REPORT NADC-79081-60

PIPSI/NAVY-RAPID EVALUATION OF PROPULSION SYSTEM EFFECTS FOR THE NAVY GAS TURBINE ENGINE CODE, NEPCOMP

W. H. Ball
The Boeing Company
Seattle, Washington 98124

11 October 1979

Final Report for Period 28 June 1979 through 11 October 1979

Contract No. N62269-79-C-0278

Approved for Public Release;
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Prepared for
NAVAL AIR DEVELOPMENT CENTER
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This report describes the work accomplished during a fourteen-week contract to modify two existing interactive computer programs for calculating installed engine performance, including inlet and nozzle corrections and to demonstrate their use for NADC.

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FOREWORD

This report describes the work performed at The Boeing Company on Contract N62269-79-C-0278. The work was performed during the period 28 June through 3 October 1979.

During the contract the existing PIPSI and DERIVP computer codes previously developed for the U.S. Air Force were modified to operate on the NADC computer system and a training session was held at NADC to explain the operation of the codes and to demonstrate its usage to NADC personnel.

Mr. John Cyrus was Project Monitor for NADC and Mr. W. H. Ball was Program Manager for The Boeing Company. Modifications to the computer code were accomplished by Mr. R. A. Atkins, Jr.

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LIST OF NOMENCLATURE AND SYMBOLS

A_C	Inlet capture area, in^2
A_O	Local stream tube area ahead of the inlet, in^2
A_{O_I}	Free-stream tube area of air entering the inlet, in^2
C_D	Drag coefficient, $\frac{D}{q A_{ref.}}$, dimensionless
C-D	Convergent-divergent
$C_{D_{ADD}}$	Additive drag coefficient, $C_{D_{ADD}} = \frac{D_{ADD}}{q A_c}$, dimensionless
$C_{D_{A10}}$	Afterbody drag coefficient, $\frac{DRAG}{q A_{10}}$, dimensionless
$C_{D_{Base}}$	Base drag coefficient, $\frac{(P_b - P_\infty) A_{base}}{q A_{10}}$, dimensionless
$C_{D_{A10-A9}}$,	
$C_{D_{PAP}}$	Drag coefficient, $\frac{D}{q_o (A_{10} - A_9)}$, based on projected area, dimensionless
C_{f_G}, C_V	Thrust coefficient, $\frac{F_g}{\frac{\dot{w}}{g}(V_i)}$, dimensionless
D	Drag, lb.; hydraulic Diameter, $\frac{4A}{P}$, in., diameter, in.
F_N	Net thrust, lb.
F_{N_A}	Installed net thrust, lb.
M	Mach number, dimensionless
P_T	Total pressure, lb/in^2
P_{T_2}/P_{T_0}	Total pressure recovery
SFC	Specific fuel consumption
SFC_A	Installed specific fuel consumption
T/F	Turbofan
T/J	Turbojet
W	Mass flow, lb/sec
W_C, $\frac{w\sqrt{\theta}}{\delta}$	Corrected airflow, lb/sec.
θ_{T_2}	Temperature correction factor, T_{T_2} /TSTD.
N	2-D nozzle wedge half-angle
P	Round plug nozzle half-angle

INTRODUCTION

The purpose of the contract work was to modify an existing Air Force/ Boeing computer code (PIPSI, documented in References 1 through 4), install the modified code on the NADC CDC computer system, and train NADC personnel in the usage of the code by means of instruction and demonstration.

The complete documentation of the calculation methods employed by the code, nomenclature, sample cases, and the library of inlet and nozzle/aftbody input maps is contained in the set of documents (References 1 through 4) which describe the code developed for the Air Force version of the program. This report describes those changes to the existing code that were made to adapt the code to the NADC computer and to provide the desired output data.

MODIFICATIONS TO PIPSI CODE

The modifications to the computer code that were accomplished to make the code compatible with the NADC computer system and the NADC input data format are described below.

Changes in Uninstalled Engine Data Format

(1) The format of the uninstalled engine data for the NADC version of the PIPSI program is slightly different from that described in Section 6.6 of Reference 2. The engine input data format for the NADC PIPSI code is shown in Figure 1. The only difference from the original code is that the areas input for A8 and A9, shown in

RALS 3000,1.0 ENGINE: RUN HOFI-62: A/F PERFORMANCE DECK

.0000	0.	1.00	25135.35384.6	316.0	2.823	496.1	417.9	.9600
.0000	0.	2.00	23453.27114.4	316.0	2.860	440.4	417.9	.9600
.0000	0.	3.00	21654.19625.4	316.0	2.888	383.8	417.9	.9600
.2000	0.	1.00	23845.36204.6	316.0	2.913	493.4	417.9	.9600
.2000	0.	2.00	22096.27733.3	316.0	2.945	438.1	417.9	.9600
.2000	0.	3.00	20226.20162.2	316.0	2.974	381.8	417.9	.9600
.4000	0.	1.00	24237.38753.3	316.1	3.177	485.7	417.9	.9600
.4000	0.	2.00	22279.29658.9	316.1	3.211	431.4	417.9	.9600
.4000	0.	3.00	20190.21423.5	316.1	3.242	376.2	417.9	.9600
.6000	0.	1.00	25672.42594.6	312.2	3.573	477.2	417.9	.9600
.6000	0.	2.00	23397.32551.7	312.2	3.610	424.0	417.9	.9600
.6000	0.	3.00	20975.23457.1	312.2	3.643	369.9	417.9	.9600
.8000	0.	1.00	26390.45518.0	294.4	3.880	476.6	417.9	.9600
.8000	0.	2.00	23844.35031.8	294.4	3.920	423.5	417.9	.9600
.8000	0.	3.00	21137.25173.2	294.4	3.955	369.4	417.9	.9600
1.0000	0.	1.00	27644.50101.1	273.7	4.274	475.9	417.9	.9600
1.0000	0.	2.00	24747.38136.5	273.7	4.317	422.9	417.9	.9600
1.0000	0.	3.00	21671.27304.8	273.7	4.357	368.9	417.9	.9600
1.2000	0.	1.00	29001.54675.3	251.6	4.719	474.9	417.9	.9600
1.2000	0.	2.00	25704.41505.5	251.6	4.766	422.1	417.9	.9600
1.2000	0.	3.00	22207.29577.7	251.6	4.810	368.2	417.9	.9600
.2000	10000.	1.00	17625.26681.2	324.6	3.018	509.5	417.9	.9600
.2000	10000.	2.00	16320.20641.4	324.6	3.054	452.0	417.9	.9600
.2000	10000.	3.00	14924.14491.3	324.6	3.086	393.7	417.9	.9600
.4000	10000.	1.00	17773.28574.1	322.7	3.257	503.2	417.9	.9600
.4000	10000.	2.00	16331.21924.0	322.7	3.295	446.5	417.9	.9600
.4000	10000.	3.00	14792.15982.2	322.7	3.329	389.0	417.9	.9600
.6000	10000.	1.00	18573.31085.3	316.0	3.608	496.5	417.9	.9600
.6000	10000.	2.00	16927.23820.8	316.0	3.648	440.8	417.9	.9600
.6000	10000.	3.00	15174.17242.5	316.0	3.685	384.1	417.9	.9600
.8000	10000.	1.00	21361.36016.5	316.2	4.355	480.1	417.9	.9600
.8000	10000.	2.00	19300.27544.0	316.2	4.400	426.6	417.9	.9600
.8000	10000.	3.00	17112.19871.7	316.2	4.441	372.0	417.9	.9600
1.0000	10000.	1.00	22099.39983.4	297.6	4.906	476.7	417.9	.9600
1.0000	10000.	2.00	20604.30513.8	297.6	4.955	423.6	417.9	.9600
1.0000	10000.	3.00	18064.21958.1	297.6	5.001	369.5	417.9	.9600
1.2000	10000.	1.00	24320.43817.2	273.8	5.434	475.9	417.9	.9600
1.2000	10000.	2.00	21590.33355.3	273.8	5.484	422.9	417.9	.9600
1.2000	10000.	3.00	18699.23880.7	273.8	5.539	368.9	417.9	.9600
.4000	20000.	1.00	12537.20368.7	327.1	3.295	525.3	417.9	.9600
.4000	20000.	2.00	11517.15667.5	327.1	3.333	465.6	417.9	.9600
.4000	20000.	3.00	10427.11410.7	327.1	3.370	405.2	417.9	.9600
.6000	20000.	1.00	13484.22545.2	325.0	3.745	514.2	417.9	.9600
.6000	20000.	2.00	12288.17320.3	325.0	3.790	456.0	417.9	.9600
.6000	20000.	3.00	11012.12589.1	325.0	3.831	397.1	417.9	.9600
.8000	20000.	1.00	15047.25578.4	319.5	4.380	501.8	417.9	.9600
.8000	20000.	2.00	13600.19617.1	319.5	4.430	445.3	417.9	.9600
.8000	20000.	3.00	12062.14219.1	319.5	4.475	388.0	417.9	.9600
1.0000	20000.	1.00	17765.30179.4	316.2	5.305	484.7	417.9	.9600
1.0000	20000.	2.00	15925.23093.9	316.2	5.452	430.5	417.9	.9600
1.0000	20000.	3.00	13975.16077.6	316.2	5.504	375.4	417.9	.9600

Figure 1 NADC Uninstalled Engine Data Input Format (Continued)

RALS 3000,1.0 ENGINE: RUN HOFI-G2: A/F PERFORMANCE DECK

.0000	0.	1.00	25135.35384.6	316.0	2.828	496.1	417.9	.9000
.0000	0.	2.00	23453.27114.4	316.0	2.860	440.4	417.9	.9000
.0000	0.	3.00	21654.19675.4	316.0	2.888	383.8	417.9	.9000
.2000	0.	1.00	23845.36704.6	316.0	2.913	493.4	417.9	.9000
.2000	0.	2.00	22096.27733.3	316.0	2.945	438.1	417.9	.9600
.2000	0.	3.00	20226.20162.2	316.0	2.974	381.8	417.9	.9600
.4000	0.	1.00	24237.38753.3	316.1	3.177	485.7	417.9	.9600
.4000	0.	2.00	22279.29658.9	316.1	3.211	431.4	417.9	.9600
.4000	0.	3.00	20190.21423.5	316.1	3.242	376.2	417.9	.9000
.6000	0.	1.00	25672.42554.6	312.2	3.573	477.2	417.9	.9000
.6000	0.	2.00	23397.32551.7	312.2	3.610	424.0	417.9	.9000
.6000	0.	3.00	20975.23457.1	312.2	3.643	369.9	417.9	.9000
.8000	0.	1.00	26390.45518.0	294.4	3.880	476.6	417.9	.9000
.8000	0.	2.00	23844.35031.8	294.4	3.920	423.5	417.9	.9000
.8000	0.	3.00	21137.25173.2	294.4	3.956	369.4	417.9	.9000
1.0000	0.	1.00	27644.50101.1	273.7	4.274	475.9	417.9	.9000
1.0000	0.	2.00	24747.38136.5	273.7	4.317	422.9	417.9	.9600
1.0000	0.	3.00	21671.27384.8	273.7	4.357	368.9	417.9	.9000
1.2000	0.	1.00	29001.54675.3	251.6	4.719	474.9	417.9	.9600
1.2000	0.	2.00	25704.41505.5	251.6	4.760	422.1	417.9	.9600
1.2000	0.	3.00	22207.29577.7	251.6	4.810	368.2	417.9	.9000
.2000	10000.	1.00	17625.26881.2	324.6	3.018	509.5	417.9	.9000
.2000	10000.	2.00	16320.20641.4	324.6	3.054	452.0	417.9	.9000
.2000	10000.	3.00	14924.14491.3	324.6	3.086	393.7	417.9	.9000
.4000	10000.	1.00	17773.28574.1	322.7	3.257	503.2	417.9	.9000
.4000	10000.	2.00	16331.21924.0	322.7	3.295	446.5	417.9	.9600
.4000	10000.	3.00	14792.15902.2	322.7	3.329	389.0	417.9	.9600
.6000	10000.	1.00	18573.31085.3	316.0	3.608	496.5	417.9	.9800
.6000	10000.	2.00	16927.23820.8	316.0	3.648	440.8	417.9	.9000
.6000	10000.	3.00	15174.17242.5	316.0	3.685	384.1	417.9	.9000
.8000	10000.	1.00	21361.36016.5	316.2	4.355	480.1	417.9	.9000
.8000	10000.	2.00	19300.27544.0	316.2	4.400	426.6	417.9	.9600
.8000	10000.	3.00	17112.19871.7	316.2	4.441	372.0	417.9	.9000
1.0000	10000.	1.00	22994.39983.4	297.6	4.906	476.7	417.9	.9000
1.0000	10000.	2.00	20604.30513.8	297.6	4.955	423.6	417.9	.9000
1.0000	10000.	3.00	18064.21938.1	297.6	5.001	369.5	417.9	.9000
1.2000	10000.	1.00	24320.43817.2	273.8	5.434	475.0	417.9	.9000
1.2000	10000.	2.00	21590.33355.3	273.8	5.489	422.9	417.9	.9000
1.2000	10000.	3.00	18699.23880.7	273.8	5.539	368.9	417.9	.9000
.4000	20000.	1.00	12537.20368.7	327.1	3.295	525.3	417.9	.9000
.4000	20000.	2.00	11517.15867.5	327.1	3.333	465.6	417.9	.9000
.4000	20000.	3.00	10427.11410.7	327.1	3.370	405.2	417.9	.9600
.6000	20000.	1.00	13484.22545.2	325.0	3.745	514.2	417.9	.9000
.6000	20000.	2.00	12286.17320.3	325.0	3.790	456.0	417.9	.9000
.6000	20000.	3.00	11012.12559.1	325.0	3.831	397.1	417.9	.9000
.8000	20000.	1.00	15047.25578.4	319.5	4.380	501.8	417.9	.9600
.8000	20000.	2.00	13600.19617.1	319.5	4.430	445.3	417.9	.9000
.8000	20000.	3.00	12062.14219.1	319.5	4.475	388.0	417.9	.9000
1.0000	20000.	1.00	17765.30179.4	316.2	5.305	484.7	417.9	.9000
1.0000	20000.	2.00	15925.23093.9	316.2	5.452	430.5	417.9	.9000
1.0000	20000.	3.00	13975.16677.6	316.2	5.504	375.4	417.9	.9000

Figure 1 NADC Uninstalled Engine Data Input Format (Continued)

1.2000	20000.	1.00	19883.34353.7	299.6	6.299	476.8	417.9	.9800
1.2000	20000.	2.00	17677.26222.5	299.6	6.363	423.7	417.9	.9800
1.2000	20000.	3.00	15343.18858.9	299.6	6.421	369.6	417.9	.9800
1.4000	20000.	1.00	21234.37840.6	273.4	7.020	475.8	417.9	.9800
1.4000	20000.	2.00	18711.28804.5	273.4	7.091	422.9	417.9	.9800
1.4000	20000.	3.00	16047.20620.9	273.4	7.156	368.9	417.9	.9800
1.6000	20000.	1.00	22638.41614.9	247.7	7.825	474.8	417.9	.9800
1.6000	20000.	2.00	19760.31575.2	247.7	7.904	422.0	417.9	.9800
1.6000	20000.	3.00	16721.22462.4	247.7	7.976	368.1	417.9	.9800
.6000	36089.	1.00	7159.12183.6	330.3	3.773	557.4	417.9	.9800
.6000	36089.	2.00	6526. 9358.7	330.3	3.829	493.1	417.9	.9800
.6000	36089.	3.00	5848. 6577.3	330.3	3.879	428.4	417.9	.9800
.8000	36089.	1.00	8231.14072.5	329.5	4.525	539.8	417.9	.9800
.8000	36089.	2.00	7443.10840.1	329.5	4.587	478.0	417.9	.9800
.8000	36089.	3.00	6604. 7913.3	329.5	4.643	415.7	417.9	.9800
1.0000	36089.	1.00	9762.16630.1	326.4	5.579	521.0	417.9	.9800
1.0000	36089.	2.00	8760.12786.0	326.4	5.649	461.9	417.9	.9800
1.0000	36089.	3.00	7697. 9345.3	326.4	5.713	402.1	417.9	.9800
1.2000	36089.	1.00	11691.19809.9	321.0	6.959	501.8	417.9	.9800
1.2000	36089.	2.00	10412.151[illegible]5.4	321.0	7.039	445.4	417.9	.9800
1.2000	36089.	3.00	9059.11016.6	321.0	7.112	388.0	417.9	.9800
1.6000	36089.	1.00	15866.27112.7	291.4	10.241	476.5	417.9	.9800
1.6000	36089.	2.00	13917.20678.3	291.4	10.345	423.4	417.9	.9800
1.6000	36089.	3.00	11863.14881.4	291.4	10.440	369.3	417.9	.9800
2.0000	36089.	1.00	17968.32535.3	234.0	12.564	477.1	417.9	.9800
2.0000	36089.	2.00	15483.24849.1	234.0	12.692	424.0	417.9	.9800
2.0000	36089.	3.00	12865.17516.3	234.0	12.809	369.8	417.9	.9800
.6000	50000.	1.00	3681. 6284.2	330.5	3.774	557.6	417.9	.9800
.6000	50000.	2.00	3355. 4832.4	330.5	3.830	493.2	417.9	.9800
.6000	50000.	3.00	3007. 3536.1	330.5	3.880	428.5	417.9	.9800
.8000	50000.	1.00	4231. 7234.0	329.5	4.526	540.0	417.9	.9800
.8000	50000.	2.00	3826. 5572.5	329.5	4.587	478.1	417.9	.9800
.8000	50000.	3.00	3395. 4068.0	329.5	4.643	415.8	417.9	.9800
1.0000	50000.	1.00	5018. 8549.0	326.4	5.580	521.2	417.9	.9800
1.0000	50000.	2.00	4503. 6573.0	326.4	5.650	462.0	417.9	.9800
1.0000	50000.	3.00	3956. 4783.6	326.4	5.713	402.2	417.9	.9800
1.2000	50000.	1.00	6013.10187.2	321.1	6.964	501.9	417.9	.9800
1.2000	50000.	2.00	5355. 7814.3	321.1	7.043	445.4	417.9	.9800
1.2000	50000.	3.00	4659. 5665.6	321.1	7.116	388.1	417.9	.9800
1.6000	50000.	1.00	8164.13947.7	291.6	10.252	476.5	417.9	.9800
1.6000	50000.	2.00	7162.10637.9	291.6	10.356	423.4	417.9	.9800
1.6000	50000.	3.00	6105. 7640.5	291.6	10.451	369.4	417.9	.9800
2.0000	50000.	1.00	9251.16743.5	234.2	12.584	477.0	417.9	.9800
2.0000	50000.	2.00	7972.12685.3	234.2	12.712	423.9	417.9	.9800
2.0000	50000.	3.00	6624. 9409.6	234.2	12.829	369.8	417.9	.9800
2.2000	50000.	1.00	9336.17646.2	204.2	13.250	483.8	417.9	.9800
2.2000	50000.	2.00	7958.13317.5	204.2	13.390	429.8	417.9	.9800
2.2000	50000.	3.00	6507. 9396.7	204.2	13.517	374.8	417.9	.9800

Figure 1 NADC Uninstalled Engine Data Input Format (Concluded)

columns 8 and 9 respectively, are input in square inches for the NADC input instead of in square feet as in the Air Force version of the PIPSI code. The square inches are converted internally (in the revised code) to square feet.

(2) The association of external file names to internal program tape definitions is done with GET statements rather than ATTACH statements. For instance,

use GET,TAPE1=AFE to connect TAPE1 with previously stored AFE (Uninstalled engine input data file).

also, GET,TAPE51 = inlet file

GET,TAPE52 = aftbody file

GET,TAPE53 = CFG file

GET,TAPE54 = capture area file

(3) The code was modified to automatically generate installed propulsion system performance output data for use in mission performance calculations. This data is written to an output file named TAPE7. This file is automatically generated with each execution of the PIPSI program. The format for the TAPE7 output is as shown in Figure 2. The format was provided by NADC at the start of the contract work.

The modifications, debugging, checkout, sample calculations, and demonstration were all performed using the NADC computer system. At the

```
TJ25TS: RUN 6: A/B PERMANCE DECK; UNINSTALLED DATA.  USE WITH PIPSI
TREF          31140.
ALT 33    5          0.      10000.     20000.     36089.     50000.
MACH   1  7      0.0000      .2000      .4000      .6000      .8000     1.0000     1.2000
THR       4     26951.8    24753.7    22472.3    20024.3
WFT       4     51613.3    40108.7    30932.1    22460.6
THR       4     27278.3    24866.5    22373.7    19716.0
WFT       4     54191.3    42129.8    32479.7    23570.9
THR       4     29525.0    26718.8    23831.4    20755.8
WFT       4     59369.3    46207.3    35579.3    25767.7
THR       4     33704.3    30296.9    26785.0    23046.9
WFT       4     67364.3    52508.0    40347.9    29122.0
THR       4     36463.6    32542.8    28493.4    24178.6
WFT       4     74027.1    57752.8    44256.6    31798.2
THR       4     38300.1    33512.9    28569.0    23285.8
WFT       4     82095.9    64082.3    48934.4    34954.6
THR       4     40439.8    34834.0    29057.0    22836.8
WFT       4     90168.2    70388.5    53514.9    37948.7
MACH   2  6       .2000      .4000      .6000      .8000     1.0000     1.2000
THR       4     20300.2    18503.3    16659.5    14692.4
WFT       4     40286.1    31222.6    24151.7    17624.5
THR       4     21750.2    19695.6    17588.0    15340.5
WFT       4     43833.0    34009.5    26278.5    19141.7
THR       4     24365.4    21922.5    19411.1    16735.0
WFT       4     49131.3    38177.3    29446.8    21387.2
THR       4     28255.0    25272.9    22199.5    18922.4
WFT       4     56226.0    43794.4    33688.6    24359.2
THR       4     31553.4    27741.8    23859.2    19706.8
WFT       4     64220.9    50096.6    38409.1    27620.4
THR       4     34883.2    30390.3    25746.0    20776.8
WFT       4     72076.8    56261.4    42963.1    30690.4
MACH   3  7       .4000      .6000      .8000     1.0000     1.2000     1.4000     1.6000
THR       4     15483.4    14031.6    12545.3    10958.2
WFT       4     31435.4    24287.2    18331.2    13794.7
THR       4     17724.1    15961.8    14158.3    12235.1
WFT       4     35614.9    27580.0    21348.5    15596.3
THR       4     20150.4    18047.1    15888.4    13582.8
WFT       4     40243.7    31239.5    24124.5    17556.4
THR       4     23673.5    20890.4    18050.8    15028.8
WFT       4     47187.7    36729.4    28276.0    20471.8
```


Figure 2 Format for TAPE7 (Installed Performance) File *(Continued)*

THR		4	28249.2	24812.5	21231.3	17416.3			
WFT		4	55358.3	43179.9	33116.3	23826.6			
THR		4	30697.1	26690.6	22500.0	17989.5			
WFT		4	61490.6	47998.3	36650.7	26178.0			
THR		4	30028.7	25669.5	21080.5	16099.0			
WFT		4	64288.9	50184.3	38122.2	26995.9			
MACH	4	6	.6000	.8000	1.0000	1.2000	1.6000	2.0000	
THR		4	9[illegible]04.6	8573.8	7625.8	6612.7			
WFT		4	19429.2	14912.9	11606.7	8557.1			
THR			11114.1	9977.1	8817.5	7576.4			
WFT		4	22279.4	17162.1	13332.5	9797.9			
THR		4	13276.7	11772.3	10227.6	8593.4			
WFT		4	26205.1	20264.1	15702.1	11490.9			
THR		4	16328.0	14430.6	12465.1	10345.2			
WFT		4	31294.1	24288.9	18760.4	13656.7			
THR		4	21665.6	18884.0	15985.4	12849.2			
WFT		4	41004.8	31993.3	24504.6	17591.9			
THR		4	19583.3	16522.8	13311.8	9747.1			
WFT		4	42339.5	33044.3	25037.9	17655.3			
MACH	5	7	.6000	.8000	1.0000	1.2000	1.6000	2.0000	2.2000
THR		4	4882.8	4404.9	3917.9	3397.5			
WFT		4	9985.1	7663.6	5964.7	4397.7			
THR		4	5713.0	5128.6	4532.5	3894.8			
WFT		4	11453.3	8822.3	6853.8	5037.1			
THR		4	6830.7	6056.8	5261.5	4420.8			
WFT		4	13478.9	10422.9	8076.6	5910.7			
THR		4	8396.9	7421.1	6410.6	5320.1			
WFT		4	16092.0	12489.6	9646.9	7022.8			
THR		4	11145.9	9715.3	8223.5	6609.8			
WFT		4	21089.4	16454.6	12503.4	9048.6			
THR		4	10079.4	8504.4	6852.2	5016.9			
WFT		4	21783.9	17001.6	12882.8	9084.9			
THR		4	8412.8	6834.4	5169.0	3299.4			
WFT		4	21185.5	16521.4	12435.4	8671.7			

Figure 2 Format for TAPE7 (Installed Performance) File *(Concluded)*

beginning of the contract, a magnetic tape containing the existing Air Force versions of the source codes for the PIPSI and DERIVP plus a complete library file of inlet performance, nozzle/aftbody drag maps, and nozzle C_{F_G} maps was mailed to NADC and was installed by NADC personnel as permanent files in their CDC computer system. The modifications were then accomplished by Boeing personnel using a remote access keyboard terminal located at Seattle, Washington.

Preparation of ADEN Nozzle Maps

A set of nozzle/aftbody drag and C_{F_G} maps for the ADEN CD Nozzle was developed for use during the installed performance calculations. These maps for the ADEN configuration are described and shown in Appendix A.

Calculation of Installed Performance

After the source code was modified, binary (object) deck files were created and stored as permanent files in the NADC computer. After the modified object decks were obtained, a series of installed performance calculations was performed using the matrix of engines, inlets, nozzle/aftbody drag maps, and nozzle C_{F_G} maps described in Appendix A. Plotted results from some of the installed performance calculations are contained in Appendix A. Appendix A also contains a catalog of the files stored in the NADC computer with key files indicated.

Demonstration and Training Session

At the conclusion of the contract work, a training session was held at NADC to explain and demonstrate the operation of the computer programs to

NADC personnel. Appendix B contains some of the general briefing charts that were contained in handout material distributed to the NADC personnel who participated in the training sessions. The charts are presented in Appendix B to provide a source of information for those who want to learn of the general operating characteristics of the computer programs without obtaining the complete set of documents describing the programs (References 1 through 4).

APPENDIX A

INSTALLED PERFORMANCE CALCULATIONS

TABLE A-I

SUMMARY OF INSTALLED PERFORMANCE CALCULATIONS

UNINSTALLED ENGINE DATA	INLET DATA		AFTBODY DRAG DATA		NOZZLE C_{F_G} DATA		DETAILED INSTALLED PERFORMANCE OUTPUT	"MARK II" MISSION PERFORMANCE DECK
FILE NAME	CONFIG.	NAME	CONFIG.	NAME	CONFIG.	NAME	FILE NAME	FILE NAME
BOEING1	2	F8	9	ADENCD	5	CVADEN	F8TFD	F8TFDM
(DRY	5	NS	9	ADENCD	5	CVADEN	NSTFD	NSTFDM
TURBOFAN)	6	NS2	9	ADENCD	5	CVADEN	NS2TFD	NS2TFDM
	7	LWF	9	ADENCD	5	CVADEN	LWFTFD	LWFTFDM
	8	ATS2	9	ADENCD	5	CVADEN	ATSTFD	ATSTFDM
BOEING2	2	F8	9	ADENCD	5	CVADEN	F8TFW	F8TFWM
(A/B	5	NS	9	ADENCD	5	CVADEN	NSTFW	NSTFWM
TURBOFAN)	6	NS2	9	ADENCD	5	CVADEN	NS2TFW	NS2TFWM
	7	LWF	9	ADENCD	5	CVADEN	LWFTFW	LWFTFWM
	8	ATS2	9	ADENCD	5	CVADEN	ATSTFW	ATSFTWM
BONGTJD	2	F8	9	ADENCD	5	CVADEN	F8TJD	F8TJDM
(DRY	5	NS	9	ADENCD	5	CVADEN	NSTJD	NSTJDM
TURBOJET)	6	NS2	9	ADENCD	5	CVADEN	NS2TJD	NS2TJDM
	7	LWF	9	ADENCD	5	CVADEN	LWFTJD	LWFTJDM
	8	ATS2	9	ADENCD	5	CVADEN	ATSTJD	ATSTJDM
BONGTJW	2	F8	9	ADENCD	5	CVADEN	F8TJW	F8TJWM
(A/B	5	NS	9	ADENCD	5	CVADEN	NSTJW	NSTJWM
TURBOJET)	6	NS2	9	ADENCD	5	CVADEN	NS2TJW	NS2TJWM
	7	LWF	9	ADENCD	5	CVADEN	LWFTJW	LWFTJWM
	8	ATS2	9	ADENCD	5	CVADEN	ATSTJW	ATSTJWM

TABLE A-II

SUMMARY OF INLET CAPTURE AREAS

INLET CONFIG.	MACH	ALT.	ENG. TYPE	$\frac{W\sqrt{\theta_2}}{\delta_2}$	$\frac{P_{T_2}}{P_{T_0}}$	$\frac{A_0}{A_c}$	A_c, FT^2
F8	.80	50000.	T/F	330.	.98	.74	9.183
	.80	50000.	T/J	284.	.98	.74	7.903
NS	.60	50000.	T/F	331.	.967	.975	7.882
	.60	50000.	T/J	284.	.967	.977	6.763
NS2	.80	50000.	T/F	330.	.982	.95	7.168
	.80	50000.	T/J	284.	.982	.95	6.169
LWF	.80	50000.	T/F	330.	.965	.77	8.690
	.80	50000.	T/J	284.	.965	.77	7.479
ATS2	2.00	50000.	T/F	234.	.925	.915	8.079
	1.60	50000.	T/J	256.	.948	.872	7.042

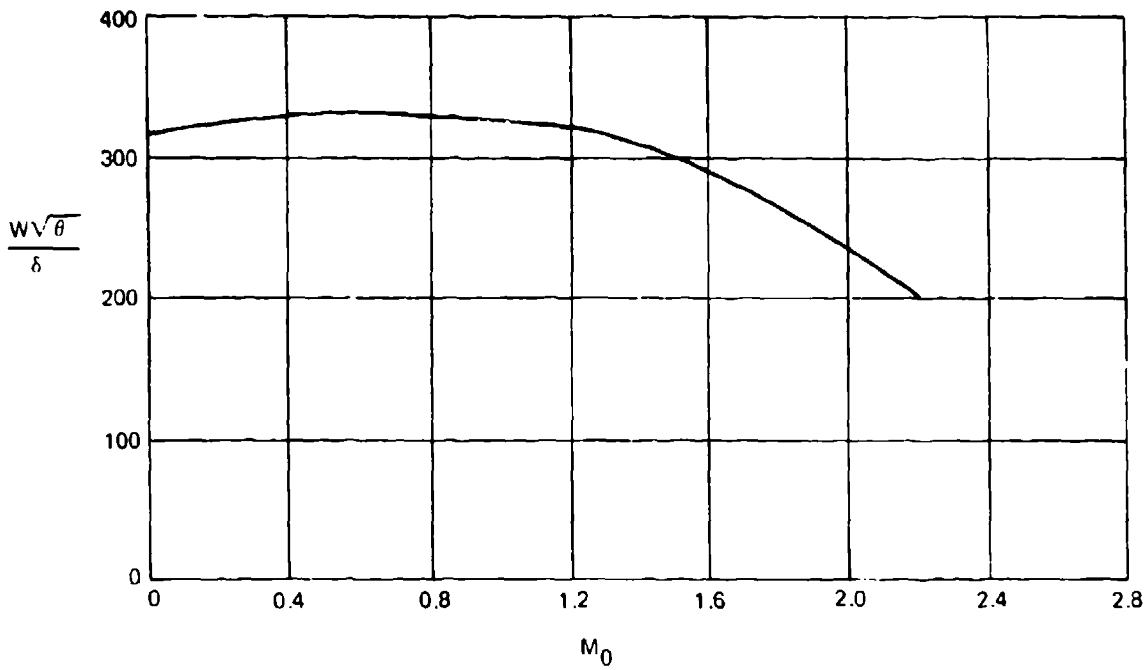

Figure A-1. Maximum Engine Airflow for Turbofan Engine

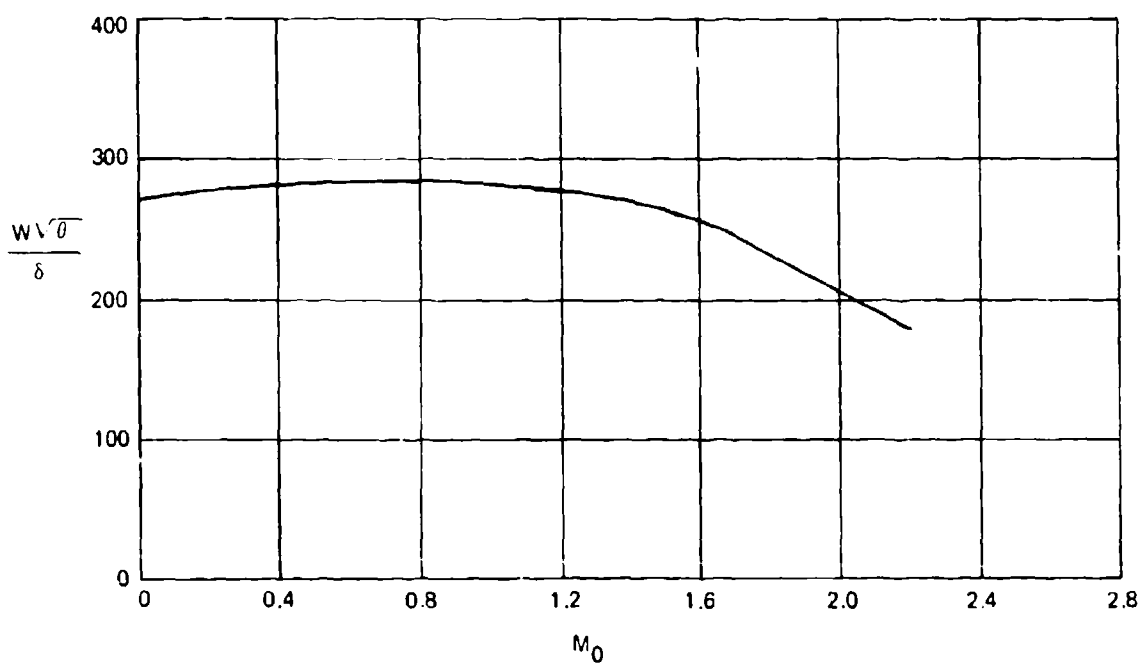

Figure A-2. Maximum Engine Airflow for Turbojet Engine

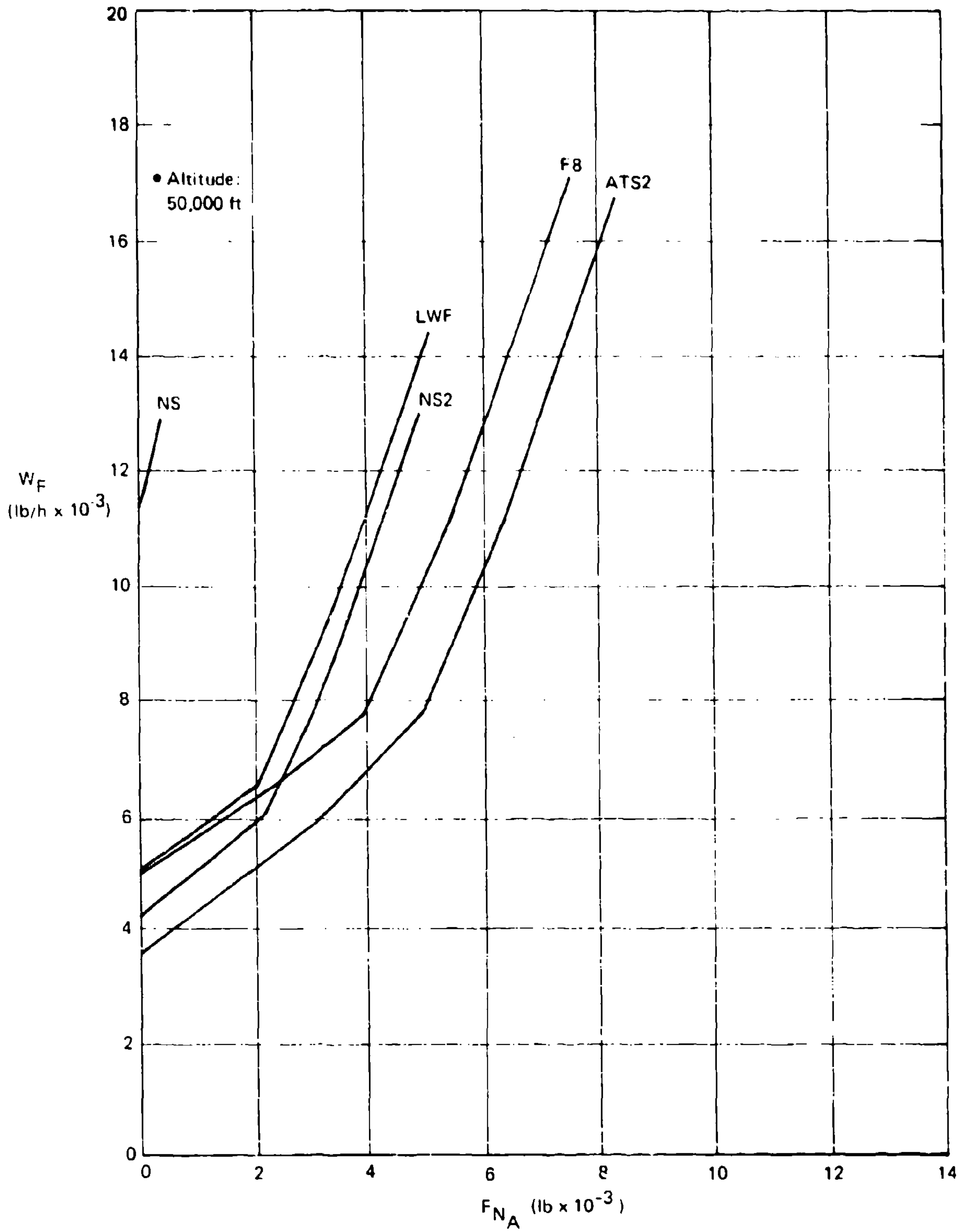

Figure A-3. Comparison of Installed Performance for Various Inlet Configurations at Mach 2.0 (Turbofan Engine)

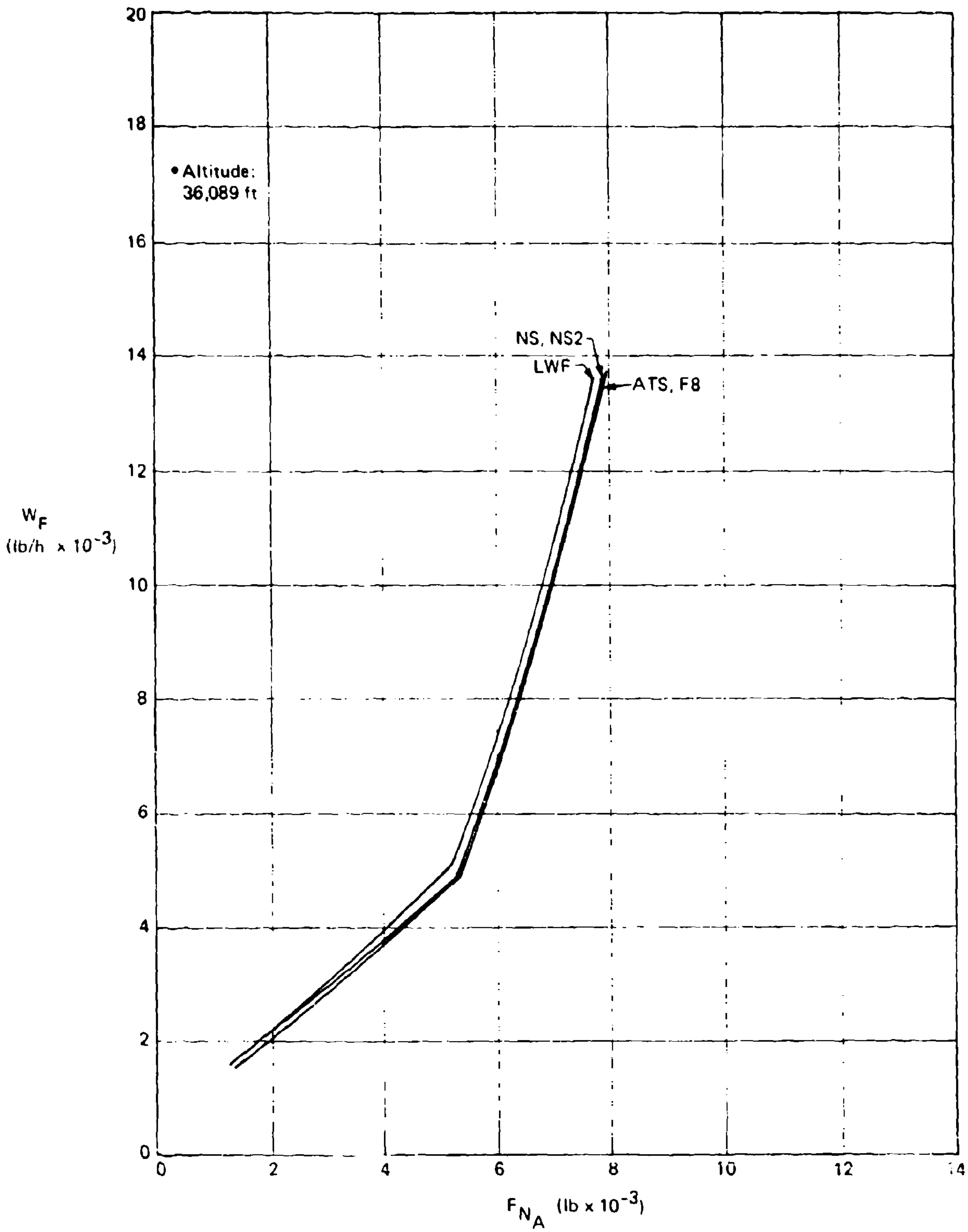

Figure A-4. Comparison of Installed Performance for Various Inlet Configurations at Mach 0.80 (Turbofan Engine)

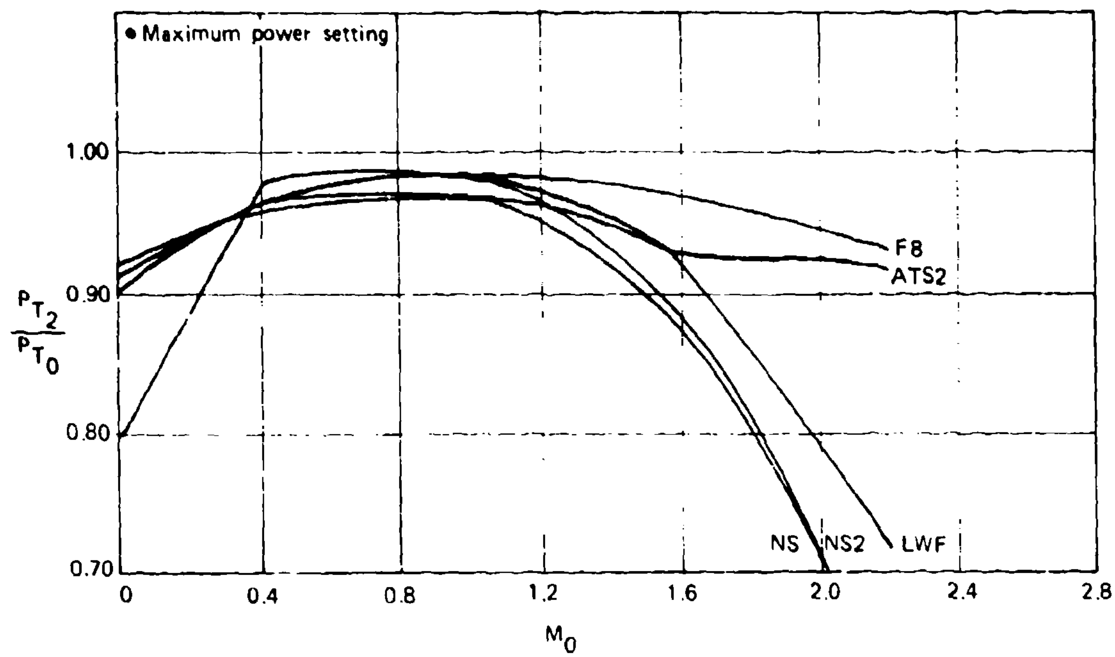

Figure A-5. Comparison of Matched Inlet Total Pressure Recovery for Various Inlets (Turbofan Engine)

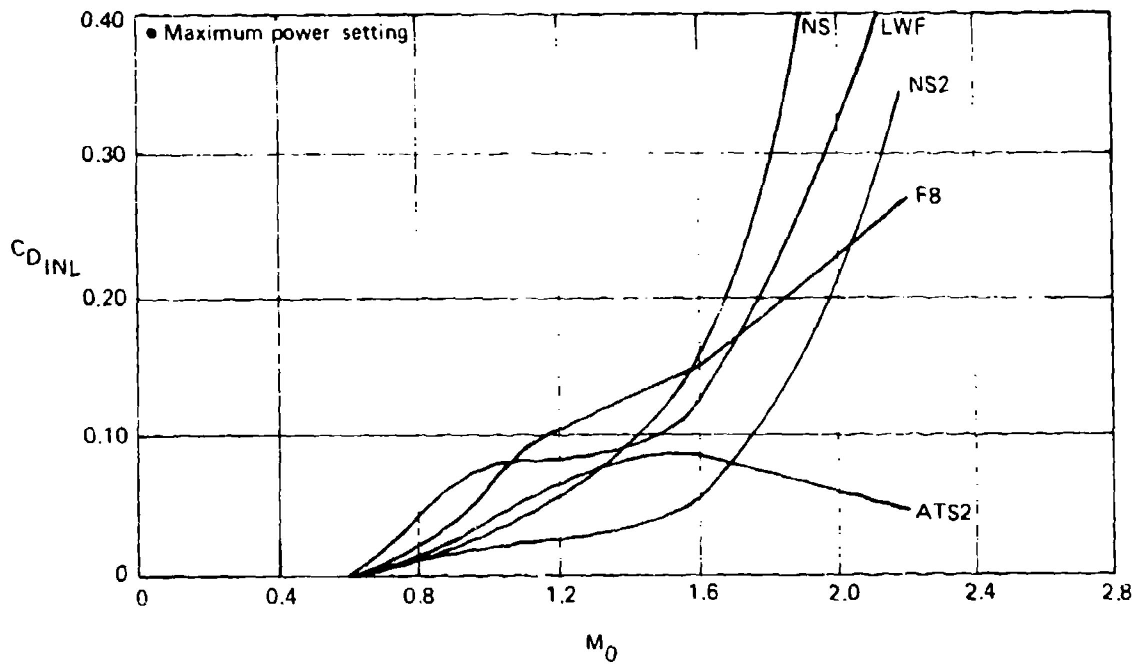

Figure A-6. Comparison of Matched Inlet Drag for Various Inlet (Turbofan Engine)

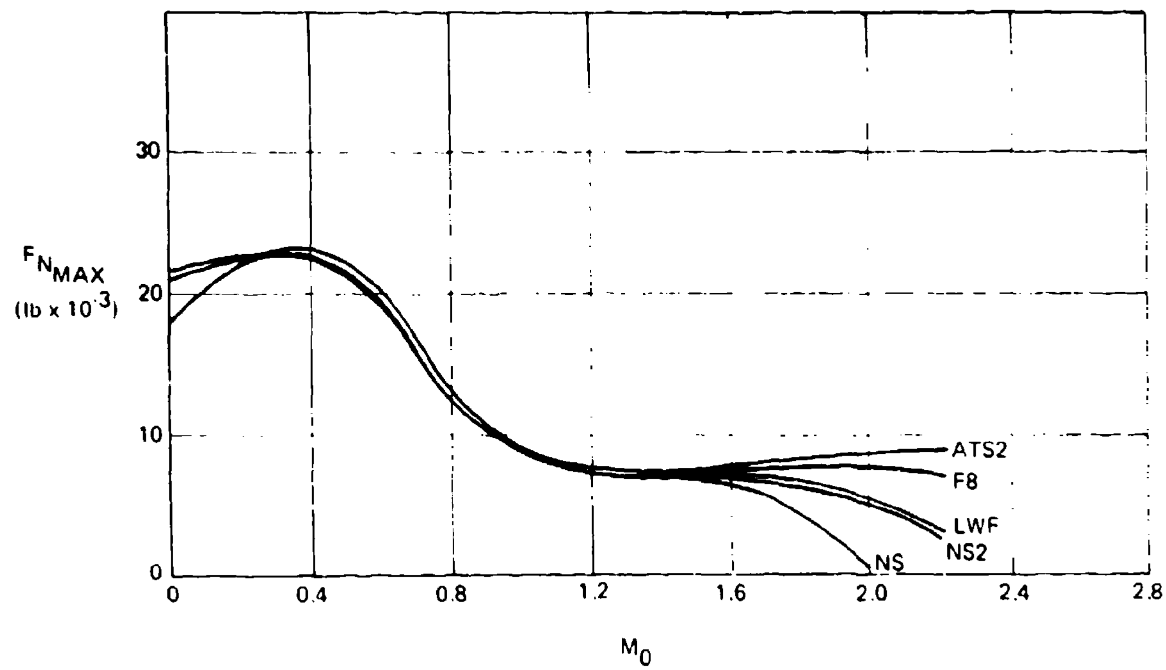

Figure A-7. Comparison of Maximum Installed Thrust for Various Inlets (Turbofan Engine)

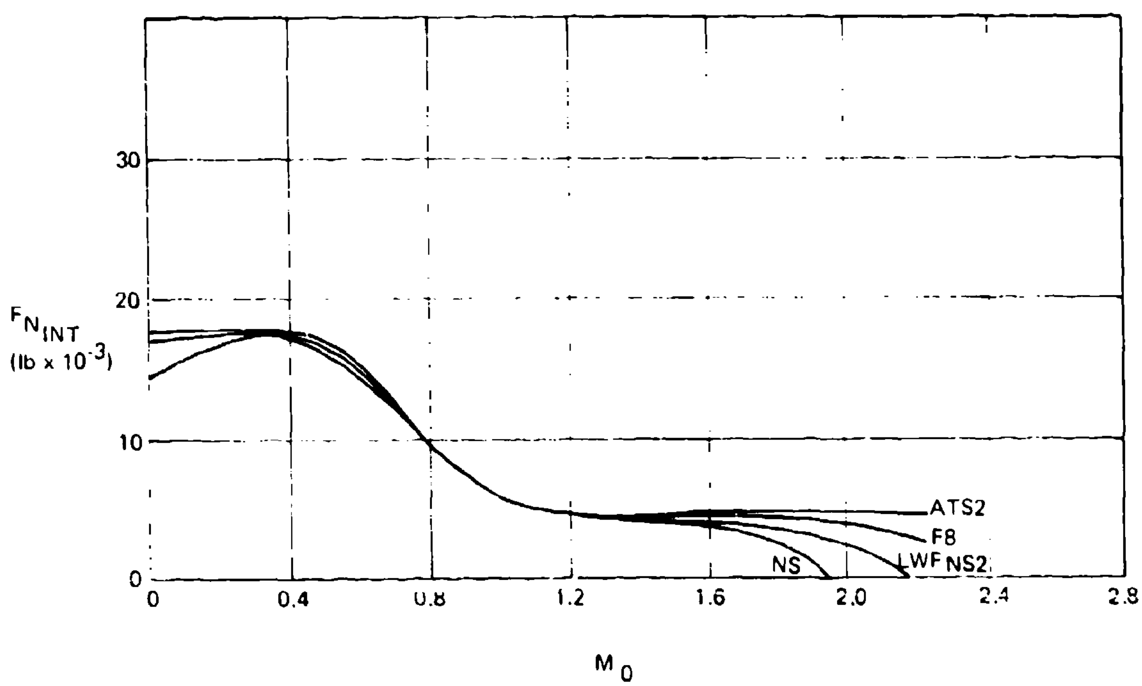

Figure A-8. Comparison of Intermediate Installed Thrust for Various Inlets (Turbofan Engine)

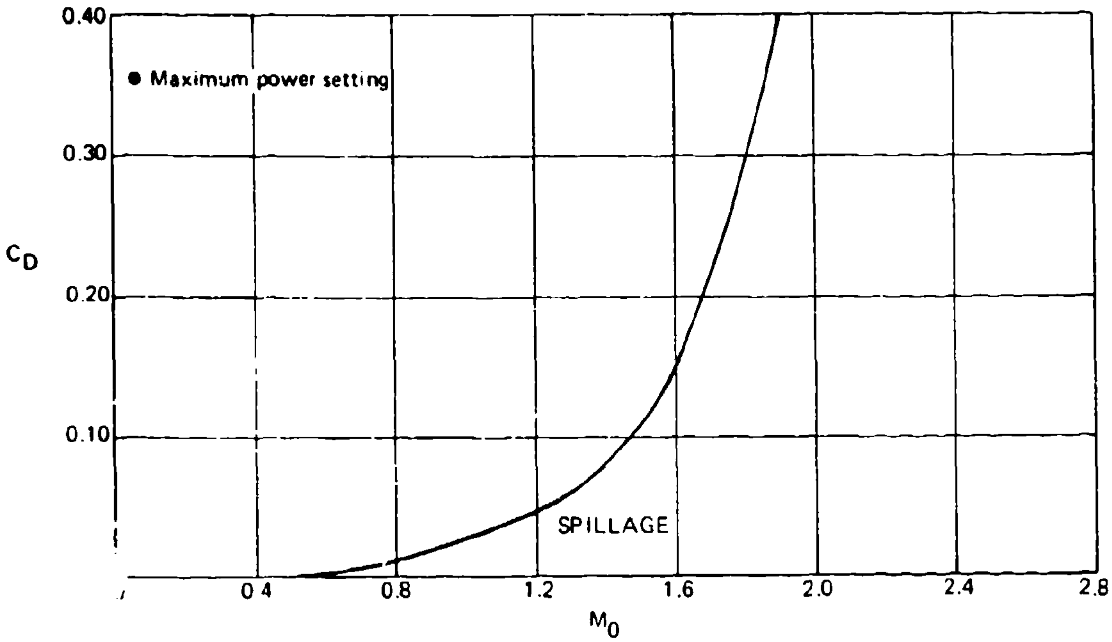

Figure A-9. Inlet Drag for a Normal Shock Inlet With a Turbofan Engine

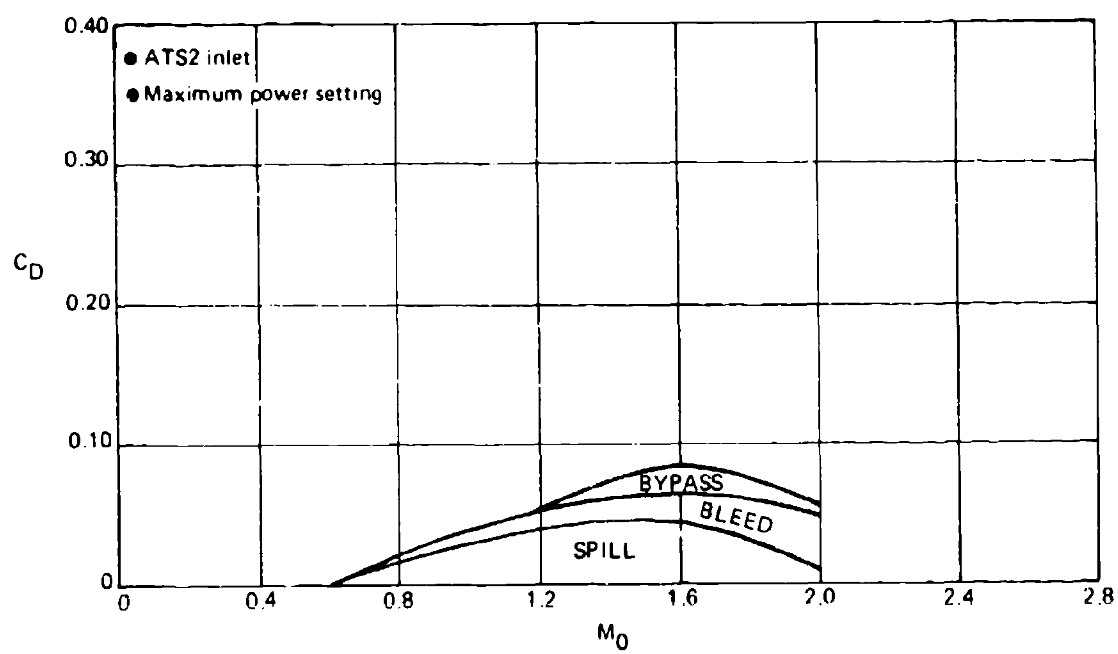

Figure A-10. Inlet Drag for a Mach 2.0 Inlet With a Turbofan Engine

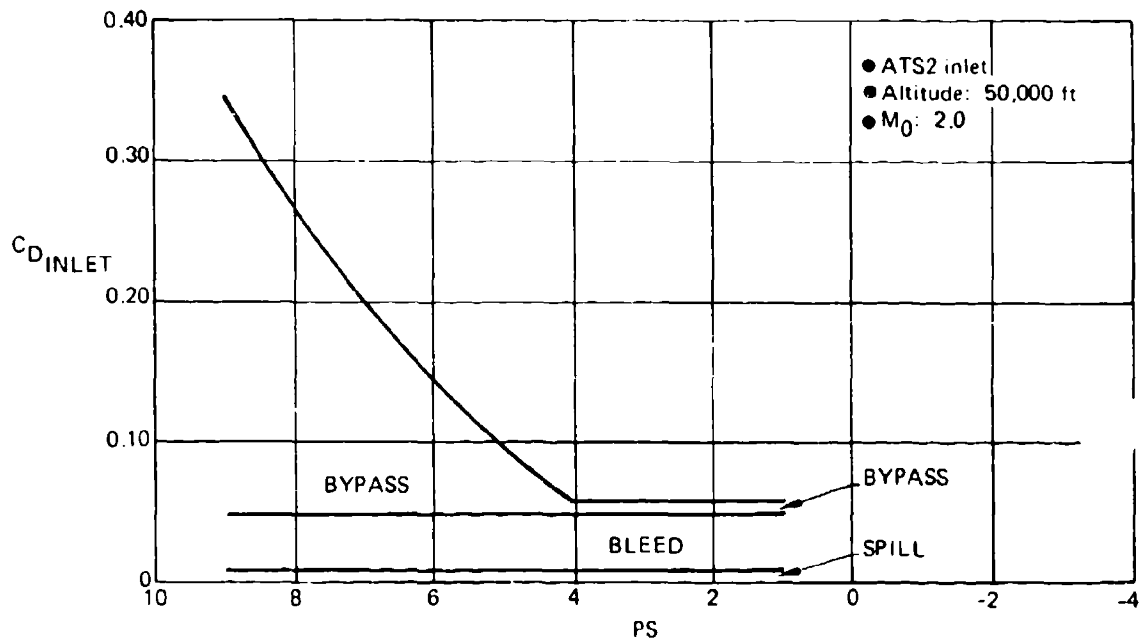

Figure A-11. Inlet Drag Versus Power Setting for a Mach 2 Inlet With a Turbofan Engine

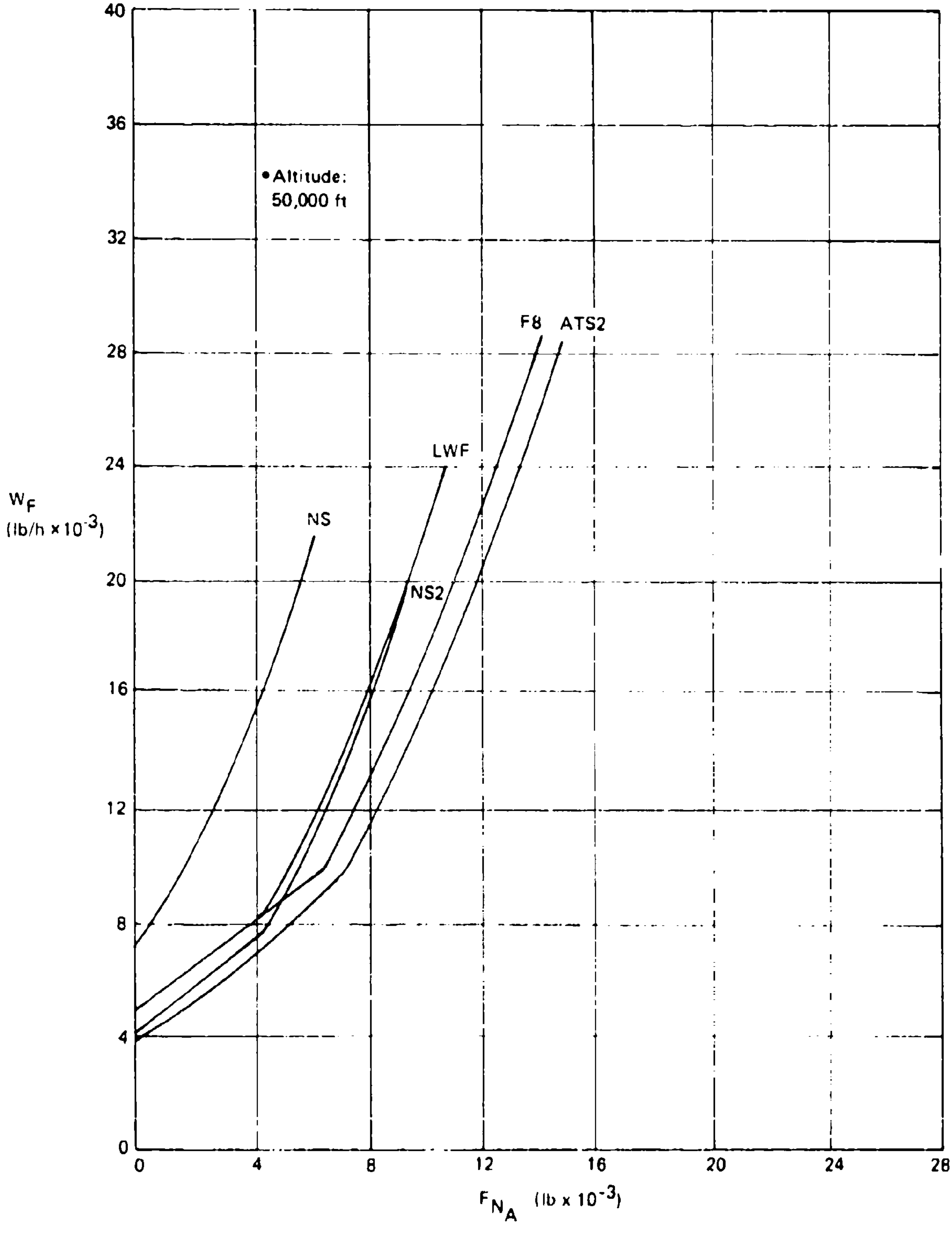

Figure A-12. Comparison of Installed Performance for Various Inlet Configurations at Mach 2.0 (Turbojet Engine)

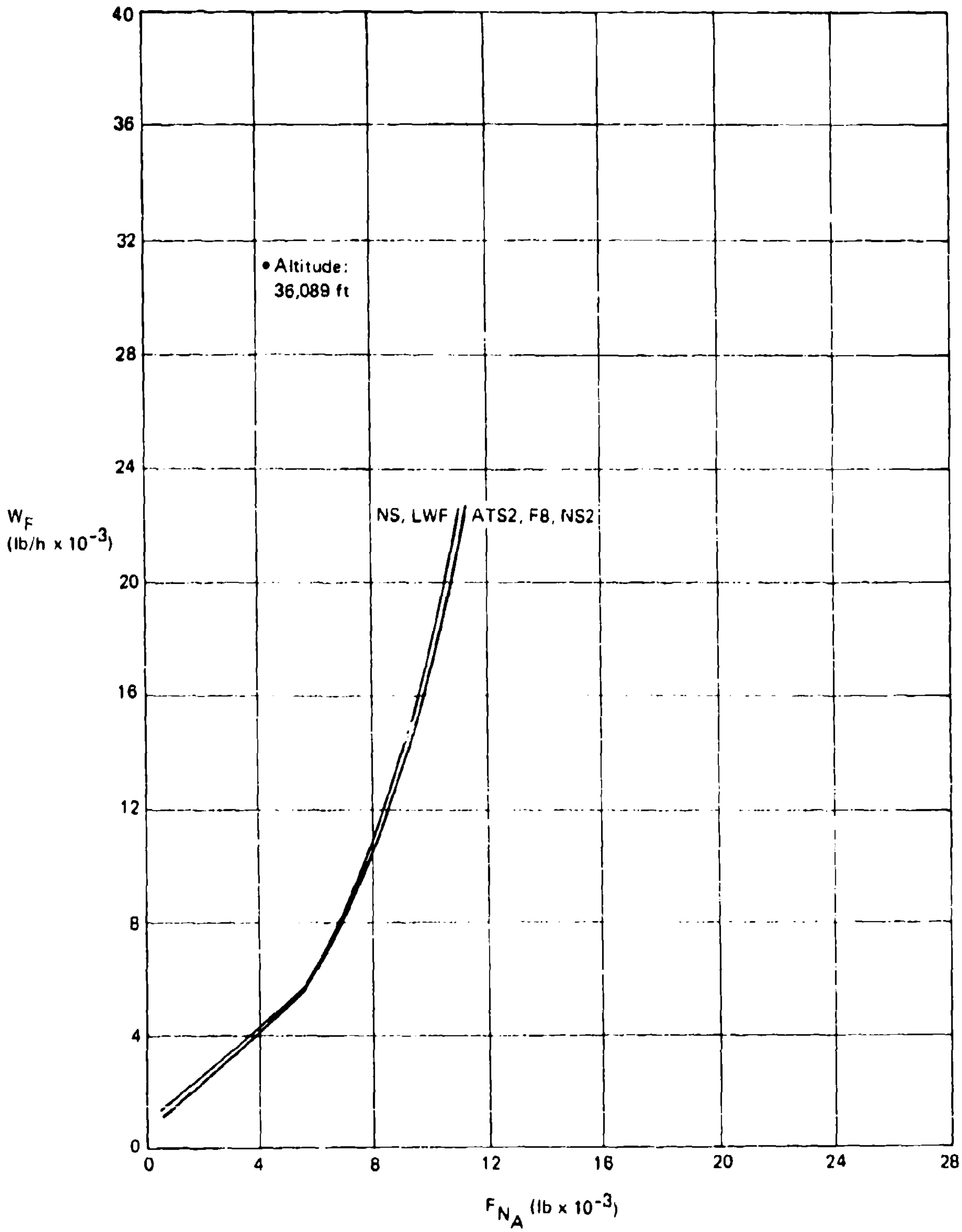

Figure A-13. Comparison of Installed Performance for Various Inlet Configurations at Mach 0.80 (Turbojet Engine)

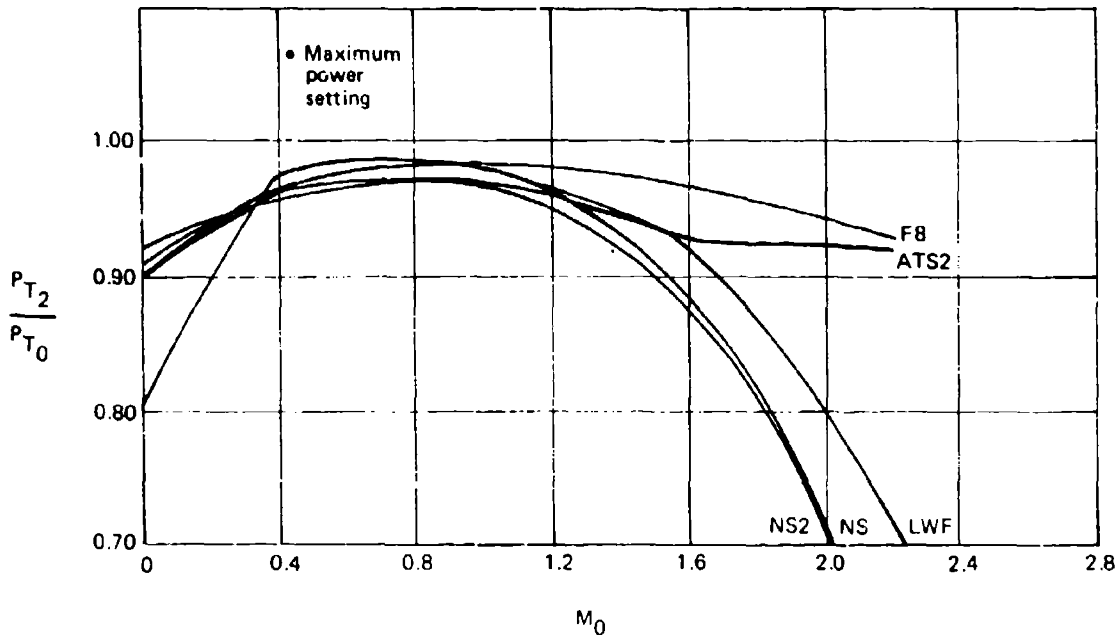

Figure A-14. Comparison of Matched Inlet Total Pressure Recovery for Various Inlets (Turbojet Engine)

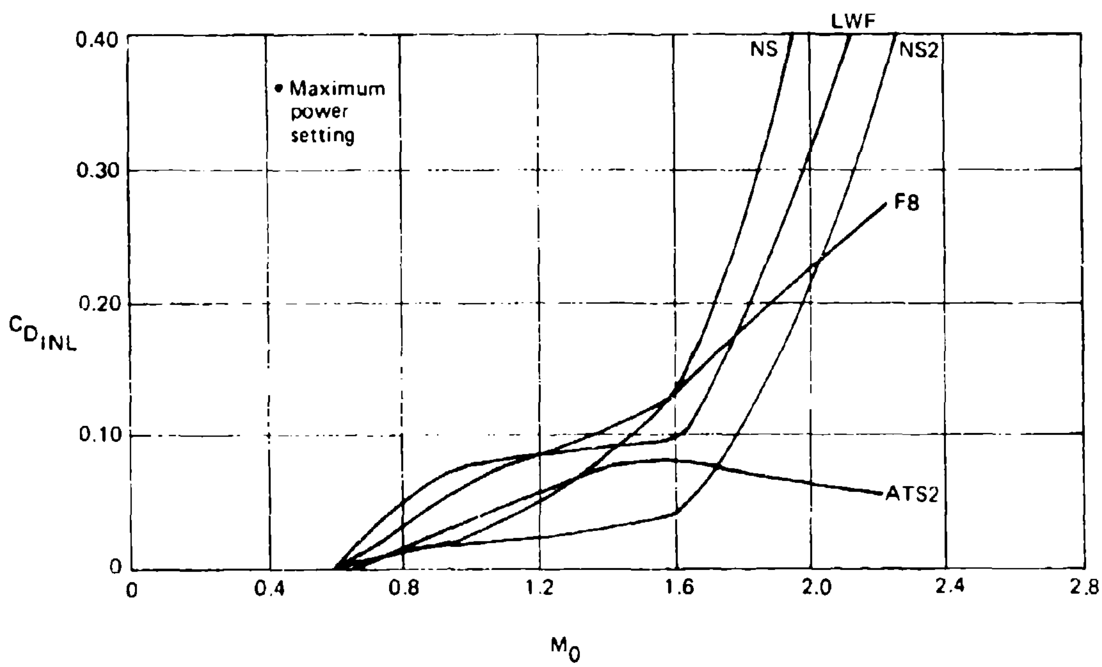

Figure A-15. Comparison of Matched Inlet Drag for Various Inlets (Turbojet Engine)

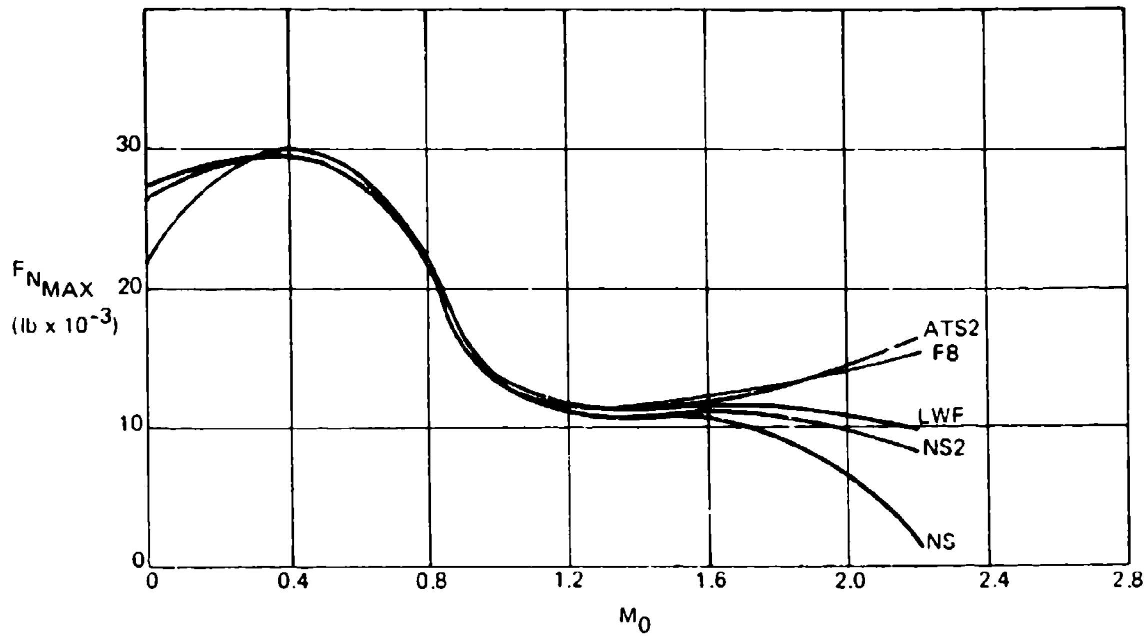

Figure A-16. Comparison of Maximum Installed Thrust for Various Inlets (Turbojet Engine)

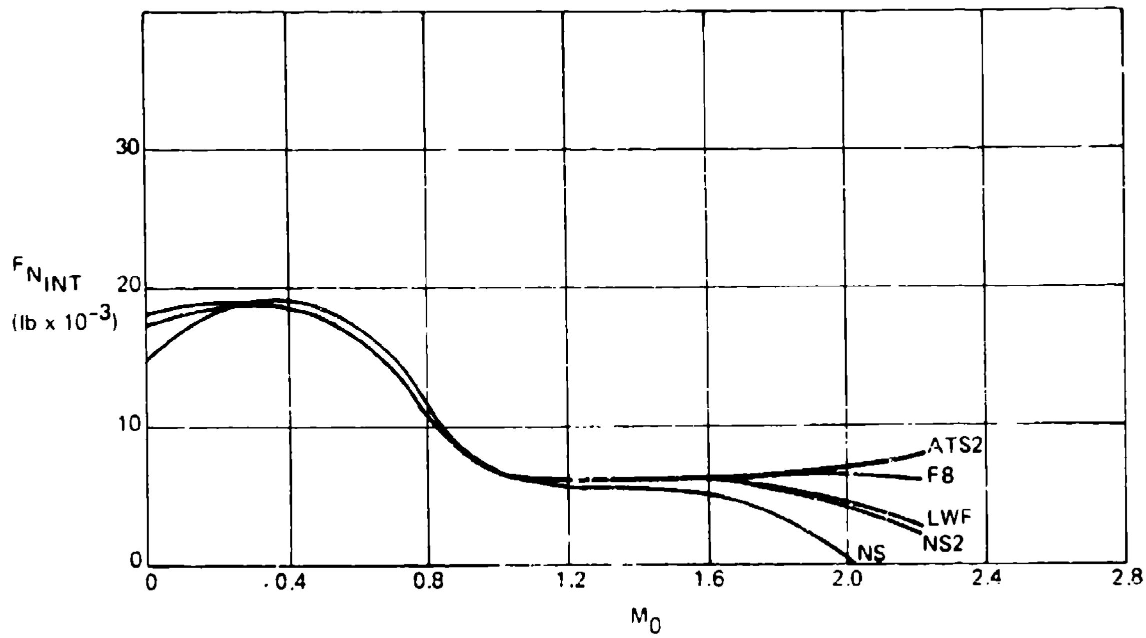

Figure A-17. Comparison of Intermediate Installed Thrust for Various Inlets (Turbojet Engine)

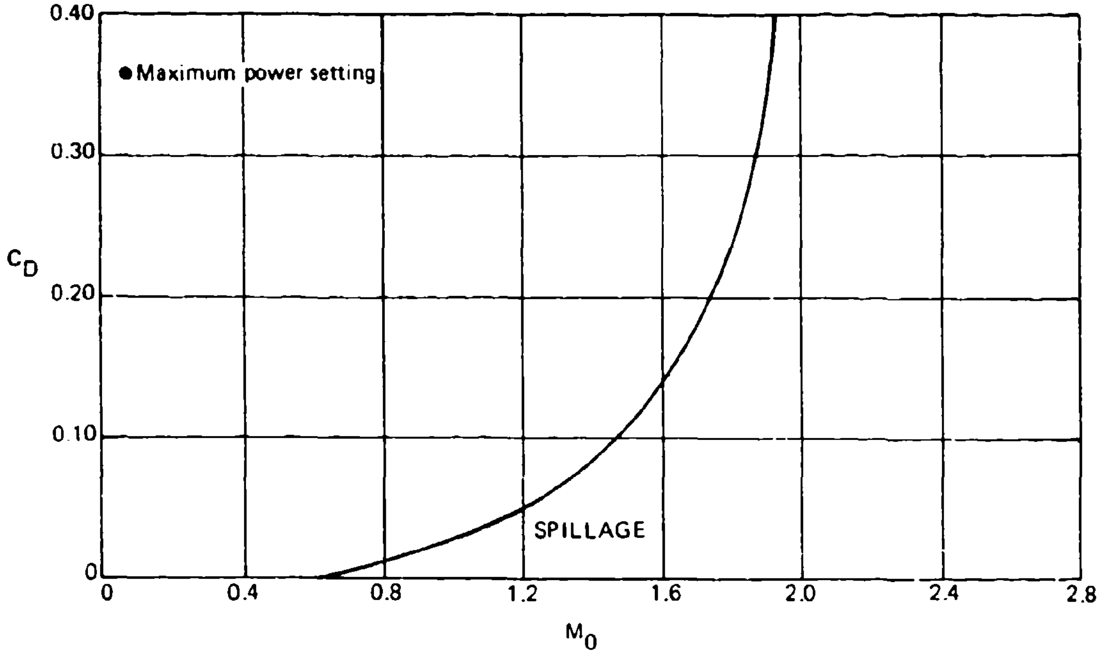

Figure A-18. Inlet Drag for a Normal Shock Inlet With a Turbojet Engine

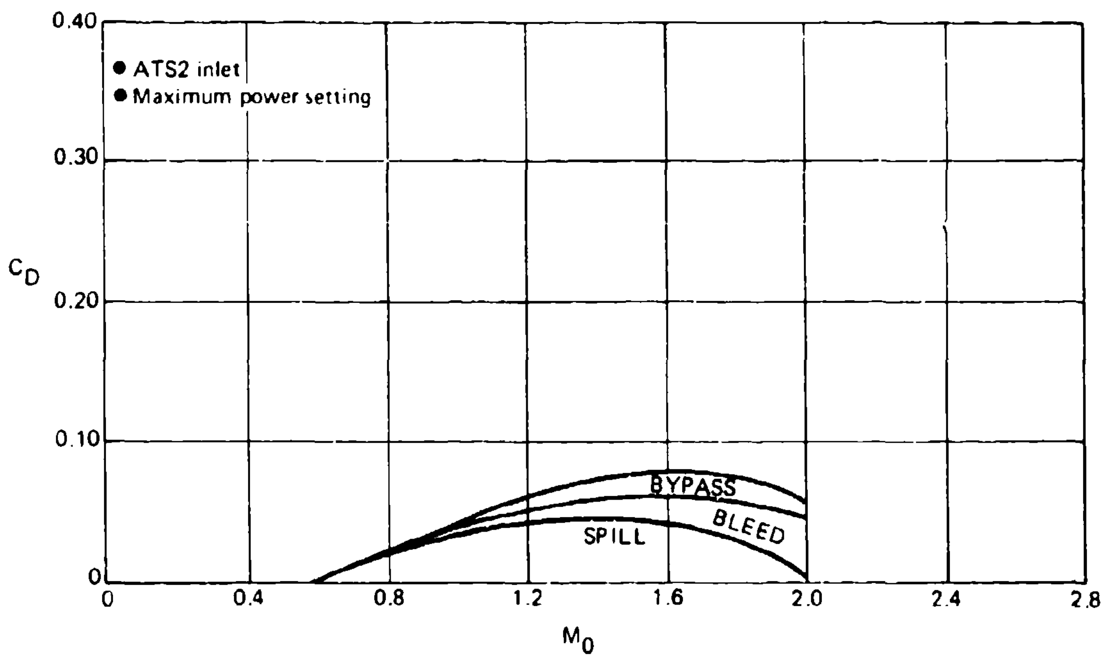

Figure A-19. Inlet Drag for a Mach 2.0 Inlet With a Turbojet Engine

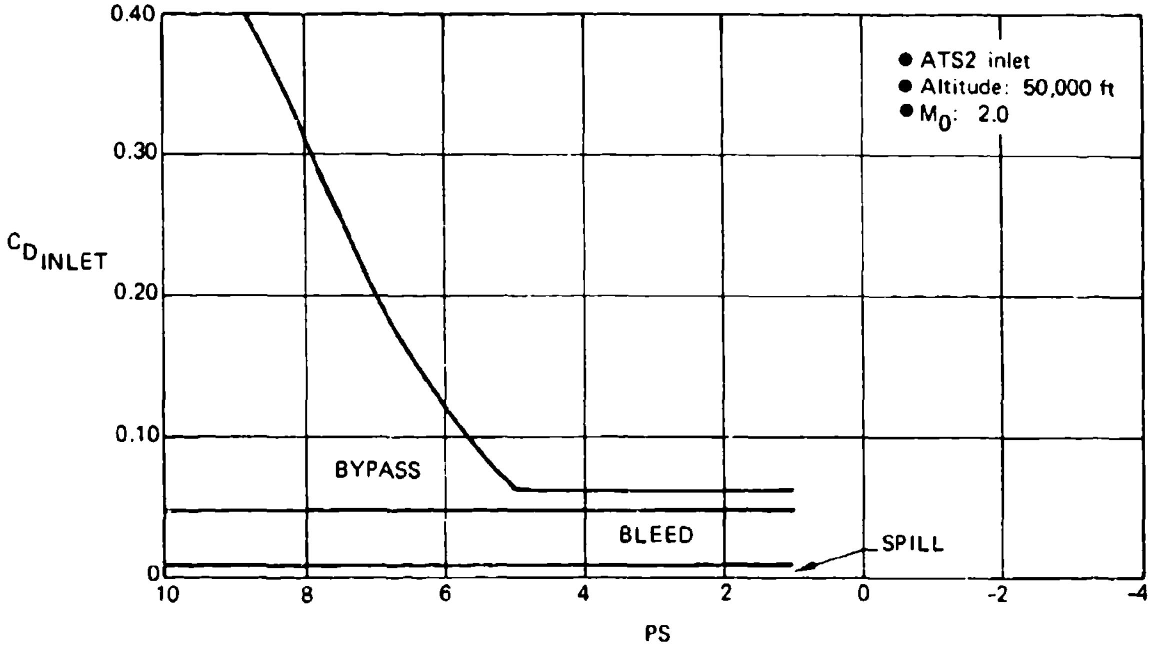

Figure A-20. Inlet Drag Versus Power Setting for a Mach 2.0 Inlet With a Turbojet Engine

```
CATALOG OF 603293                          79/10/09.  12.54.06

 FILE NAME(S)

ACDM31   ACDM36   ADENCD   AIAA     ATSTFDM  ATSTFW   ATSTFWM
ATSTJD   ATSTJDM  ATSTJW   ATSTJWM  ATS2     ATS2DM3  BILOUT
BOEING1  BOEING2  BONGTJD  BONGTJW  CVADEN   CVADEN2  CV1
CV2D     CV2D1    CV2D6    ENGDEKM  F8       F8TFD    F8TFDM
F8TFW    F8TFWM   F8TFWM1  F8TFW2   F8TFW3   F8TFW3M  F8TFW4
F8TFW4M  F8TJD    F8TJDM   F8TJW    F8TJWM   LWF      LWFTFD
LWFTFDM  LWFTFW   LWFTFWM  LWFTJD   LWFTJDM  LWFTJW   LWFTJWM
MAPX1    M9SUB    NADC3    NADC3B   NADC4    NADC4B   NADC7
NADC7B   NADC8B   NADC9B   NS       NSTFD    NSTFDM   NSTFW
NSTFWM   NSTJD    NSTJDM   NSTJW    NSTJWM   NS2      NS2TFD
NS2TFDM  NS2TFW   NS2TFWM  NS2TJD   NS2TJDM  NS2TJW   NS2TJWM
NUTEST   NU7      NUSDP1   NUSDP6   NUSTD    TAPE7    TESTOUT
USER     WPABDP   WPABDPB  XXXX     208NTTY

        89 FILES(S)

READY
```

FILE NAME	FILE CONTENTS
BOEING1	Dry Turbofan Engine Uninstalled Data
BOEING2	Afterburning Turbofan Engine Uninstalled Data
BONGTJD	Dry Turbojet Engine Uninstalled Data
BONGTJW	Afterburning Turbojet Engine Uninstalled Data
NADC7	Source Deck for PIPSI Program
NADC9B	Object Deck for PIPSI Program
WPABDP	Source Deck for Derivative Process Program
WPABDPB	Object Deck for Derivative Process Program
MAPXI	Library File of Inlet, Nozzle/Aftbody Drag, and Nozzle C_{F_G} Maps
CVADEN	ADEN Nozzle C_{F_G} Map
ADENCD	Nozzle/Aftbody Drag Map for ADEN Nozzle

Figure A-21 Catalog of Permanent Files on NADC Computer Account

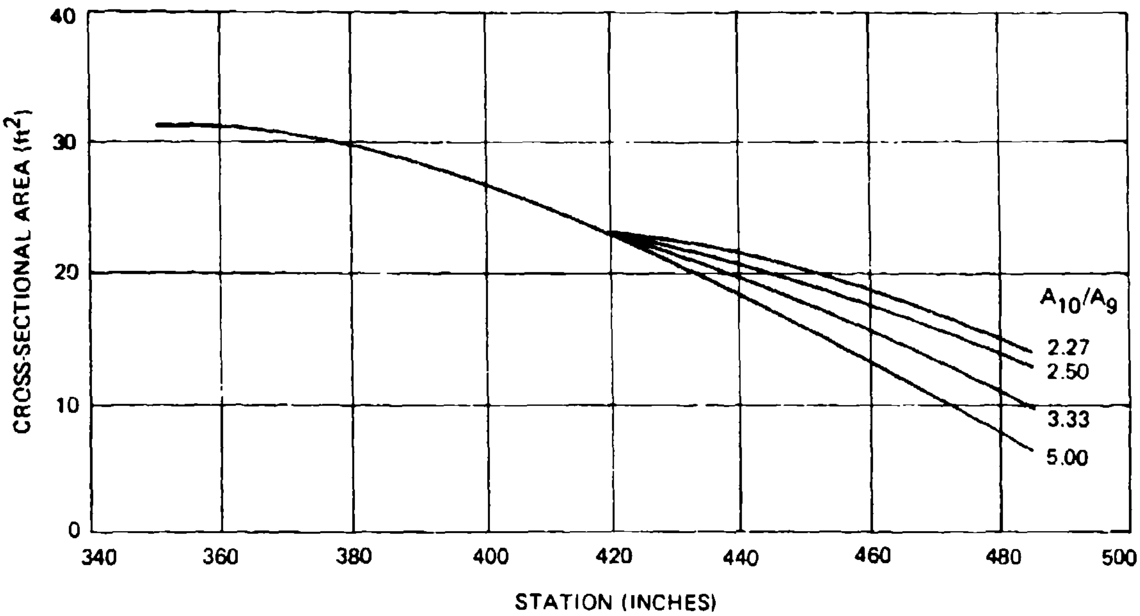

Figure A-22. Nozzle and Aftbody Area Distribution for a Twin ADEN Nozzle Configuration

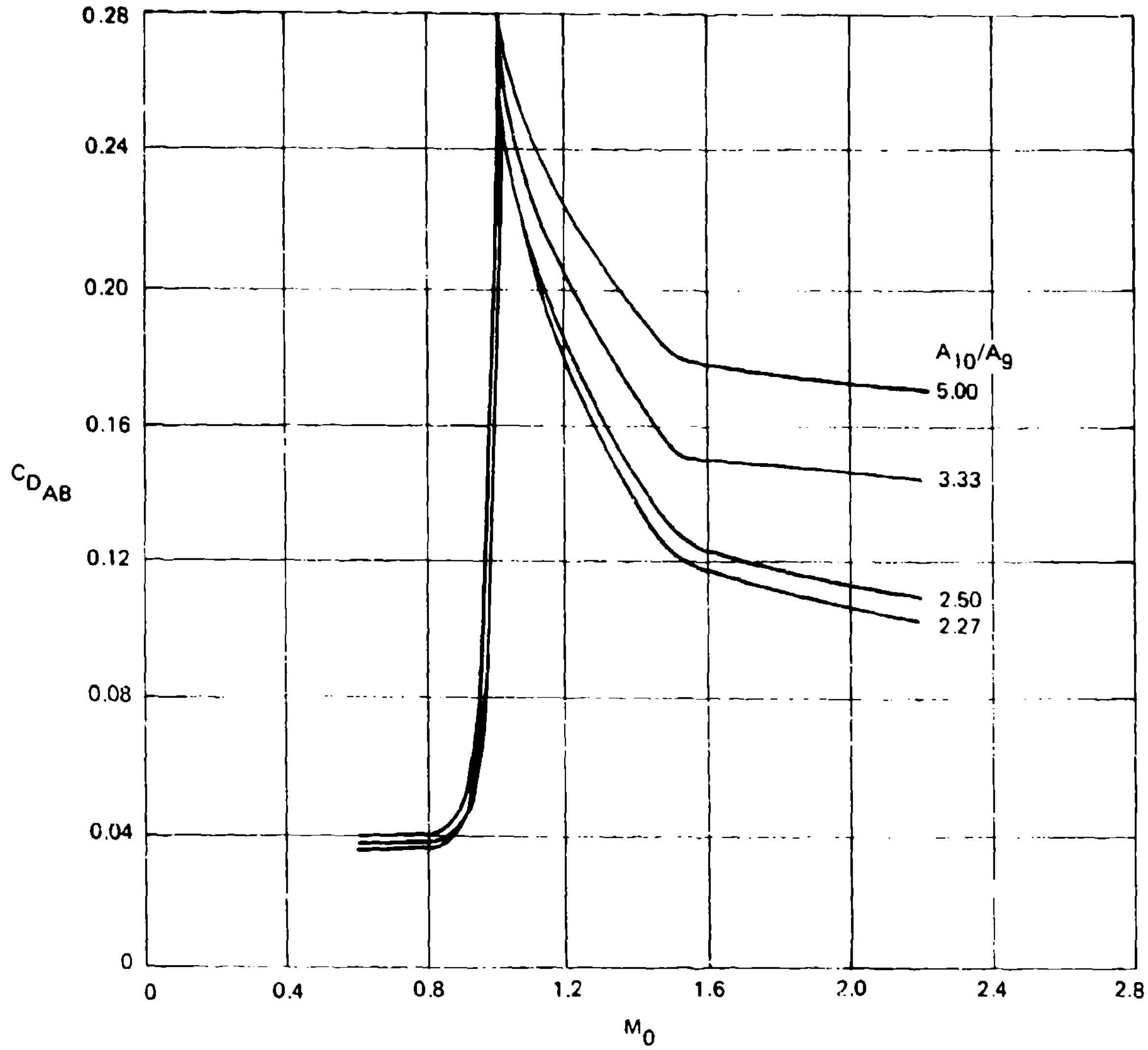

Figure A-23. Drag for a Twin ADEN Nozzle Configuration

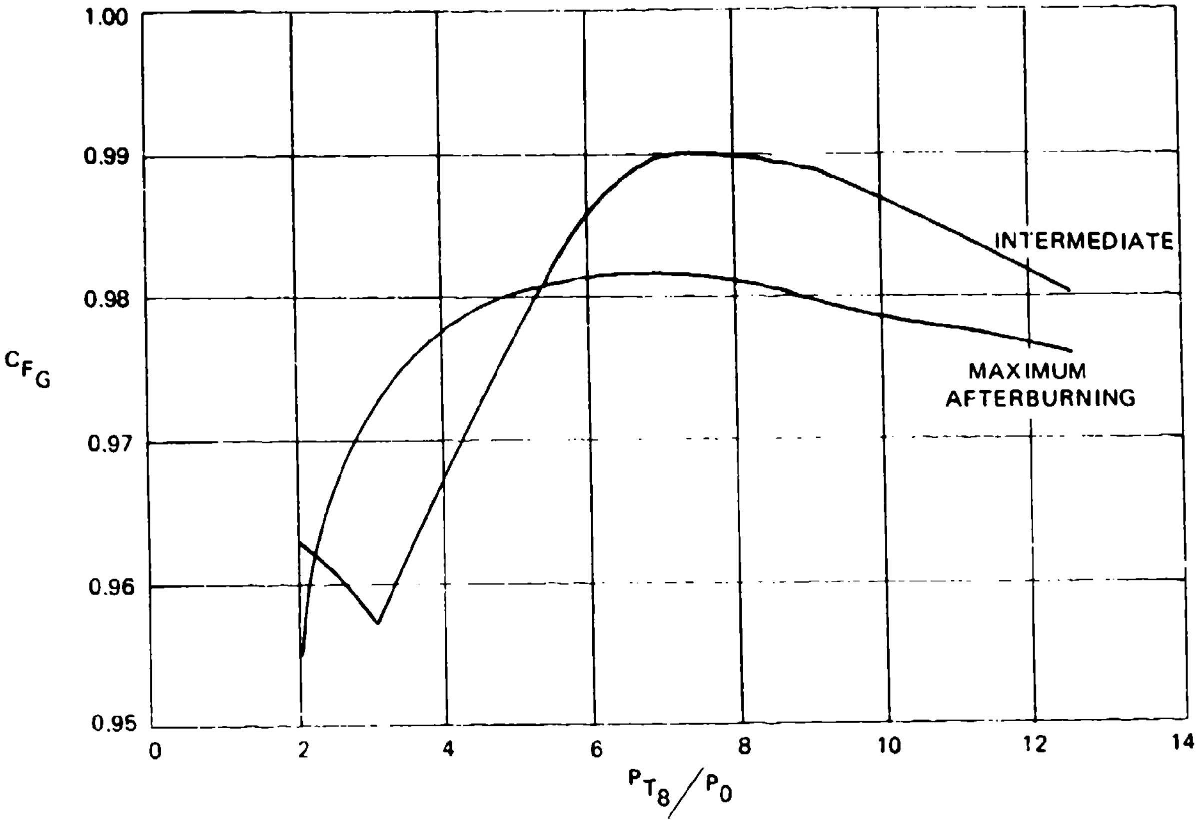

Figure A-24. Gross Thrust Coefficient for an ADEN Nozzle Configuration

APPENDIX B

GENERAL COMPUTER PROGRAM OPERATING CHARACTERISTICS

What is PIPSI?

- An improved version of a computerized engineering procedure designed to calculate installed propulsion system performance for preliminary design studies of advanced military aircraft.
- A previous version of the program (P.I.P.S.) was supplied to the Air Force as part of contract F33615-72-C-1580.
- The engineering procedure used in the original study was designated P.I.T.A.P. (Propulsion Installation and Table Assembly Program; ref: AFFDL-TR-72-147, vols I-IV).
- P I P S I program is documented in AFFDL-TR-78-91, Vols I-IV July 1978.

Figure B-1 Description of PIPSI Program and References

Preliminary Analysis Process Using PIPSI

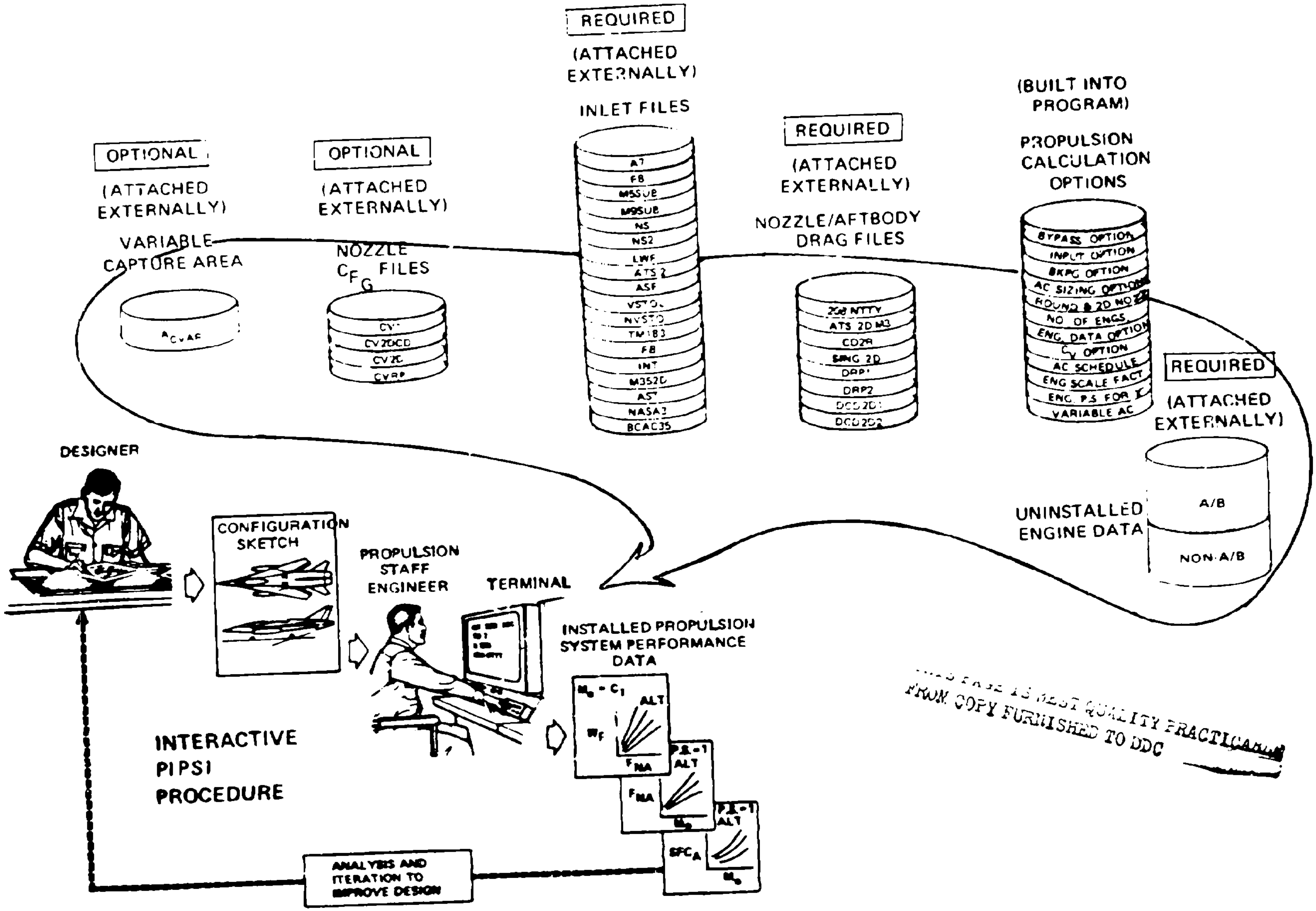

Figure B-2 PIPSI Analysis Process and Files Utilized

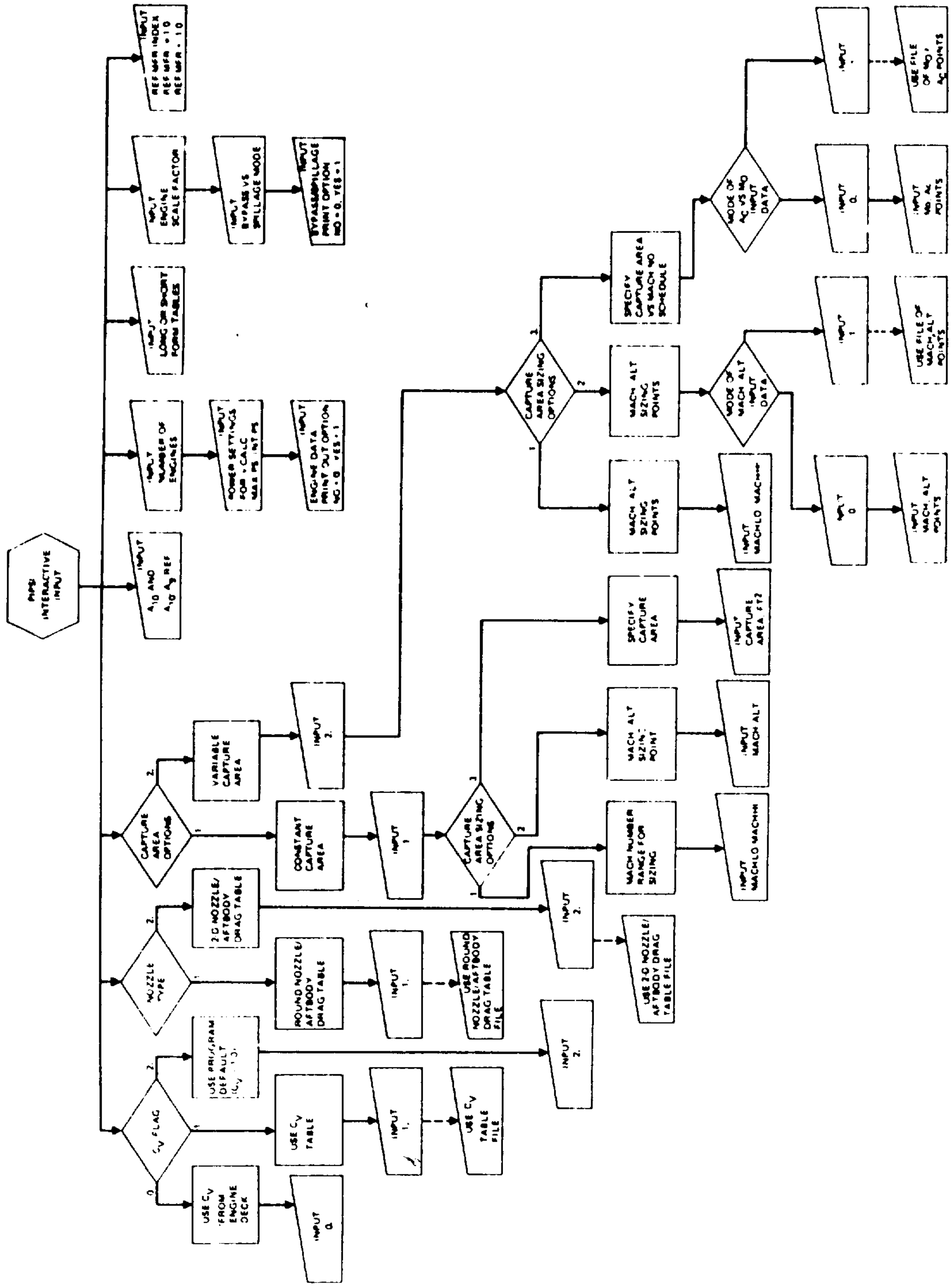

Figure B-3 PIPSI Interactive Input Options

Best Available Copy

PIPSI Data Flow

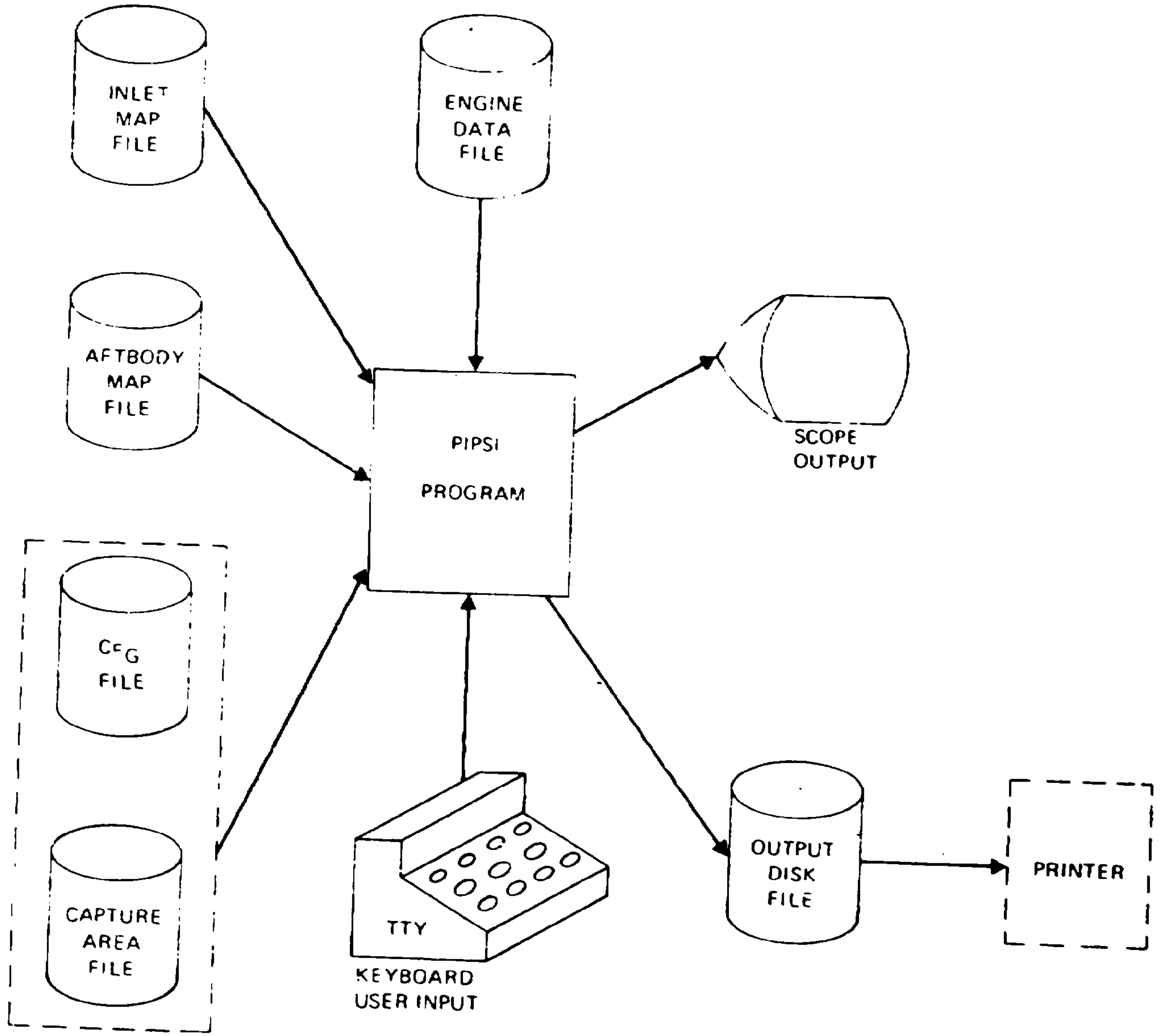

Figure B-4 PIPSI Data Flow

Matrix of Inlet Maps

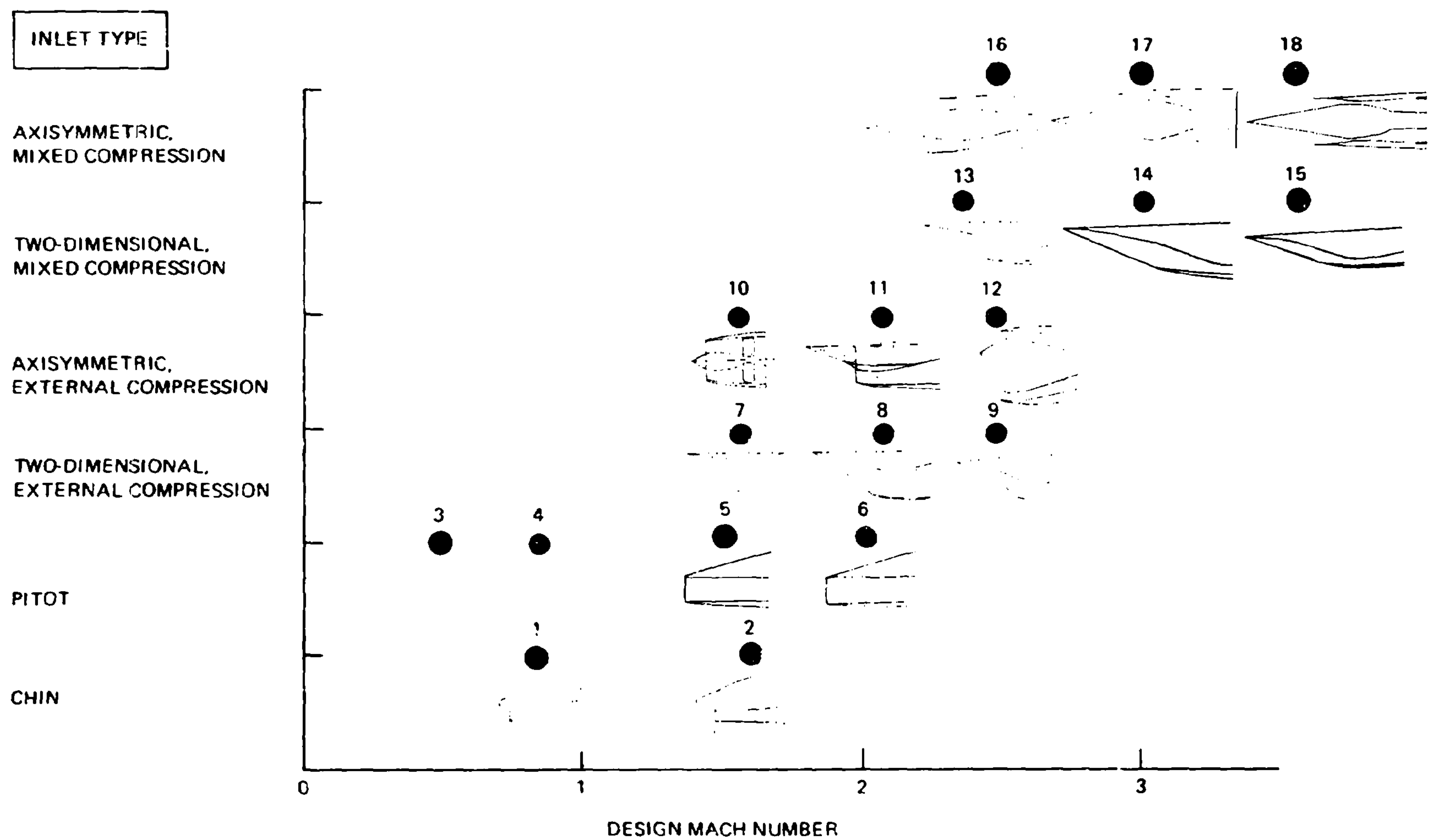

Figure B-5 Matrix of Inlet Maps in Library File

Matrix of Nozzle Types

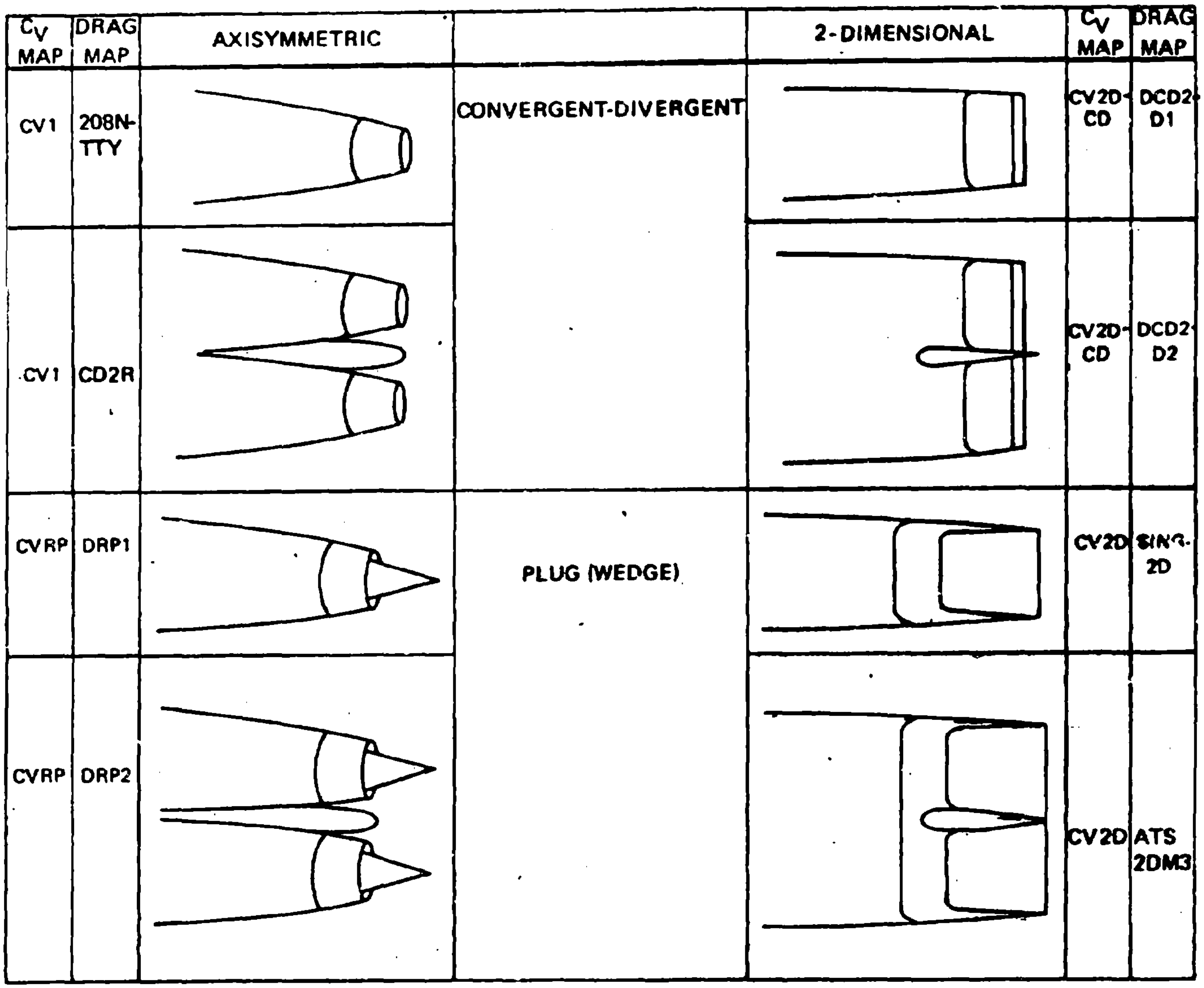

Figure B-6 Matrix of Nozzle Maps in Library File

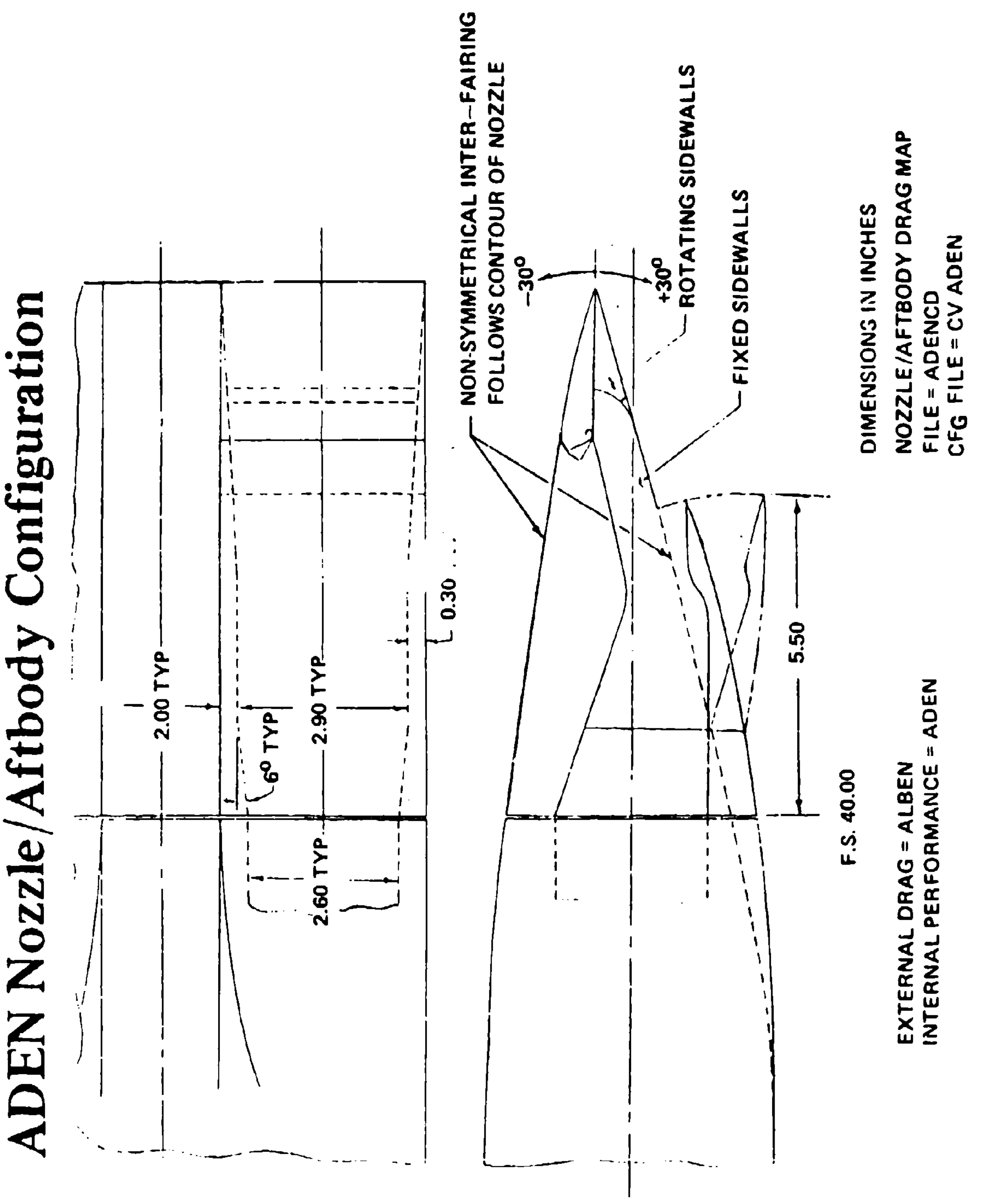

Figure B-7 ADEN Nozzle Configuration Available as a Separate Input File

The Derivative Process

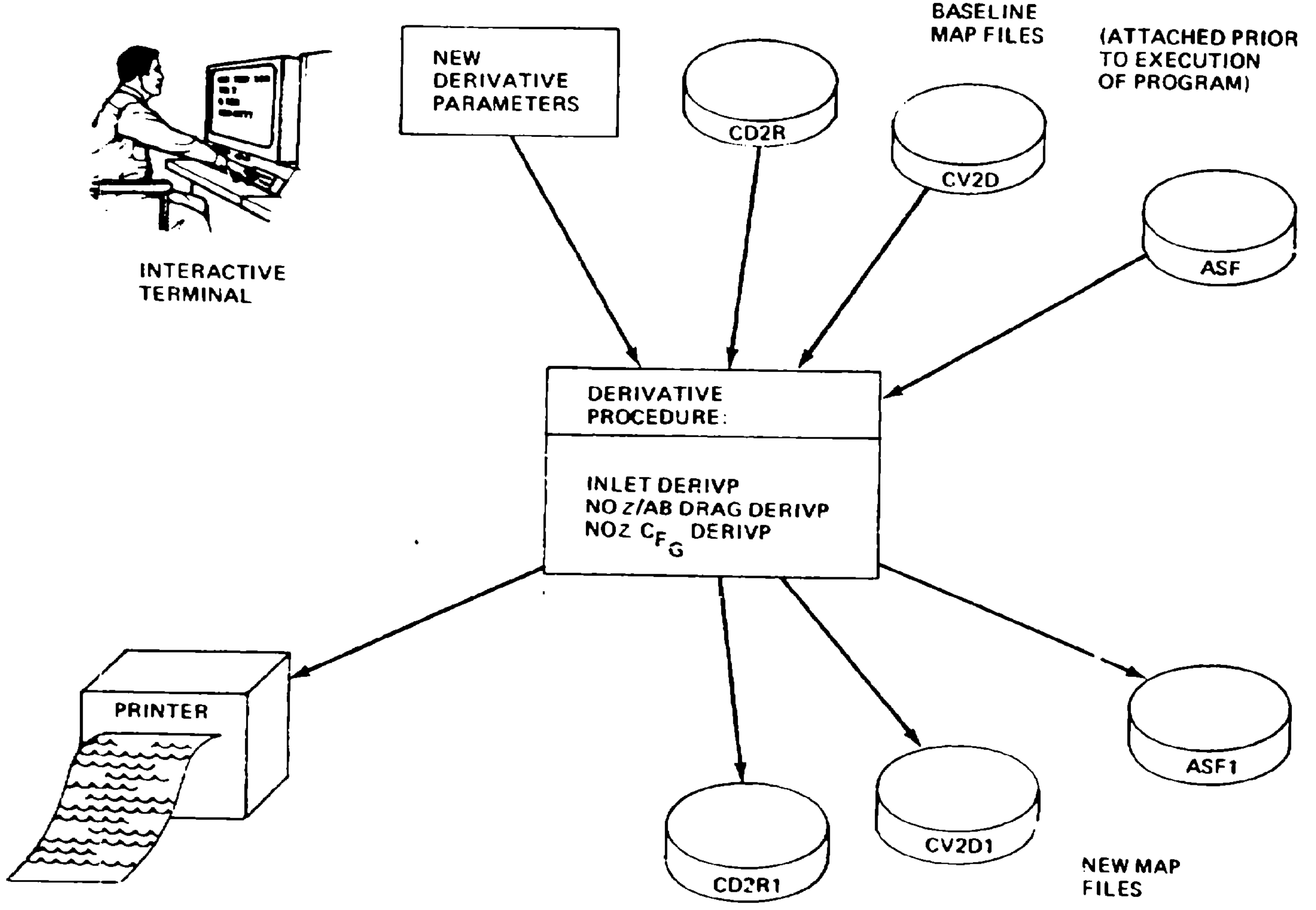

Figure B-8 Illustration of the Derivative Process

```
N>GET, NADC7B, TAPE1= BOEING1, TAPE51=ATS2, TAPE52=ADENCD, TAPE53=CVADEN

N>BATCH
C>RFL,60000
RFL,60000.
C> NADC7B
 INPUT NOZZLE THRUST COEFFICIENT(CV) FLAG WHERE
 CV=0  FOR CV FROM ENGINE DECK
 CV=1  FOR CV FROM CV TABLE
 CV=2  FOR CV=1.(PROGRAM DEFAULT)

I>1
 INPUT NOZZLE TYPE WHERE
 NOZZLE=1. FOR ROUND NOZZLE
 NOZZLE=2. FOR 2-D NOZZLE

I>1.
 INPUT CAPTURE AREA OPTION WHERE
 (CONSTANT CAPTURE AREA=1.,VARIABLE OPTION=2.)

I>1.
 INPUT NUMBER OF ENGINES AND ENGINE SCALE FACTOR

I>2. .9
 INPUT POWER SETTINGS FOR GAMMA CALCULATION
 (MAXIMUM POWER SETTING AND INTERMEDIATE POWER SETTING)

I>1. 5.
 INPUT A10 AND A10/A9 REF

I>47.9 4.
 INPUT REFERENCE MASS FLOW RATIO INDEX
 (0. TO USE TABLES 3A AND 3B.  1. FOR MFR=1.0)

I>1.
 INPUT ENGINE PRINT OPTION(NO=1. YES=2.)

I>2.
```

Figure B-9. Example of a PIPSI Terminal Session (Continued)

```
INPUT BYPASS MODE INDEX WHERE

XMODE=1. ALL EXCESS INLET AIRFLOW SPILLED EXTERNALLY
XMODE=2. ALL EXCESS INLET AIRFLOW BYPASSED ABOVE MOSBP
XMODE=3. SCHEDULED BYPASS WITH REST OF EXCESS INLET AIRFLOW SPILLED
XMODE=4. OPTIMUM COMBINATION OF BYPASS AND SPILLAGE FOR MIN INLET DRAG
XMODE=5. OPTIMUM COMBINATION OF BYPASS AND SPILLAGE FOR MIN SFCA

I>3.
ENTER 1. FOR BYPASS MODE PRINT OUT   0. OTHERWISE

I>0.
ENTER 1. IF ONLY RECOVERY AND DRAG MAPS ARE ON THE
INLET MAP FILE      ENTER 0. IF THE INLET MAP FILE HAS
ALL INLET MAPS
I>0.

INLET SIZING INPUTS
INPUT ONE OF THE FOLLOWING CODES
1. XMLO,XMHI (SIZING ENVELOPE OPTION)
2. MACH,ALT (SIZING POINT OPTION)
3. ACAPT (INPUT CAPTURE AREA - SQ FT)

I>1.
INPUT XMLO AND XMHI(SIZING ENVELOPE OPTION)

I>.5 2.
CVFLAG=      1.00 XNOZFG=      1.00 CAPOPT=      1.00 SIZEFG=      0.00
ENGNO =      2.00 SCALE =       .90 XDBASE=      1.00 XDNI  =      5.00
A10   =     47.90 A10A9R=      4.00 OPT   =      2.00 OPTB  =      3.00
OPTBP =      0.00 REFMFR =     1.00 TABFF =      0.00
XMLO  =       .50 XMHI  =      2.00
ENTER 1 IF CORRECTION DESIRED, OTHERWISE ENTER 0

I>0
```

Figure B-9. Example of a PIPSI Terminal Session (Continued)

```
1                     INLET SIZING DATA

INLET SIZING POINT  MACH  .80     ALT60000.     WC 164.70
CAPTURE AREA  4.670 SQ FT

BEGIN PROCESSING MARK12 DECK
     AIR FORCE TEST CASE

INPUT NOZZLE THRUST COEFFICIENT(CV) FLAG WHERE
CV=0  FOR CV FROM ENGINE DECK
CV=1  FOR CV FROM CV TABLE
CV=2  FOR CV=1.(PROGRAM DEFAULT)

I>"END"
     4.157 CP SECONDS EXECUTION TIME
C>DISPOSE (TAPE6=PR/EI=VT0004)
C>DISPOSE, TAPE7=PV
```


Figure B-9. Example of a PIPSI Terminal Session (Concluded)

```
GET, WPABDPB , TAPE51=NVSTO   ,TAPE2=CD2R  TAPE53=CV1
C > WPABDPB
          DERIVATIVE PROCESSOR PROGRAM

 ENTER CODE FOR MAPS TO BE CHANGED
 1   FOR INLET MAP CHANGES
 2   FOR NOZZLE/AFTBODY CHANGES
 3   FOR CV MAP CHANGES

I >1

   NVSTO INLET

 ENTER CODE FOR OUTPUT DESIRED
 0  FOR TAPE6 OUTPUT ONLY
 1  FOR TAPE6 OUTPUT AND TAPE1 (NEW PIPSI)

I >0

 INLET TYPE = AXISYMMETRIC

 MODE= EXTERNAL COMPRESSION
                  INLET MAP DERIVATIVE PARAMETERS
 PARAMETER NUMBER          PARAMETER DEFINITION                OLD VALUE
        3           FIRST RAMP ANGLE(DEG)                      22.0000
        4           DESIGN MACH NUMBER                          2.0000
        5           COWL LIP BLUNTNESS                           .0150
        6           TAKE OFF DOOR AREA                           .4600
        7           EXTERNAL COWL ANGLE(DEG)                   19.0000
        8           EXIT NOZZLE TYPE FOR BLEED                  1.0000
        9           EXIT NOZZLE ANGLE FOR BLEED(DEG)           20.0000
       10           EXIT FLAP ASPECT RATIO FOR BLEED            1.0000
       11           EXIT FLAP AREA FOR BLEED                     .1000
       12           EXIT NOZZLE TYPE FOR BYPASS                 1.0000
       13           EXIT NOZZLE ANGLE FOR BYPASS(DEG)          20.0000
       14           EXIT FLAP ASPECT RATIO FOR BYPASS           1.0000
       15           EXIT FLAP AREA FOR BYPASS                    .2000
       16           SUBSONIC DIFFUSER AREA RATIO                1.3300
       17           SUBSONIC DIFFUSER TOTAL WALL ANGLE(DEG)     9.0000
       19           SUBSONIC DIFFUSER LOSS COEFFICIENT           .1200
```

Figure B-10. Example of a DERIVP Terminal Session (Continued)

```
INPUT NUMBER OF PARAMETERS TO BE CHANGED

I>3

INPUT THE PARAMETERS TO BE CHANGED FOLLOWED BY THE
 NEW VALUES IN PAIRS(PARAMETER NUMBER,NEW VALUE)

I>3 20. 4 2.3 18 .2
PARAMETER NUMBER            PARAMETER DEFINITION              NEW VALUE
       3          FIRST RAMP ANGLE(DEG)                       20.0000
       4          DESIGN MACH NUMBER                           2.3000
      18          SUBSONIC DIFFUSER LOSS COEFFICIENT            .2000

ARE THE DERIVATIVE PARAMETERS CORRECT(0=YES  1=NO)

I>0
          DERIVATIVE PROCESSOR PROGRAM

ENTER CODE FOR MAPS TO BE CHANGED
1   FOR INLET MAP CHANGES
2   FOR NOZZLE/AFTBODY CHANGES
3   FOR CV MAP CHANGES

I>2

CD2R INPUT MAP


ENTER CODE FOR OUTPUT DESIRED
0  FOR TAPE6 OUTPUT ONLY
1  FOR TAPE6 OUTPUT AND DERIVATIVE PROCESSOR FILE

I>0

AFTERBODY TYPE = CD-AXISYMMETRIC DUAL NOZZLE
                 AFTERBODY MAP DERIVATIVE PARAMETERS
PARAMETER NUMBER            PARAMETER DEFINITION              OLD VALUE
       1          NOZZLE STATIC PRESSURE RATIO                 1.0000
       2          TAIL FIN CONFIGURATION                       2.0000
       3          TAIL FIN ANGLE(DEG)                          0.0000
       4          TAIL FIN FORE AND AFT LOCATION RATIO          .1736
       5          BASE AREA RATIO                              0.0000
```

Figure B-10. Example of a DERIVP Terminal Session (Continued)

```
INPUT NUMBER OF PARAMETERS TO BE CHANGED

I>2

INPUT THE PARAMETERS TO BE CHANGED FOLLOWED BY THE
NEW VALUES IN PAIRS(PARAMETER NUMBER, NEW VALUE)

I>4 .2 5 .1
PARAMETER NUMBER              PARAMETER DEFINITION                NEW VALUE
       4         TAIL FIN FORE AND AFT LOCATION RATIO               .2000
       5         BASE AREA RATIO                                    .1000

ARE DERIVATIVE PARAMETERS CORRECT(0=YES  1=NO)

I>0

THE FOLLOWING ARE THE OLD TABLES(STATION(IN) VERSUS AREA(SQFT))
ASSOCIATED WITH A PARTICULAR A10/A9
THE USER MAY CHANGE A TABLE VALUE FOR A
PARTICULAR A10/A9 RATIO


          TABLE NUMBER =  1    A10/A9 =     2.18
                              STATION AND AREA
637.00  44.50 700.00  41.50 760.00  36.00 800.00  31.00 820.00  25.00
830.00  20.50 876.00  20.50

          TABLE NUMBER =  2    A10/A9 =     2.50
                              STATION AND AREA
637.00  44.50 700.00  41.50 760.00  36.00 800.00  31.00 820.00  25.00
830.00  20.50 876.00  17.84

          TABLE NUMBER =  3    A10/A9 =     3.33
                              STATION AND AREA
637.00  44.50 700.00  41.50 760.00  36.00 800.00  31.00 820.00  25.00
830.00  20.50 876.00  13.39
```

Figure B-10. Example of a DERIVP Terminal Session (Continued)

```
              TABLE NUMBER =  4    A10/A9 =     5.00
                                  STATION AND AREA
 637.00  44.50 700.00  41.50 760.00  36.00 800.00  31.00 820.00  25.00
 830.00  20.50 876.00   8.92

              TABLE NUMBER =  5    A10/A9 =     7.43
                                  STATION AND AREA
 637.00  44.50 700.00  41.50 760.00  36.00 800.00  31.00 820.00  25.00
 830.00  20.50 876.00   6.00

 DO YOU WISH TO CHANGE A TABLE (0=NO 1=YES)

I>1

 ENTER THE TOTAL NUMBER OF TABLES TO BE CHANGED
I>1

 ENTER THE CORRESPONDING  NUMBERS OF THE TABLES TO BE CHANGED

I>5

 HOW MANY POINTS ARE IN YOUR NEW TABLE          5

I>7

 INPUT THE POINTS IN PAIRS(STATION(IN),AREA(SQFT))

I>637. 44.50 700. 43.00 760. 40. 800. 36. 820. 30. 830. 22. 876. 6.

  THE FOLLOWING ARE THE NEW TABLES(STATION(IN) VERSUS AREA(SQFT))
 ASSOCIATED WITH A PARTICULAR A10/A9
 THE USER MAY CHANGE A TABLE VALUE FOR A
 PARTICULAR A10/A9 RATIO

              TABLE NUMBER =  5    A10/A9 =     7.43
                                  STATION AND AREA
 637.00  44.50 700.00  43.00 760.00  40.00 800.00  36.00 820.00  30.00
 830.00  22.00 876.00   6.00
```

Figure B-10. Example of a DERIVP Terminal Session (Continued)

```
ARE TABLES CORRECT(0=YES  1=NO)
I>0
DO YOU WISH TO CHANGE THE DEFAULT A9A8 SCHEDULE(0=NO  1=YES)

I>0
          DERIVATIVE PROCESSOR PROGRAM

ENTER CODE FOR MAPS TO BE CHANGED
1    FOR INLET MAP CHANGES
2    FOR NOZZLE/AFTBODY CHANGES
3    FOR CV MAP CHANGES

I>3

CV1 INPUT MAP

ENTER CODE FOR OUTPUT DESIRED
0   FOR TAPE6 OUTPUT ONLY
1   FOR TAPE6 OUTPUT AND TAPE1 (NEW PIPSI)

I>0

NOZZLE TYPE = ROUND CONVERGENT-DIVERGENT NOZZLE
                CFG MAP DERIVATIVE PARAMETERS
PARAMETER NUMBER          PARAMETER DEFINITION              OLD VALUE
      1          DIVERGENCE HALF ANGLE(DEG)                 11.4500

INPUT NUMBER OF PARAMETERS TO BE CHANGED

I>1

INPUT THE PARAMETERS TO BE CHANGED FOLLOWED
BY THE NEW VALUE IN PAIRS(PARAMETER NUMBER,NEW VALUE)

I>1 12.5                                                    NEW VALUE
PARAMETER NUMBER          PARAMETER DEFINITION              12.5000
      1          DIVERGENCE HALF ANGLE(DEG)
```

Figure B-10. Example of a DERIVP Terminal Session (Continued)

```
ARE THE DERIVATIVE PARAMETERS CORRECT(0=YES  1=NO)

I>0
          DERIVATIVE PROCESSOR PROGRAM

ENTER CODE FOR MAPS TO BE CHANGED
1    FOR INLET MAP CHANGES
2    FOR NOZZLE/AFTBODY CHANGES
3    FOR CV MAP CHANGES

I>"END"
     7.520 CP SECONDS EXECUTION TIME
C>DISPOSE, (TAPE6=PR/EI=VT0004)
C>DISPOSE(TAPE1=PR/EI=VT0004)
```


Figure B-10. Example of a DERIVP Terminal Session (Concluded)

REFERENCES

1. Ball, W. H., and Hickcox, T. E., Rapid Evaluation of Propulsion System Effects, Volume 1 - Final Report, AFFDL-TR-78-91, Vol. I, Air Force Flight Dynamics Laboratory, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio 45433, July 1978.

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3. Hickcox, T. E., Atkins, R. A. Jr., and Ball, W. H., Rapid Evaluation of Propulsion System Effects, Volume III - Derivative Procedure (DERIVP) Users Manual, AFDL-TR-78-91, Vol. III, Air Force Flight Dynamics Laboratory, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio, 45433, July 1978.

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