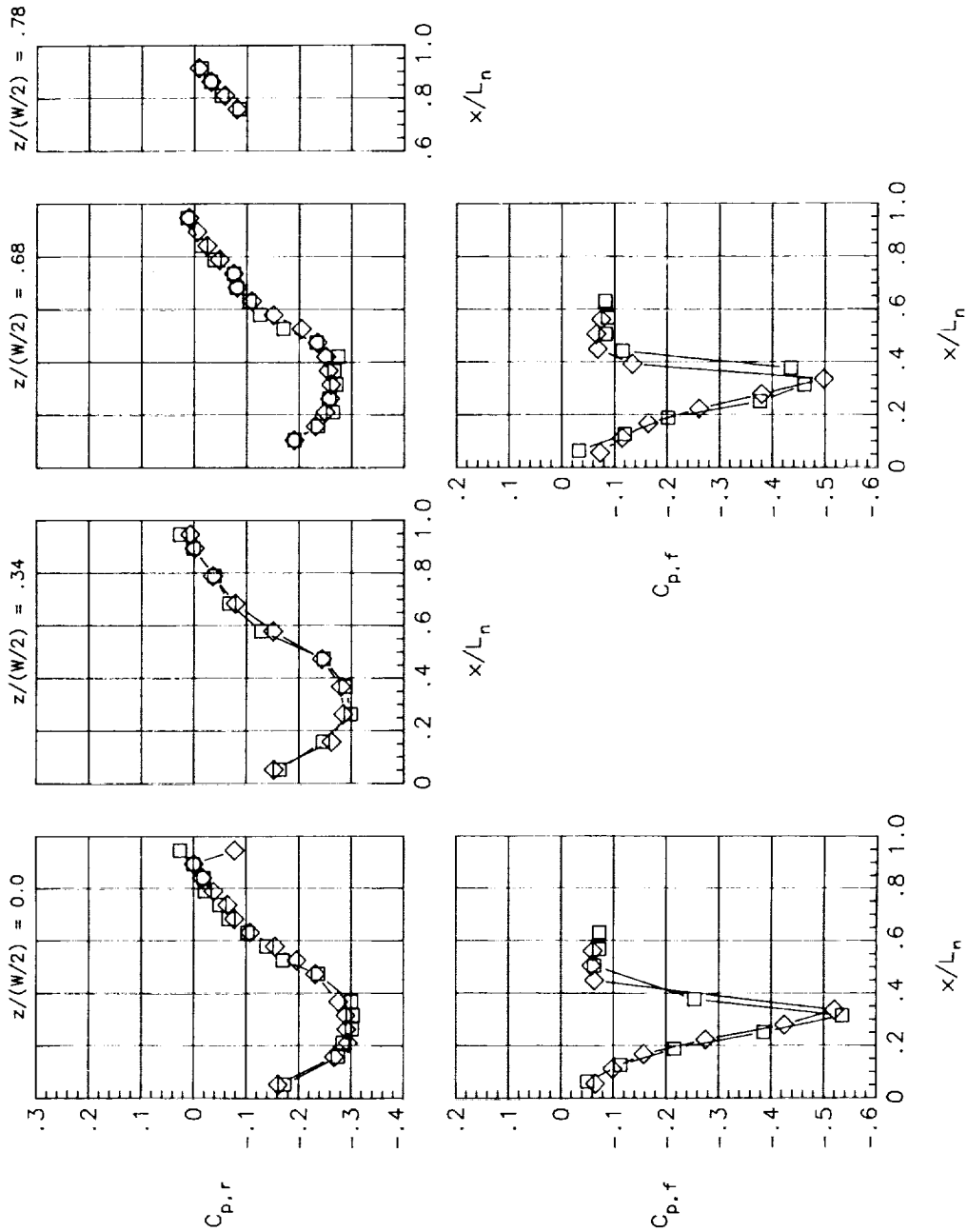
(j)  $M = 0.90$ ;  $NPR = 7$ .

Figure 54. Continued.

Nozzle  $l_f/h_{t,n}$   $\theta_f$ , deg  $\beta_f$ , deg

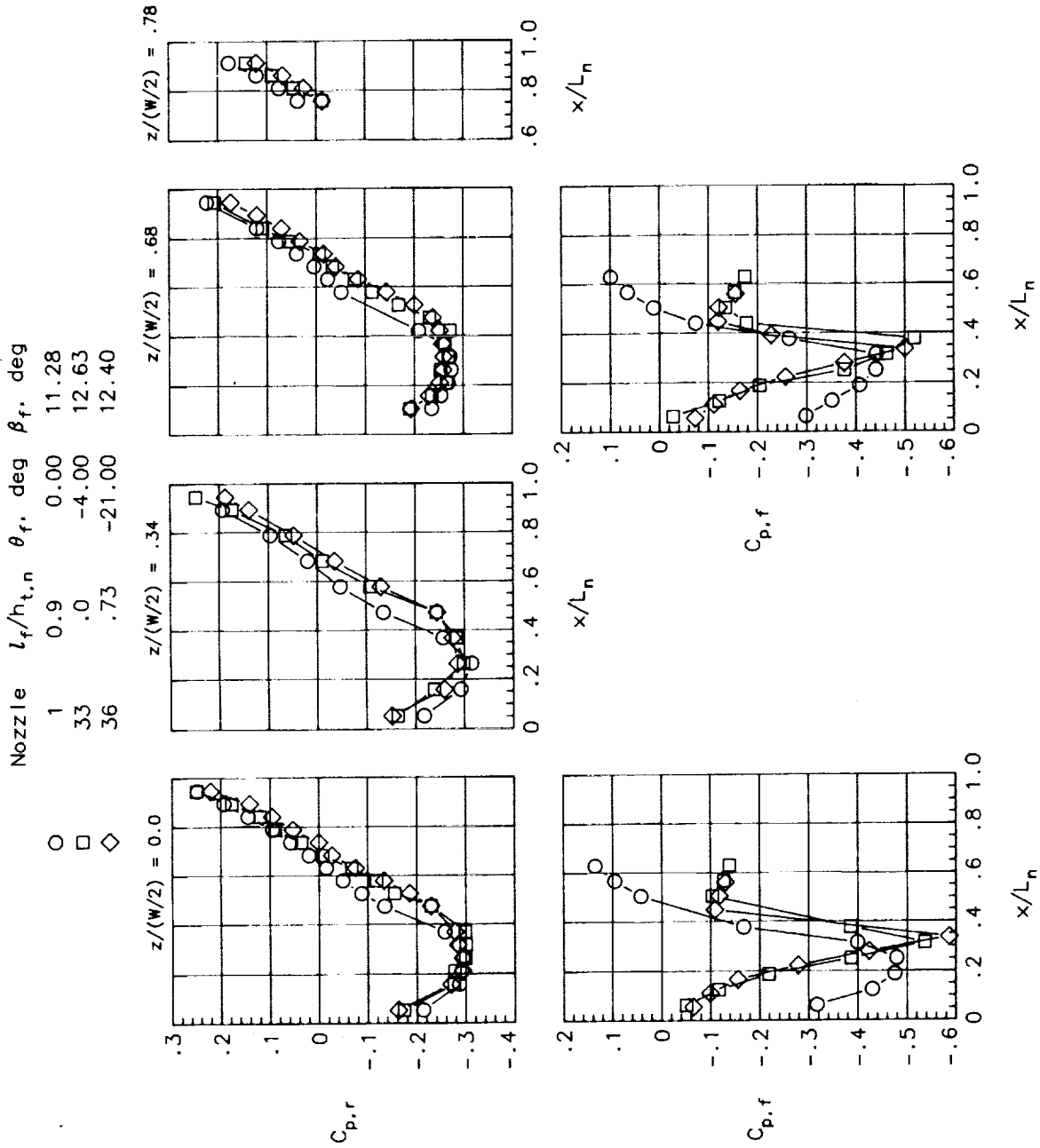
33	.0	-4.00	12.63
36	.73	-21.00	12.40

□ ◇



(k)  $M = 0.95$ ; NPR = 1.

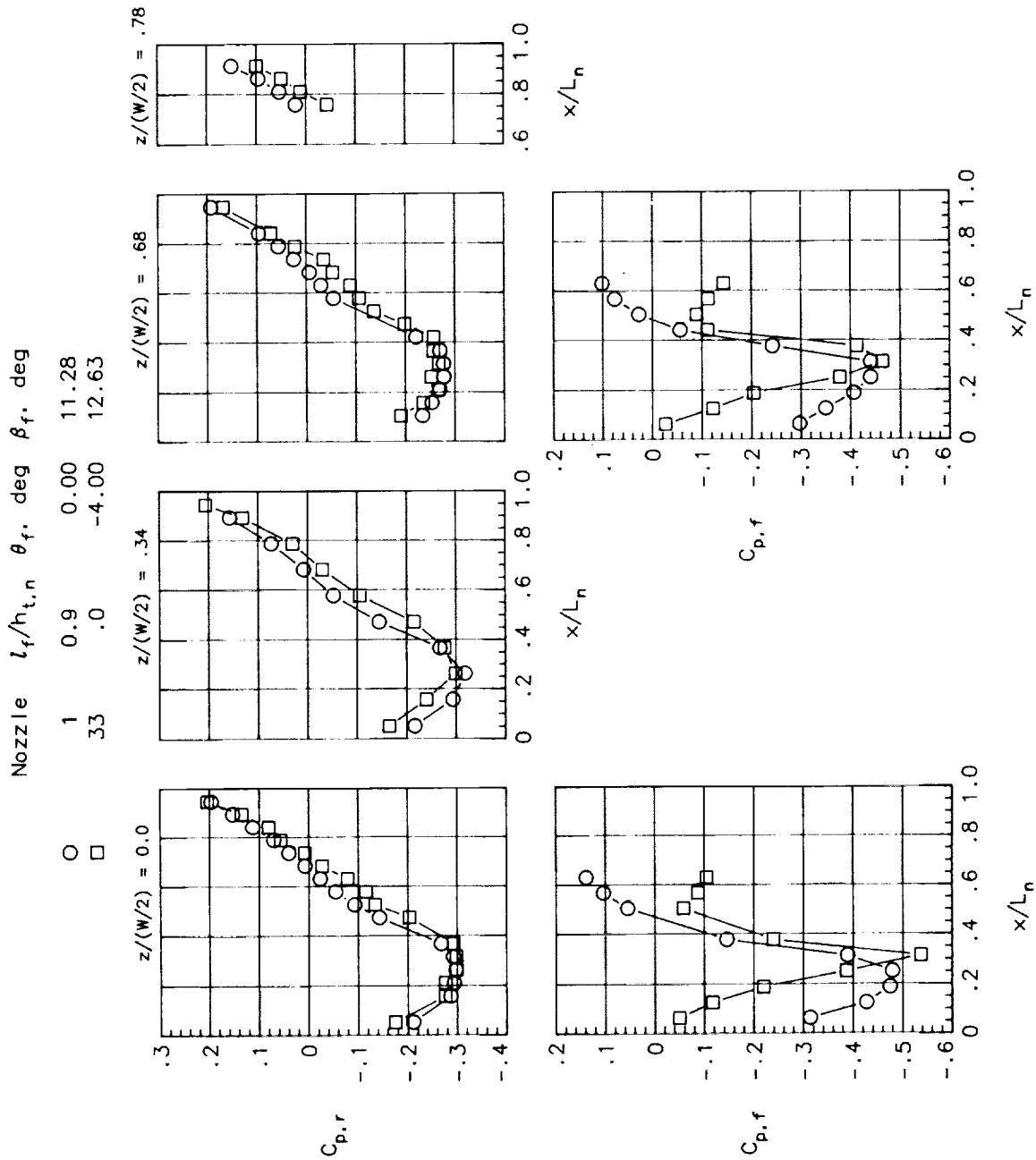
Figure 54. Continued.



(1)  $M = 0.95$ ;  $NPR = 7$ .

Figure 54. Continued.





(m)  $M = 0.95$ ; NPR = 9.

Figure 54. Concluded.

**REPORT DOCUMENTATION PAGE**

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13. ABSTRACT (Maximum 200 words) An investigation has been conducted in the Langley 16-Foot Transonic Tunnel to determine the effects of varying six nozzle geometric parameters on the internal and aeropropulsive performance characteristics of single-expansion-ramp nozzles. This investigation was conducted at Mach numbers from 0.60 to 1.20, nozzle pressure ratios from 1.5 to 12, and angles of attack of 0° and ±6°. Maximum aeropropulsive performance at a particular Mach number was highly dependent on the operating nozzle pressure ratio. For example, as the nozzle upper ramp length or angle increased, some nozzles had higher performance at a Mach number of 0.90 because the nozzle design pressure was the same as the operating pressure ratio. Thus, selection of the various nozzle geometric parameters should be based on the mission requirements of the aircraft. A combination of large upper ramp and large lower flap boattail angles produced greater nozzle drag coefficients at Mach numbers greater than 0.80, primarily from shock-induced separation on the lower flap of the nozzle. At static conditions, the convergent nozzle had high and nearly constant values of resultant thrust ratio over the entire range of nozzle pressure ratios tested. However, these nozzles had much lower aeropropulsive performance than the convergent-divergent nozzle at Mach numbers greater than 0.60.					
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