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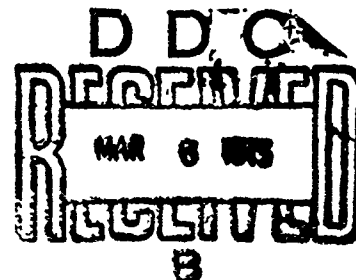
AD 907815

AFFDL-TR-72-147 - VOL. II

**PROPULSION SYSTEM  
INSTALLATION CORRECTIONS**

**VOLUME II:  
PROGRAMMERS MANUAL**

W. H. BALL  
THE BOEING COMPANY



TECHNICAL REPORT AFFDL-TR-72-147 - VOL. II  
DECEMBER 1972

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**PROPULSION SYSTEM  
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## FOREWORD

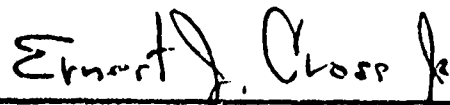
This report was prepared by the Research and Engineering Division, Aerospace Group, of The Boeing Company under Air Force Contract F33615-72-C-1580, "Propulsion System Installation Corrections", Project 1366. The program was conducted under the direction of the Prototype Division, Air Force Flight Dynamics Laboratory, Air Force Systems Command. Mr. Gordon Tamplin was the Air Force Program Monitor.

The program was initiated on 31 December 1971 and draft copies of the final reports were submitted for approval on 31 October 1972.

Dr. P. A. Ross was Program Manager and Mr. W. H. Ball was principal investigator during the program. Significant contributions to the program were made by the following individuals: Mr. Joe Zeeben, engine performance; Dr. Franklin Marshall, inlet and exhaust system technology; Mr. John Petit, nozzle internal performance and nozzle/afterbody drag; and Mr. Gary Shurtleff, programming.

This report contains no classified information extracted from other classified reports.

Publication of this report does not constitute Air Force approval of the report's findings or conclusions. It is published for the exchange and stimulation of ideas.



Lt. Col. Ernest J. Cross, Jr.  
Chief, Prototype Division  
Air Force Flight Dynamics Laboratory

## ABSTRACT

This report presents the results of a research program to develop a procedure for calculating propulsion system installation losses. These losses include inlet and nozzle internal losses and external drag losses for a wide variety of subsonic and supersonic aircraft configurations up to Mach 4.5. The calculation procedure, which was largely developed from existing engineering procedures and experimental data, is suitable for preliminary studies of advanced aircraft configurations. Engineering descriptions, equations, and flow charts are provided to help in adapting the calculation procedures to digital computer routines. Many of the calculation procedures have already been programmed on the CDC 6600 computer. Program listings and flow charts are provided for the calculation procedures that have been programmed. The work accomplished during the program is contained in four separate volumes. Volume I contains an engineering description of the calculation procedures. Volume II is a programmer's manual containing flow charts, listings, and subroutine descriptions. Volume III contains sample calculations and sample input data. Volume IV contains bookkeeping definitions and data correlations.

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# SYMBOLS AND NOMENCLATURE

|                   |                                                                                   |
|-------------------|-----------------------------------------------------------------------------------|
| $A$               | Area, in <sup>2</sup>                                                             |
| $A_C$             | Inlet capture area, in <sup>2</sup>                                               |
| $A_O$             | Local stream tube area ahead of the inlet, in <sup>2</sup>                        |
| $A_{OI}$          | Free-stream tube area of air entering the inlet, in <sup>2</sup>                  |
| $R$               | Aspect ratio, dimensionless                                                       |
| $B$               | Velocity decay exponent, dimensionless                                            |
| $C$               | Sonic velocity, ft/sec.                                                           |
| $C_D$             | Drag coefficient, $\frac{D}{qA_{REF}}$ , dimensionless                            |
| $C-D$             | Convergent-divergent                                                              |
| $C_{D_{ADD}}$     | Additive drag coefficient, $C_{D_{ADD}} = \frac{D_{ADD}}{qA_C}$ , dimensionless   |
| $C_{D_{A_{MAX}}}$ | Afterbody drag coefficient, $\frac{DRAG}{qA_{MAX}}$ , dimensionless               |
| $C_{D_{Base}}$    | Base drag coefficient $\frac{(P_b - P_\infty)A_{BASE}}{qA_{MAX}}$ , dimensionless |
| $C_{D_S}$         | Scrubbing drag coefficient, $\frac{DRAG}{qA_{MAX}}$ , dimensionless               |
| $C_{f_g}$         | Thrust coefficient, $\frac{F_g}{\frac{w}{g}(V_{cp})}$ , dimensionless             |
| $C_S$             | Stream thrust coefficient, dimensionless, (defined by Figure 48 of Volume IV)     |
| $C_V$             | Nozzle velocity coefficient, dimensionless                                        |
| Conv.             | Convergent                                                                        |
| $D$               | Drag, lb.; Hydraulic Diameter, $\frac{4A}{P}$ , in., diameter, in.                |

# SYMBOLS AND NOMENCLATURE (Continued)

|                  |                                                                                                                                                                              |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $F$              | Thrust, lb.                                                                                                                                                                  |
| $F_{g_i}$        | Ideal gross thrust (fully expanded), lb.                                                                                                                                     |
| $f/a$            | Fuel/air ratio, dimensionless                                                                                                                                                |
| $g$              | Gravitational constant, $\text{ft/sec}^2$                                                                                                                                    |
| $h$              | Enthalpy per unit mass, BTU/lb.; height, in.                                                                                                                                 |
| $h_{\text{fan}}$ | Enthalpy of fan discharge flow, BTU/lb                                                                                                                                       |
| $h_{\text{pri}}$ | Enthalpy of primary exhaust flow after heat addition<br>BTU/lb                                                                                                               |
| $h_t$            | Throat height, $\text{in}^2$                                                                                                                                                 |
| $K$              | Velocity decay coefficient, dimensionless                                                                                                                                    |
| $L$              | Length, in.                                                                                                                                                                  |
| $M$              | Mach number, dimensionless                                                                                                                                                   |
| $P$              | Pressure, $\text{lb/in}^2$                                                                                                                                                   |
| $P_r$            | Relative pressure; the ratio of the pressures $p_a$<br>and $p_b$ corresponding to the temperatures $T_a$ and $T_b$ ,<br>respectively, along a given isentrope, dimensionless |
| $P_T$            | Total pressure, $\text{lb/in}^2$                                                                                                                                             |
| $Q$              | Effective heating value of fuel, BTU/lb.                                                                                                                                     |
| $q$              | Dynamic pressure, $\text{lb/in}^2$                                                                                                                                           |
| $R, r$           | Radius, in.                                                                                                                                                                  |
| $S$              | Nozzle centerline spacing, in.                                                                                                                                               |
| $T$              | Temperature, °R                                                                                                                                                              |
| $V$              | Velocity, $\text{ft/sec}$                                                                                                                                                    |

## SYMBOLS AND NOMENCLATURE (Continued)

|                                       |                                                                   |
|---------------------------------------|-------------------------------------------------------------------|
| $W$                                   | Mass flow, lb/sec                                                 |
| $W_{BX}$                              | Bleed air removed from engine, lb/sec.                            |
| $W_C, \frac{W \sqrt{\theta}}{\delta}$ | Corrected airflow, lb/sec.                                        |
| $W_f$                                 | Weight flow rate of fuel, lb/sec.                                 |
| $W_2$                                 | Weight flow rate of air, primary plus secondary, lb/sec.          |
| $W_8$                                 | Primary nozzle airflow rate, lb/sec.                              |
| $x$                                   | Length, in.                                                       |
| $\alpha$                              | Angle of attack; convergence angle of nozzle, degrees             |
| $\gamma$                              | Ratio of specific heats, dimensionless                            |
| $\epsilon$                            | Diffuser loss coefficient, $\frac{\Delta P_T}{q}$ , dimensionless |
| $\eta_B$                              | Burner efficiency, dimensionless                                  |
| $\nu$                                 | Kinematic viscosity, $\text{ft}^2/\text{sec}$ .                   |
| $\rho$                                | Density, $\text{lb}/\text{ft}^3$                                  |

### SUBSCRIPTS

|                   |                                |
|-------------------|--------------------------------|
| $B$               | Burner                         |
| $b, \text{ base}$ | Base flow region               |
| $BP$              | Bypass                         |
| $BLC$             | Boundary layer bleed           |
| $btail$           | Boattail                       |
| $c$               | Core (nozzle); capture (inlet) |
| $DES$             | Design conditions              |

## SYMBOLS AND NOMENCLATURE (Continued)

### SUBSCRIPTS

|          |                                 |
|----------|---------------------------------|
| e        | Boattail trailing edge          |
| EFF      | Based on effective area         |
| ENG      | Refers to engine demand         |
| f        | Fuel                            |
| g        | gross                           |
| GEOM     | Based on geometric area         |
| int      | Interference; internal          |
| ip       | Ideal, primary exhaust flow     |
| jet      | Exhaust flow jet                |
| max      | Maximum                         |
| min      | Minimum                         |
| s        | Scrubbing flow region           |
| SPILL    | Spillage                        |
| T        | Total condition; throat station |
| $t_f$    | Total condition, fan flow       |
| T/O      | Takeoff                         |
| $t_p$    | Total condition, primary flow   |
| o        | Local conditions ahead of inlet |
| 2        | Compressor face station         |
| 8        | Nozzle throat station           |
| 9        | Nozzle exit station             |
| 18       | Fan discharge throat station    |
| $\infty$ | Free-stream condition           |
| x        | Local                           |

## SECTION I

### GENERAL DESCRIPTION OF COMPUTER PROGRAM

The engine installation calculation procedure naturally breaks into three divisions: inlet, engine, and nozzle/afterbody. Each of these divisions is represented in TEM-333 by a set of subprograms logically subordinate to a monitoring subprogram which functions as a quasi-main program for that set. The term module will be used to designate a quasi-main and its subordinate programs. Further, within a module procedures are subprogrammed to isolate the procedures from one another and to isolate logical direction programming from computational programming. The benefits of this organization are threefold. First, checkout. Each module can be checked out independently of the others. Secondly, logical simplicity. The logical structure of the program as a whole is more apparent. Individual subprograms are simpler; being small with a limited purpose. Finally, ease of modification. Engine installation programs are constantly undergoing modification so the ability to attach and detach new modules or procedures quickly is a necessity. The small subprogram-module arrangement allows for quick change since the connection to the next level is more apparent.

The modules are tied together by subroutine COMPUTE which calculates the installed performance for a single uninstalled performance point. The main program, TEM-333, handles calls to the input routines, then reads the uninstalled performance points one-by-one; calling COMPUTE for each, outputting data when required until the last point has been computed.

Programs included in TEM-333 and their purposes are:

TEM-333 - Main Program, monitors program logic

COMPUTE - Controls calculation of a performance point

#### Inlet Module

TABIN - Reads Inlet Input Deck

INLDRAG - Monitors Inlet Drag Computation

AIRBYP - Computes External-Compression Mode

**AIRSPL** - Computes Mixed Compression Mode

**SIZINL** - Computes Inlet Capture Area

**DEMAND** - Computes Engine Demand

**AREAF** - Computes  $F_1$  where  $A_0 = F_1 W_1 \eta$

#### Afterbody Module

**ABINPT** - Reads Nozzle Input Deck

**DRAGAB** - Monitors Afterbody Drag Calculations

**DINTFR** - Computes Nozzle Interference Drag

**DBØATR** - Monitors Boattail Drag Computation

**DBASER** - Computes Base Drag

**DBTTB** - Computes  $C_{D_{BT}} = f(M, PS)$

**CDCØNV** - Monitors C-D Nozzle Boattail Computation

**PLUGMX** - Computes Boattail Drag for Plug Nozzle,  
Mixed Flow

**PLUGNM** - Computes Boattail Drag for Plug Nozzle,  
Non-mixed Flow

**DRG** - Computes Boattail Drag for C-D Nozzle

**SUBBT** - Computes Subsonic  $C_{D_{BT}}$  for C-D Nozzle

**SUPET** - Computes Supersonic  $C_{D_{BT}}$  for C-D Nozzle

**CABTAB** - Computes  $C_{D_{BT}}$  as Function of  $A_{10}/A_9$

**AEXHST** - Computes Nozzle Exit Area

#### Engine Module

**PERF** - Computes Gross Thrust

**CHKRP** - Computes Thermodynamic Properties at  
Throat

**GTHRST** - Computes Performance of Propulsive  
Nozzles

**HØFT** - Computes Enthalpy Given Temperature

**TØFH** - Computes Temperature Given Enthalpy

**PRØFH** - Computes Relative Pressure Given Enthalpy

**HØFPR** - Computes Enthalpy Given Relative Pressure

**CØFH** - Computes Critical Velocity Given Total  
Enthalpy

**CØFHT** - Computes Critical Velocity Given Static  
Enthalpy

#### Miscellaneous Programs

**STØRE** - Stores results of a performance point

**ØUTGØ** - Outputs an engine performance matrix

**WARNING** - Prints warning message heading

**FIXDIM** - Determine dimensions of A8 and A9 input

**ATMØS** - Computes atmospheric data

**DATA** - Transfers and output input card images

#### Tabular Input Programs

**TABL1** - Inputs table format 1 tables

**TABL2** - Inputs table format 2Q tables

**TABL22** - Inputs table format 2K tables

**TABL3** - Inputs table format 3 tables

**PLACIN** - Reads a tabular array

**KØUNT** - Counts non-blank input fields

#### Linear Interpolation Programs

**TABU1** - Interpolates  $F = f(x)$

**TABU2** - Interpolates  $F = f(x,y)$

**TABU3** - Interpolates  $F = f(x,y,z)$   
**IFIND** - Finds Interpolation Interval  
**FACINT** - Computes Interpolation Factor  
**CVINT** - Perform Linear Interpolation Calculation

## SECTION II

### DESCRIPTIONS OF SUBROUTINES AND LISTINGS

**SUBJECT:** PRØGRAM TEM-333

**PURPØSE:** Main Program TEM-333 monitors the overall program logic.

**METHØD:** All supporting data is input, then the program reads performance points one by one, computes and stores the results, and outputs an array of results whenever Mach or altitude changes.

**USAGE:** PRØGRAM TEM333 (INPUT, ØUTPUT, TAPE5, TAPE6 = ØUTPUT, TAPE1 = INPUT)

|                 |                      |
|-----------------|----------------------|
| INPUT or TAPE1  | System Input         |
| ØUTPUT or TAPE6 | System output        |
| TAPE5           | Card Images of Input |
| TAPE7           | MARK II output       |

|                     |        |       |        |
|---------------------|--------|-------|--------|
| <b>SUBPRØGRAMS:</b> | ABINPT | DATA  | FIXDIM |
|                     | ØUTGØ  | STØRE | TABIN  |
|                     | TABL1  | TABL2 |        |

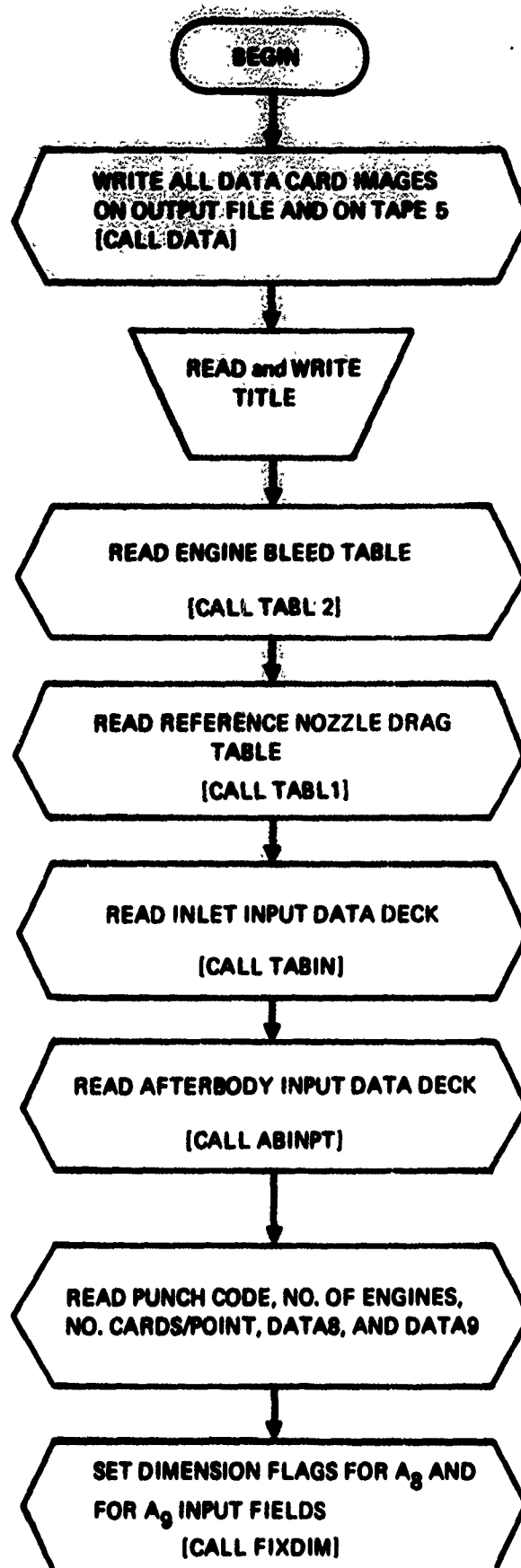


Figure 1: FLOW CHART FOR PROGRAM TEM 333

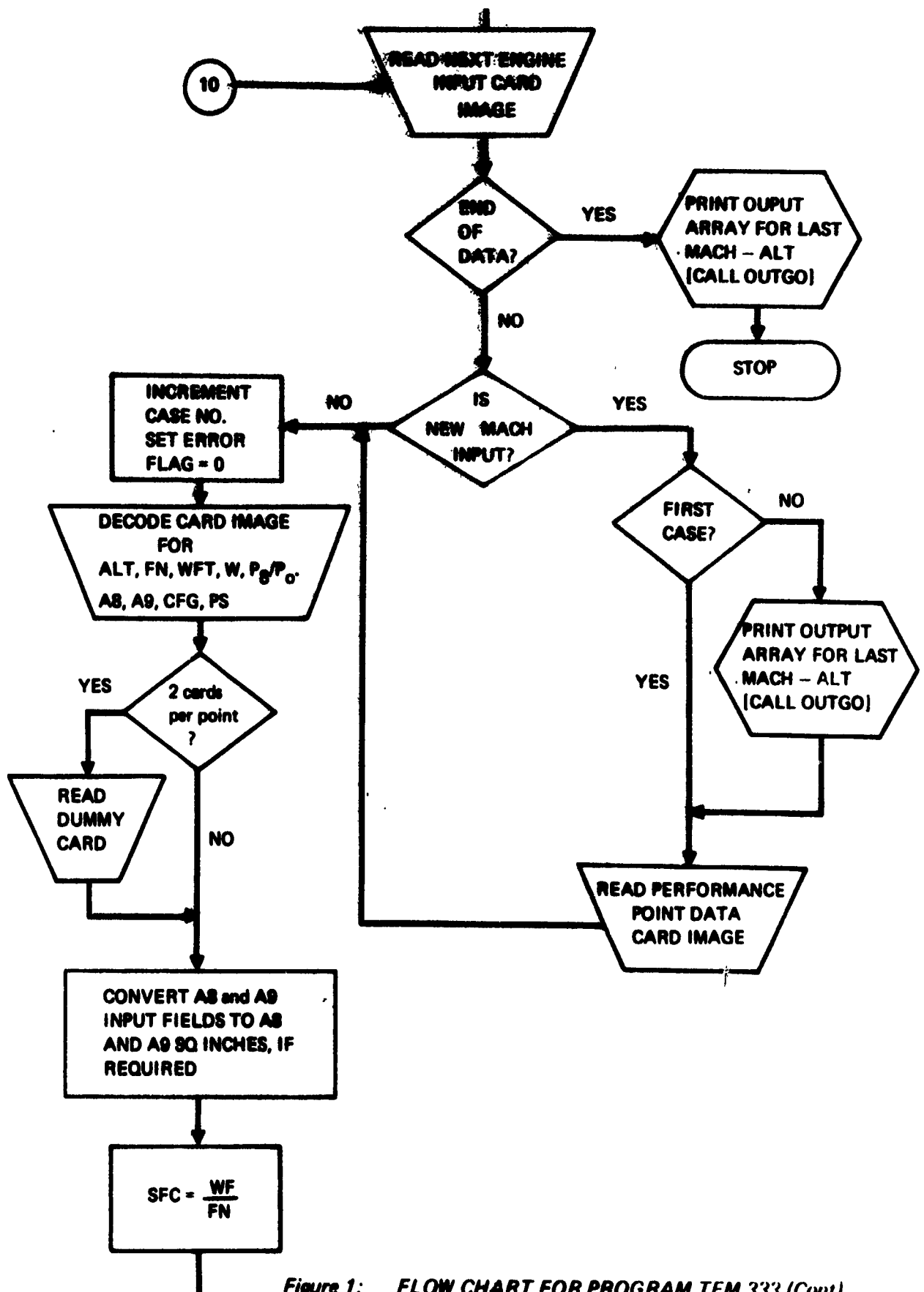


Figure 1: FLOW CHART FOR PROGRAM TEM 333 (Cont)

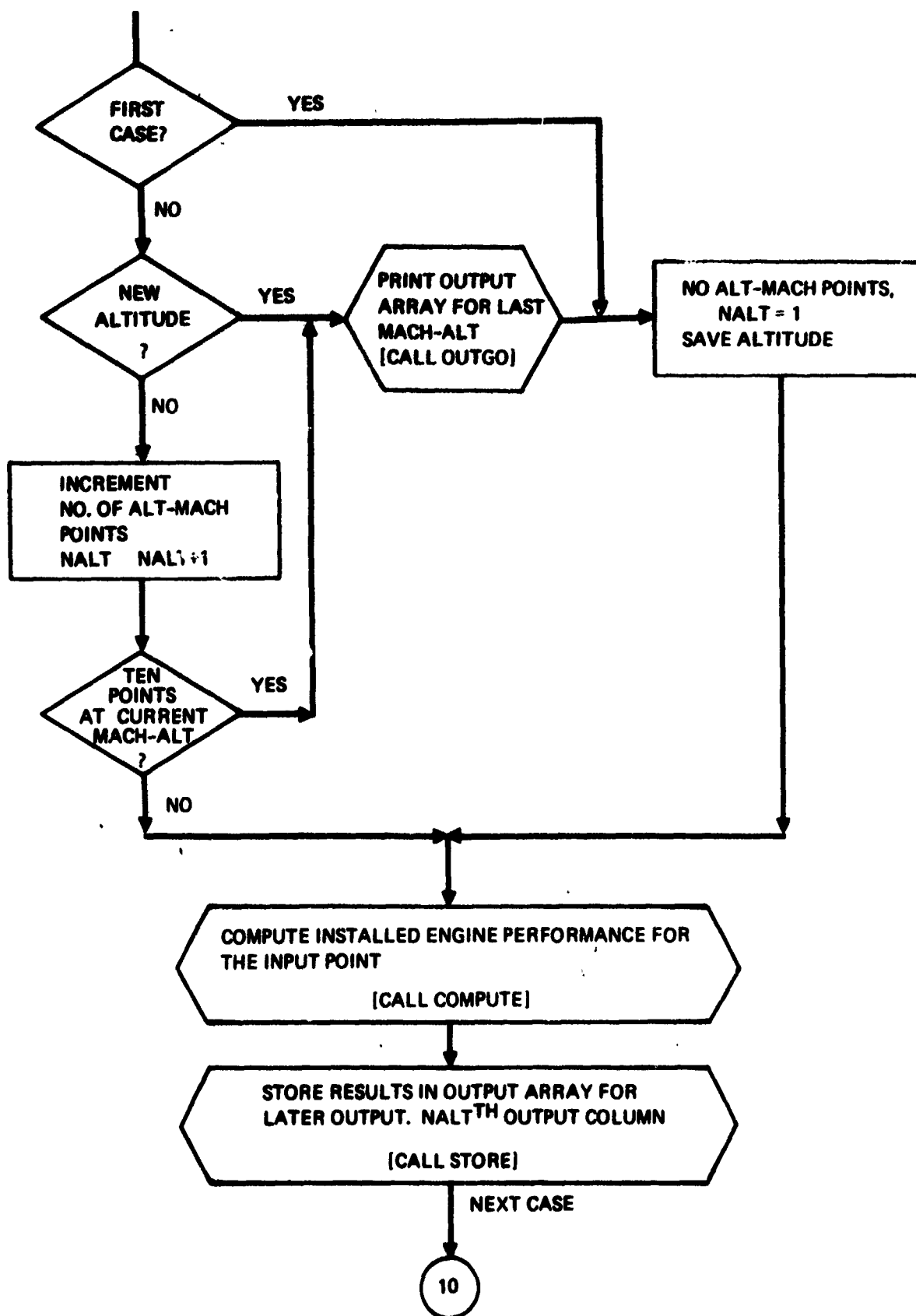


Figure 1: FLOW CHART FOR PROGRAM TEM 333 (Concluded)





|        |                                                                      |          |
|--------|----------------------------------------------------------------------|----------|
| GG334  | CALL STORE(NALT)                                                     | INDR1088 |
| CC3306 | GO TO 10                                                             |          |
| GG337  | 7777 CALL OUTGO(NALT)                                                |          |
| GG311  | CALL EXIT                                                            | INDR1100 |
| CC312  | 603 FORMAT(GA13)                                                     | INDR1110 |
| GG312  | 501 FORMAT(F7.0,3X)                                                  | INDR1120 |
| CC312  | 502 FORMAT(F4.9F7.0)                                                 | INDR1130 |
| GG312  | 603 FORMAT(I3F7.0)                                                   | INDR1140 |
| GG312  | 504 FORMAT(IH1,5X,*IEN-333 ENGINE PERFORMANCE PROGRAM*/INH,23X,(A10) |          |
| CC312  | 506 FORMAT(*JPCODE* F4.1,5X,*NO. ENGINES*,F4.1,5X,A10,* INPLT/POINT* |          |
|        | A 2F20.1)                                                            |          |
| CC312  | END                                                                  | INDR1150 |

PROGRAM LENGTH INCLUDING I/O BUFFERS  
013527

FUNCTION ASSIGNMENTS

| STATEMENT ASSIGNMENTS |   |        |     |   |        |      |   |        |     |   |        |
|-----------------------|---|--------|-----|---|--------|------|---|--------|-----|---|--------|
| 10                    | - | 000129 | 15  | - | 000136 | 20   | - | 000155 | 40  | - | 000176 |
| 50                    | - | 000255 | 55  | - | 000257 | 60   | - | 000266 | 70  | - | 000272 |
| 80                    | - | 000277 | 90  | - | 000363 | 600  | - | 000365 | 601 | - | 000367 |
| 602                   | - | 000352 | 603 | - | 000355 | 604  | - | 000357 | 606 | - | 000367 |
| 607                   | - | 000330 | 608 | - | 000334 | 7777 | - | 000307 |     |   |        |

EXTERNALS AND TABS

|        |   |        |       |   |        |        |   |        |         |   |        |
|--------|---|--------|-------|---|--------|--------|---|--------|---------|---|--------|
| DATA   | - | SC0200 | IMPT5 | - | SC0310 | OUTPT5 | - | SC0422 | TABL2   | - | SC0503 |
| TABL1  | - | SC0600 | TABIN | - | SC0700 | ABINPT | - | SC0800 | FIXDIM  | - | SC1100 |
| IFENJF | - | SC1200 | IMPT5 | - | SC1300 | OUT50  | - | SC1430 | COMPUTE | - | SC1500 |
| STORE  | - | SC1600 | EXIT  | - | SC1700 | END.   | - | SC2600 | QENTRY  | - | SC0100 |

BLOCK NAMES AND LENGTHS

|       |   |        |       |   |        |       |   |        |        |   |        |
|-------|---|--------|-------|---|--------|-------|---|--------|--------|---|--------|
| ENGNO | - | 000103 | MACH4 | - | 000172 | DMREF | - | 000025 | IMS    | - | 000003 |
| GAMA  | - | 000901 | U     | - | 000001 | R     | - | 000031 | TAPENO | - | 000002 |
| IBAD  | - | 000001 | DATA  | - | 000001 | OUTS  | - | 000055 | TITLE  | - | 000013 |
| PCJDE | - | 000001 | DATE  | - | 000002 | CARD  | - | 000010 | KTRAM  | - | 000001 |
| MEAN  | - | 000001 |       |   |        |       |   |        |        |   |        |

VARIABLE ASSIGNMENTS

|        |   |        |       |   |        |        |   |        |       |   |        |
|--------|---|--------|-------|---|--------|--------|---|--------|-------|---|--------|
| ALT    | - | 000001 | DATA  | - | 000001 | DATA   | - | 000001 | DATA  | - | 000001 |
| CARD   | - | 000001 | CASE  | - | 000001 | CFL    | - | 000001 | BLANK | - | 000001 |
| DATA1  | - | 000001 | DATA2 | - | 000001 | UNREFM | - | 000001 | ENGNO | - | 000001 |
| EXTRA  | - | 000001 | DATA3 | - | 000001 | UNREFM | - | 000001 | GAMA  | - | 000001 |
| DATA4  | - | 000001 | DATA4 | - | 000001 | IOUR   | - | 000001 | IOUR  | - | 000001 |
| J9     | - | 000001 | KASE  | - | 000001 | K8     | - | 000001 | K9    | - | 000001 |
| L8     | - | 000001 | L9    | - | 000001 | MACH4  | - | 000001 | MACH4 | - | 000001 |
| MACH4  | - | 000001 | MILKF | - | 000001 | NALT   | - | 000001 | NALT  | - | 000001 |
| MEAN   | - | 000001 | MILKF | - | 000001 | NALT   | - | 000001 | NALT  | - | 000001 |
| OLDALT | - | 000001 | PCJDE | - | 000001 | NMT4   | - | 000001 | NMT4  | - | 000001 |
| POP    | - | 000001 | PCJDE | - | 000001 | PCJDE  | - | 000001 | PCJDE | - | 000001 |
| TITLE  | - | 000001 | PCJDE | - | 000001 | SFC    | - | 000001 | SFC   | - | 000001 |
| X      | - | 000001 | PCJDE | - | 000001 | PCJDE  | - | 000001 | PCJDE | - | 000001 |

START OF CONSTANTS

|        |   |        |        |   |        |        |   |        |        |   |        |
|--------|---|--------|--------|---|--------|--------|---|--------|--------|---|--------|
| 000001 | - | 000001 | 000001 | - | 000001 | 000001 | - | 000001 | 000001 | - | 000001 |
|--------|---|--------|--------|---|--------|--------|---|--------|--------|---|--------|

START OF TEMPORARIES

|        |   |        |        |   |        |        |   |        |        |   |        |
|--------|---|--------|--------|---|--------|--------|---|--------|--------|---|--------|
| 000001 | - | 000001 | 000001 | - | 000001 | 000001 | - | 000001 | 000001 | - | 000001 |
|--------|---|--------|--------|---|--------|--------|---|--------|--------|---|--------|

START OF INDIRECTS

|        |   |        |        |   |        |        |   |        |        |   |        |
|--------|---|--------|--------|---|--------|--------|---|--------|--------|---|--------|
| 000001 | - | 000001 | 000001 | - | 000001 | 000001 | - | 000001 | 000001 | - | 000001 |
|--------|---|--------|--------|---|--------|--------|---|--------|--------|---|--------|

SPACE REQUIRED TO COMPLETE

|        |   |        |        |   |        |        |   |        |        |   |        |
|--------|---|--------|--------|---|--------|--------|---|--------|--------|---|--------|
| 000001 | - | 000001 | 000001 | - | 000001 | 000001 | - | 000001 | 000001 | - | 000001 |
|--------|---|--------|--------|---|--------|--------|---|--------|--------|---|--------|

**SUBJECT:** SUBROUTINE COMPUTE

**PURPOSE:** SUBROUTINE COMPUTE controls the calculation of the installed performance for a single input case.

**METHOD:** Using the input performance data COMPUTE first calculates atmospheric data and the reference recovery factor (MIL STD 5008 B). Gross thrust is computed for the input  $W_F$ ,  $W_O$ , and  $P_8/P_O$ . The inlet module is called to find inlet drag and recovery factor. Then a second gross thrust calculation is made using values corrected by the recovery ratio. The input array to the afterbody module is loaded and the module called to compute afterbody drags. Reference afterbody drag is obtained by interpolation. Now installed thrust is calculated by combining the appropriate terms and the total calculation is complete.

**USAGE:** CALL COMPUTE

All inputs are in labeled COMMON blocks.

Input variables are:

Mach, ALT, PS,  $P_8/P_O$ ,  $A_9$ ,  $A_8$ ,  $F_N$ ,  $W_{F_T}$ ,  
SFC,  $W_{O_C}$ , Table 2.1,  $W_{BLD} = f(\text{Mach}, \text{ALT})$ ,  
and Table 2.2,  $C_{D_{AB_{REF}}} = f(\text{Mach})$ .

All of these input variables are direct input to the program or immediate consequences of the input, e.g.

$$\text{SFC} = W_F / F_N.$$

|                     |       |        |         |
|---------------------|-------|--------|---------|
| <b>SUBPROGRAMS:</b> | ATMOS | DRAGAB | INLDRAG |
|                     | PERF  | SQRT   | TABU1   |
|                     | TABU2 |        |         |

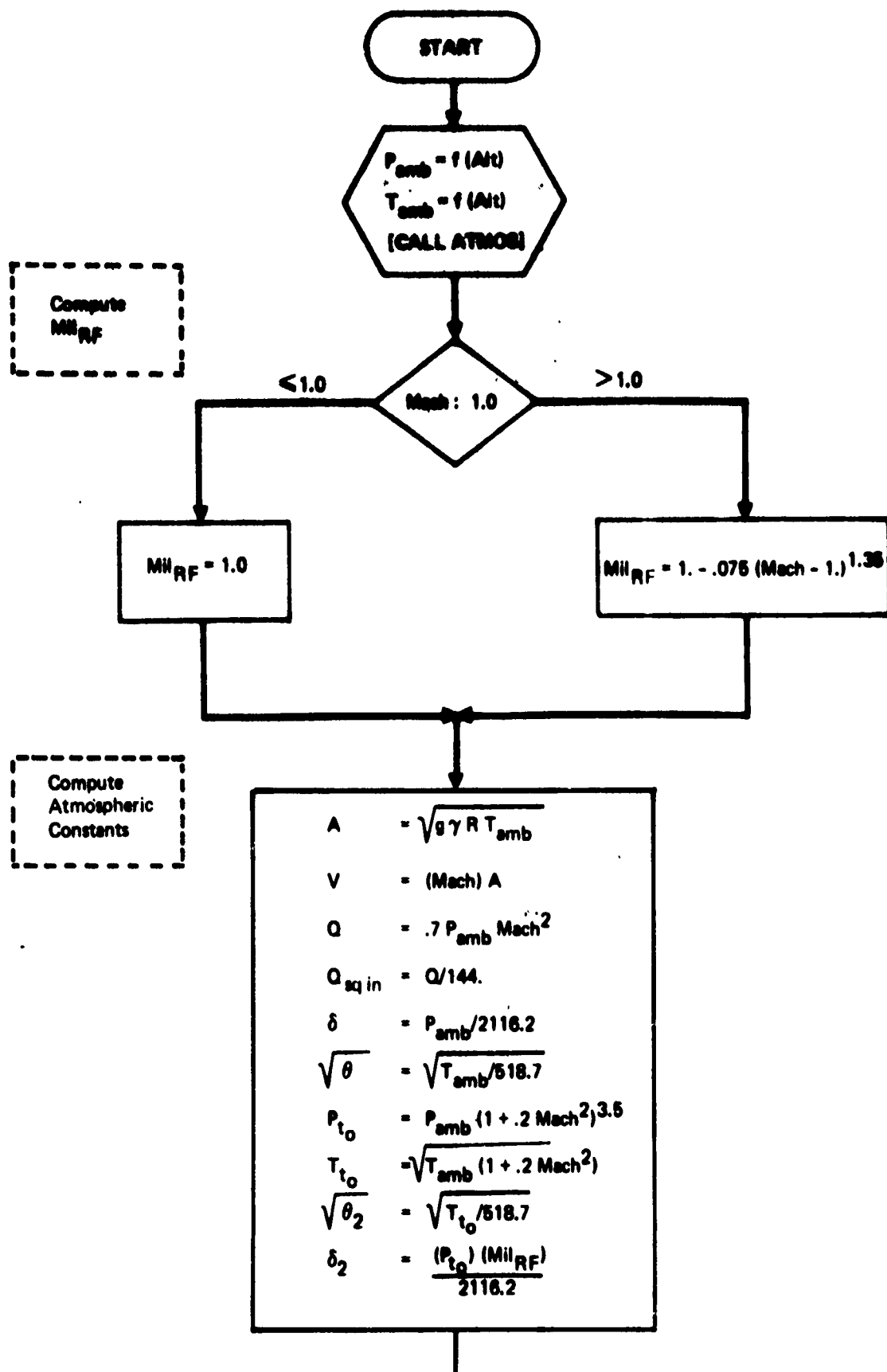


Figure 2: FLOW CHART FOR SUBROUTINE COMPUTE

Compute  
Gross  
Thrust

$$W_{obs} = \frac{W_{S2}}{\sqrt{\theta_2}}$$

$$F_{ram} = \frac{(W_{obs})(V)}{g}$$

$$F_T = F_N + F_{ram}$$

$$W_{BLD} = f(\text{Mach, Alt})$$

from table 2.1

$$W_g = W_{obs} - W_{BLD}$$

COMPUTE  $P_{B1} = f(W_{T1}, W_g, P_B/P_0, T_{t0}, P_{amb})$   
[CALL PERF]

Compute  
Inlet  
Performance

Compute  $D_{in}$  and  
 $RF = f(\text{MACH}, P_{t0}, W)$   
[CALL INLDRAG]

STORE FOR OUTPUT, ADDITIONAL  
INLET DATA  
 $C_{D_{SPL}}, C_{D_{BLD}}, C_{D_{BYP}}, C_{D_{INL}}$   
 $A_{01}/A_c, A_{0E}/A_c, A_0/A_c$

Correct  
for  
Recovery

$$W_{gRF} = W_g \frac{RF}{MILRF}$$

$$P_B/P_{0RF} = P_B/P_0 \frac{RF}{MILRF}$$

$$W_{T_{RF}} = W_{T1} \frac{RF}{MILRF}$$

$$F_{ramRF} = F_{ram} \frac{RF}{MILRF}$$

Figure 2: FLOW CHART FOR SUBROUTINE COMPUTE (Cont)

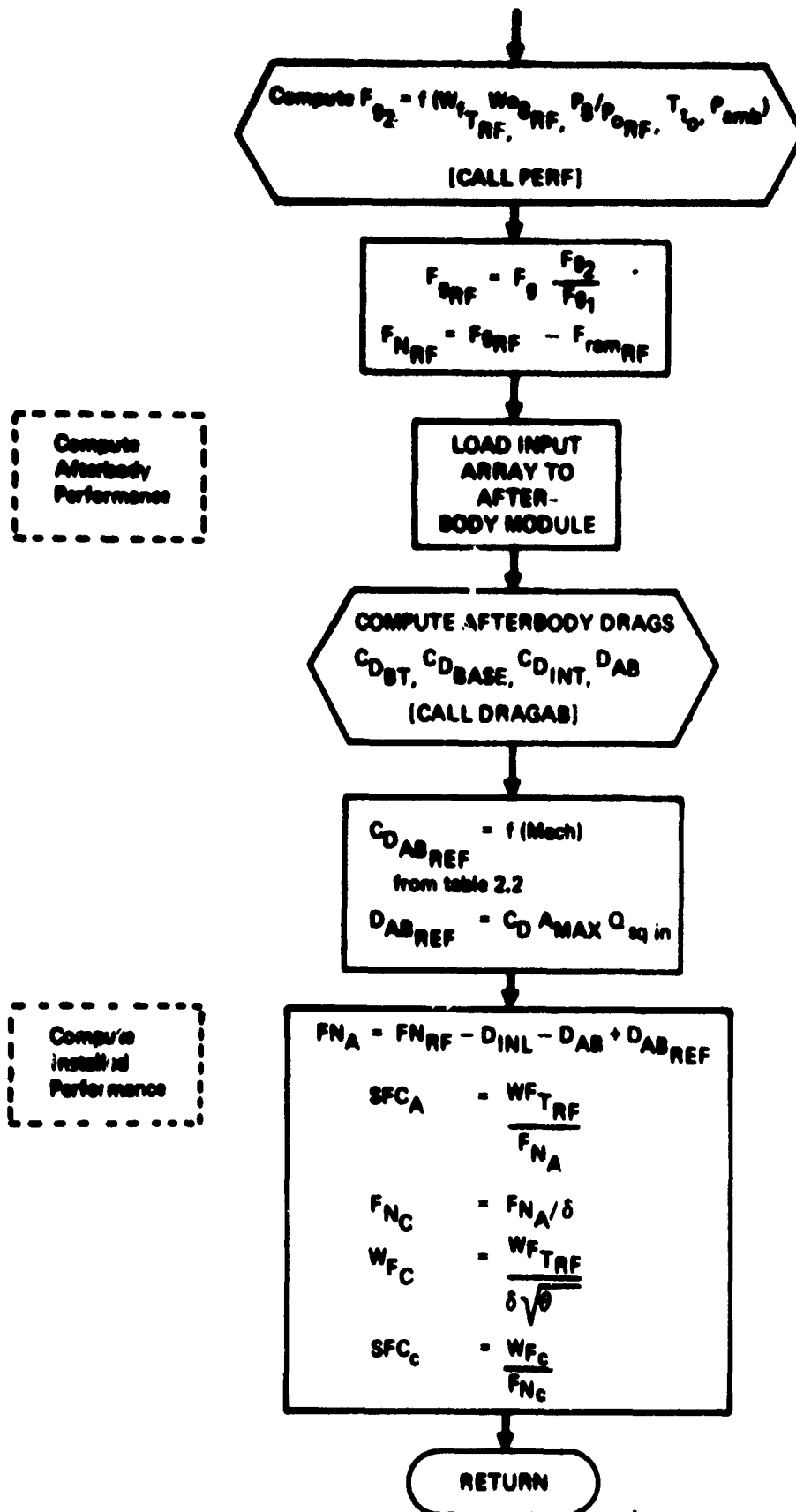


Figure 2: FLOW CHART FOR SUBROUTINE COMPUTE (Concluded)

|        | SUBROUTINE COMPUTE                                             | COMPUT16<br>COMPUT23 |
|--------|----------------------------------------------------------------|----------------------|
| 000032 | COMMON/INS/ MACH,OLDALT,CON                                    |                      |
| 000032 | COMMON/2/G                                                     |                      |
| 000032 | COMMON/OUTS/ CASE, ALT, PS, FNA, WTRF, SFCOUT, FNRF, FRAM, RF, |                      |
|        | 1 MILRF, DINLET, COSPL, COBLO, COBSP, COINL, DNOZ,             |                      |
|        | 2 COOT, COBASE, COINT, DNOZRF, PABO, A9, A8, CFG,              |                      |
|        | 3 BETA, FN, WFT, SFC, M, WABS, FNOR, WFCOR, SFCOR,             |                      |
| 000032 | *TAMB, PAMB, TTG, 3, AGEAC, AGIAC, AJAG, STATUS, EXTRA(4)      |                      |
| 000032 | COMMON/4/MACHM8/MACHM8(10),ALT48(13),M8(10,10),NXM8,NYM8       |                      |
| 000032 | COMMON/3/REF/DNR2F(11),DNREF(13),DNREF                         |                      |
| 000032 | COMMON/NOZARR/ A(40)                                           |                      |
| 000032 | COMMON/OUTINL/OUTINL(13)                                       |                      |
| 000032 | COMMON/ENGNO/ENGNO,XUNI,XOBASE                                 |                      |
| 000032 | DIMENSION O(13)                                                |                      |
| 000032 | REAL MILRF                                                     |                      |
| 000032 | REAL MACH                                                      |                      |
| 000032 | DATA PIBV+/.70543/                                             |                      |
| 000032 | DATA 07144/.0069444/                                           |                      |
| 000032 | CALL AT403(ALT,YA40,PAMB)                                      | COMPUT16             |
| 000035 | PSUI4=PAMB*WY144                                               |                      |
| 000037 | 43 C=SQRT(CO*TA40)                                             | COMPUT320            |
| 000037 | V=MACH*2                                                       | COMPUT332            |
| 000037 | IF (MACH-1.0) 203,209,205                                      | COMPUT632            |
| 000037 | 203 4ILRF=1.3                                                  | COMPUT653            |
| 000037 | GO TO 213                                                      | COMPUT670            |
| 000037 | 205 4ILRF=1.3-.075*(MACH-1.0)*1.35                             | COMPUT633            |
| 000037 | 210 W=70*PAMB*MACH*2                                           |                      |
| 000037 | 45*W=C*W144                                                    |                      |
| 000037 | DELTA=PAMB/2116.22                                             |                      |
| 000037 | RTMETHA=3*RT(TAMB/518.09)                                      |                      |
| 000037 | 22MACH=1.3+.2*MACH*2                                           |                      |
| 000037 | PT3=PAMB*22MACH*3.5                                            |                      |
| 000037 | TT3=TAMB*22MACH                                                |                      |
| 000037 | RTMET2=3*RT(TT3/518.09)                                        |                      |
| 000037 | DELTA2=PT3*MILRF/2116.22                                       |                      |
| 000037 |                                                                | COMPUT332            |
| 000037 | W435=W*DELTA2/RTMET2                                           |                      |
| 000037 | FRAMWABS=V/G                                                   |                      |
| 000037 | FG=FN*FRAY                                                     |                      |
| 000037 | 408=ABS-FA9U2(MACH,ALT,MACHM8,ALT48,M8,                        |                      |
| 000037 | CALL PERF(WFT,M8,P8PG,TT3,PAMB,FG,AGEAC)                       |                      |
| 000037 | CALL INJRAU(MACH,PT0,M,3.0,DINLET,RF)                          |                      |
| 000037 | COSPL=OUTINL(1)                                                |                      |
| 000037 | COELJ=OUTINL(2)                                                |                      |
| 000037 | COEYP=OUTINL(3)                                                |                      |
| 000037 | AGEAC=OUTINL(4)                                                |                      |
| 000037 | AGEAC=OUTINL(5)                                                |                      |
| 000037 | COINL=OUTINL(6)                                                |                      |
| 000037 | AGEAC=OUTINL(7)                                                |                      |
| 000037 | RATIO=W/4ILRF                                                  |                      |

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CC1135 M06RF=M03\*RATIO  
 CC1136 P06RF=P030\*RATIO  
 CC1140 4FT0=MFT\*RATIO  
 CC1141 CALL PERFMFTRF,M06RF,P06RF,TT0,PANB,FG2,AE0  
 CC1150 FGRF=FG\*FG2/F51  
 CC1153 FNR=FGRF-FRAN\*RATIO

C SET UP AFTERBODY DRAG MODULE INPUT ARRAY

CC1156 A(1)=AE0  
 CC1157 A(2)=A0

C A(3)=0.0  
 C A(4)=0.0

CC1161 A(5)=P03  
 C A(6)=0.0  
 C A(7)=FG2  
 C A(8)=0.0  
 C A(9)=PS  
 C A(10)=GAMMA P  
 C A(11)=0.0  
 C A(12)=MACH  
 C A(13)=PSLIN  
 C A(14)=QSLIN  
 C A(15)=A3  
 C A(16)=0.0  
 C A(17)=CFG  
 C A(18)=UME  
 C A(19)=0.0  
 C A(20)=PUG  
 C A(21)=FLAMIX  
 C A(22)=UMAX  
 C A(23)=UMBASE  
 C A(24)=ZPLUG  
 C A(25)=ZLTAL  
 C A(26)=SPACE  
 C A(27)=BASE  
 C A(28)=BTAB  
 C A(29)=THETA  
 C A(30)=XONI  
 C A(31)=XBASE  
 CALL DRABAB(A,0)  
 DNOZ=0(1)  
 DUT=0(2)  
 C DASE=0(3)  
 C DINF=0(4)  
 J=TA=0(5)  
 JYAX=A(22)  
 UNOZKF=TAJUS(MACH,ONREF,UNREF, NONREF)\*PIBY4\*QSQIN\*JMAX\*\*2  
 FNA=FNR-JINLET-UNOZ\*UNOZRF  
 SF COJ=FTRF/FNA  
 FVOR=FNA/DELTA  
 WCOX=FTRF/(DELTA\*RTHETA)  
 SF COX=FVOR/FVOR

C 7777 RETURN

COMPU010  
 COMPU020  
 COMPU030  
 COMPU035  
 COMPU040  
 COMPU050

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CG0237 END COMPU0000  
\*DECK OUTGO

SUBPROGRAM LENGTH  
00332C

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

4C - 000007 200 - 000017 205 - 000021 210 - 000030  
7777 - 000230

EXTERNALS AND TAGS

ATMOS - S00100 SURT - S00200 RBAREX - S00300 TABU2 - S00400  
PERF - S00500 INLDAG - S00600 DRAGAB - S00700 TABU1 - S01000  
ENJ. - S01100

BLOCK NAMES AND LENGTHS

INS - 000003 6 OUTS - 000001 OUTL - 000055 MACHN8 - 000172  
DNREF - 000025 NOZAR - 000053 OUTL - 000012 ENGN0 - 000003

VARIABLE ASSIGNMENTS

A - 00000006 AEN - 000010 ALT - 00000103 ALTM8 - 000012004  
AGAC - 00004703 AGEAC - 000045003 AJIAC - 000045003 AB - 000026003  
A9 - 000025003 BEA - 000030003 BY144 - 0000272 C - 0000274  
CUJASE - 000021003 CDBLU - 000014003 CDBT - 000023003 CDBYP - 000015003  
CUJNL - 000010003 CUJVT - 000022003 COSPL - 000013003 CFG - 000027003  
CON - 000002001 DELTA - 0000277 DME - 0000304 OME - 0000316  
GINLET - 000012003 UMAX - 0000317 UNOZ - 000017003 ONOZRF - 000023003  
DNREF - 00000005 UNREF - 000012005 EXTRA - 000051003 FG - 0000305  
FG2P - 0000315 FGI - 0000307 FG2 - 0000314 FN - 000031003  
FMA - 00000003 FNCOR - 000036003 FNR - 00000003 FRAM - 000007003  
G - 00000002 MACH - 00000001 MAC1M8 - 000010004 MLCRF - 000011003  
MCHREF - 000024005 MACH - 000017004 NYM3 - 000017004 O - 0000257  
OUTL - 00000007 PAB - 000002003 PABV4 - 0000271 PS - 000002003  
PSJ1 - 0000273 PTG - 0000302 PAPJ - 000024003 PAPORF - 0000313  
G - 000044003 QJAIN - 0000276 RATIO - 0000311 RF - 000013003  
RT1:TA - 000000 KTHET2 - 0000303 SFCCOR - 000043003 SFCOUT - 000050003  
TA48 - 000041003 ITG - 000043003 V - 0000275 M - 000034003  
WASS - 000035003 WFSOR - 000037003 WFT - 000032003 WFTRF - 000004003  
WOB - 0000300 WOBRF - 0000312 W8 - 000024004 XBASE - 000002010  
XLYI - 000001010 ZMAC4 - 0000311

START OF CONSTANTS

00024C

START OF TEMPORARIES

000294

START OF INDIRECTS

000257

SPACE REQUIRED TO COMPILE

035736

**SUBJECT:** SUBROUTINE TABIN

**PURPOSE:** SUBROUTINE TABIN reads the Inlet performance data deck, Cards 3.1 to 3.2.12.

**METHOD:** The input deck is read. Table 2A is enriched as required to evaluate that table. If inlet capture area is not input it is computed.

**USAGE:** CALL TABIN

All COMMON blocks in this routine are filled by calling this subprogram.

**SUBROUTINES CALLED:**

|        |       |       |
|--------|-------|-------|
| SIZINL | TABL1 | TABL2 |
| TABL22 | TABU1 |       |

SUBROUTINE TABIN  
TABIN INPUT TABLES FOR INLET CALCULATIONS

C

COMMON/TAB1/TAB1(20),NT1  
COMMON/TAB2A1/TAB2A(10),TAB2AA(10,10),TAB2AP(10,10),NTX2A1,  
NTY2A1(10)

COMMON/ENRICH/ ATAB(4,1,10),PTAB(4,1,10)  
COMMON/AMMIN/AMMIN

COMMON/TAB2B/TAB2B(20),NT2B

COMMON/TAB2C/TAB2C(20),NT2C

COMMON/TAB2D/TAB2D(20),NT2D

COMMON/TAB2E/TAB2E(20),NT2E

COMMON/TAB3/TAB3(120),NTX3,NTY3

COMMON/TAB4/TAB4(120),NTX4,NTY4

COMMON/TAB5/TAB5(120),NTX5,NTY5

COMMON/TAB6A/TAB6A(120),NTX6A,NTY6A

COMMON/TAB7/TAB7(120),NTX7,NTY7

COMMON/TAB6B/TAB6B(20),NT6B

COMMON/AC/AC,ACEAC,A0BYAC,A0BAC,A0IAC

COMMON/IDEGM/XMDES,MCENGO,MCSECD

COMMON/XMACHS/XMACHS

DIMENSION AT(4,1),PT(4,1)

1 FORMAT(\*JTABE NUMBER +A3)

2 FORMAT(I3F7.0)

3 FORMAT(\*IINLET INPUT DECK:5X 0INPUT AC,5X,5MMACHS,2X,0MMACH DES,  
8+X,00MC ENG,4X,6MWC SEC / 20K,3F10.3,2F10.1)

READ(5,2) AC,XMACHS,XMDES,MCENGO,MCSECD

WRITE(6,3) AC,XMACHS,XMDES,MCENGO,MCSECD

NO=141

WRITE(6,1)NO

CALL TABL1(TAB1,10,NT1)

NO=342A

WRITE(6,1)NO

CALL TABL22(TAB2AM,10,10,NTX2A1,NTY2A1)

CALL ENRICHED TABLE

DO 20 I=1,NTX2A1

V=NTX2A1(I)

IF (M.EC.1) GO TO 75

AMI=TAB2AA(N,I)

ALO=TAB2AA(1,I)

CA=-5\*(AMI-ALO)

JAA=C1556607\*(AMI-ALO)

ATAB(1,I)=ALO

PTAB(1,I)=TAB2AP(1,I)

ATAB(4,1,I)=AMI

PTAB(4,1,I)=TAB2AP(N,I)

ATAB(1,I)=ALO

DO 20 K=2,40

IF (K=11) 22,22,23

22 A=A+JA

DO TO 24

22 A=A+0AA

24 ATAB(K,I)=A

```
003142 PTAB(K,I)=TABJ1(A,TAB2AA(1,I),TAB2AP(1,I), N)
003154 25 CONTINUE
003160 WRITE(6,5)
003153 5 FORMAT('TABLE 2A AS EXPANDED TO *1 POINTS WITH INTERMEDIATE MACH
ACJRVES INTERPOLATED AS DIAGNOSTIC A100')
003163 DO 53 I=1,NTX2A1
003165 WRITE(6,*) TAB2AM(I)
003172 WRITE(6,7) (ATAD(K,I),K=1,41)
003206 WRITE(6,7) (PTAB(K,1),K=1,41)
003222 IF (1.E2.NTX2A1) 50 TO 50
003224 T4ACH=C.5*(TAB2AM(I+1)+TAB2AM(I))
003227 DO 43 L=1,41
003231 AT(L)=C.5*(TAB2AM(I+1)+TAB2AM(I))
003241 43 PT(L)=C.5*(PTAB(L,1+1)+PTAB(L,I))
003247 WRITE(6,*) TMACH
003254 WRITE(6,7) AT
003262 WRITE(6,7) PT
003270 50 CONTINUE
003273 4 FORMAT(14,F5.2)
003273 7 FORMAT(3X,11F9.4/(18X,10F9.4))
003273 75 CONTINUE
003273 XMMIN=TAB2AM(1)
003275 WRITE(6,5) XMMIN
003302 6 FORMAT('0 MINIMUM MACH NUMBER FOR INLET DRA5 CALCULATIONS'F7.3)
003302 NO=2420
003304 WRITE(6,1) NO
003311 CALL TABL1(TAB2B,10,NT2B)
003314 NO=2420
003316 WRITE(6,1) NO
003323 CALL TABL1(TAB2C,10,NT2C)
003326 NO=2420
003330 WRITE(6,1) NO
003335 CALL TABL1(TAB2D,10,NT2D)
003340 NO=2420
003342 WRITE(6,1) NO
003347 CALL TABL1(TAB2E,10,NT2E)
003352 NO=143
003354 WRITE(6,1) NO
003361 CALL TABL2(TAB3,10,10,NTX3,NTY3)
003365 NO=144
003367 WRITE(6,1) NO
003374 CALL TABL2(TAB4,10,10,NTX4,NTY4)
003376 NO=145
003377 WRITE(6,1) NO
003382 CALL TABL2(TAB5,10,10,NTX5,NTY5)
003387 NO=246A
003393 WRITE(6,1) NO
003402 CALL TABL2(TAB6A,1,10,NTX6A,NTY6A)
003405 NO=246B
003407 WRITE(6,1) NO
003415 CALL TABL1(TAB6B,10,NT6B)
003417 NO=147
003422 WRITE(6,1) NO
```

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CC0457  
CC0453  
CC0456  
CC0457

CALL TABL2(TAB7,10,10,NTX7,NTY7)  
IF (AC.LE.0.0) CALL SIZINL  
RETURN  
END

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SUBPROGRAM LENGTH  
CC3717

FUNCTION ASSIGNMENTS

| STATEMENT  | ASSIGNMENTS                      |
|------------|----------------------------------|
| 1 - CC361  | 2 - 00465 3 - 00467 4 - 00353    |
| 5 - 00512  | 6 - 00537 7 - 00533 22 - 00130   |
| 23 - 00133 | 24 - 00135 50 - 00270 75 - 00273 |

EXTERNALS AND TAGS

| INPUTC. | S00103 | OUTPUTC. | S00200 | TABL1 | S00300 | TABL22 | S03400 |
|---------|--------|----------|--------|-------|--------|--------|--------|
| TABU1   | S00500 | TABL2    | S00600 | SIZIM | S00700 | END.   | S01000 |

BLOCK NAMES AND LENGTHS

| BLOCK | NAME  | LENGTH | ENRICH | XXHIM  | XXHIM  |
|-------|-------|--------|--------|--------|--------|
| TAB1  | CC325 | TAB2A1 | CC335  | ENRICH | 00146  |
| TAB2  | CC325 | TAB2C  | CC325  | TAB20  | 003025 |
| TAB3  | CC172 | TAB3   | CC172  | TAB5   | 003172 |
| TAB7  | CC172 | TAB6B  | CC172  | AC     | 000005 |
| XXHIM | CC301 |        |        | IOESGN | 000003 |

VARIABLE ASSIGNMENTS

| VARIABLE | ASSIGNMENTS                                                       |
|----------|-------------------------------------------------------------------|
| A        | CC3713 AC - 003000017 AMI - 000707 ALO - 003713                   |
| AT       | CC3562 ATAB - 003000033 DA - 003711 DAA - 003712                  |
| I        | CC3714 K - 003714 L - 003716 N - 003706                           |
| NO       | CC3704 NTA2A1 - 00322002 NTX3 - 00370011 NTX4 - 003713012         |
| NTX5     | CC170013 NTX5A - 00370014 NTX7 - 00370015 NTX2A1 - 003713002      |
| NTX3     | CC170011 NTX4 - 00371012 NTX5 - 00371013 NTX6B - 00371014         |
| NTX7     | CC170015 NTX1 - 00371015 NTX2B - 00371016 NTX2C - 00371017        |
| NTX2     | CC320007 NTX2E - 00371018 NTX2F - 00371019 PT - 003710            |
| PTA3     | CC3532003 TAJ1 - 003000003 TAJ2A4 - 003000003 TAJ2AM - 003000003  |
| TAB2AP   | CC150002 TAB2B - 003000005 TAB2C - 003000005 TAB2D - 003000007    |
| TAB2E    | CC3000016 TAB3 - 003000001 TAB4 - 003000001 TAB5 - 003000001      |
| TABCA    | CC3000014 TAB5B - 003000001 TAB7 - 003000001 TAB8 - 003000001     |
| MCENGD   | CC3000020 MCSEDD - 003000002 XMAJMS - 003000002 XMOES - 003000002 |
| XXHIM    | CC3000004                                                         |

START OF CONSTANTS

CC3500

START OF TEMPORARIES

CC3557

START OF INDIRECTS

CC3502

SPACE REQUIRED TO COMPILE

CC37730

**SUBJECT:** SUBROUTINE INLDRAG Controls the Calculation of Inlet Performance.

**METHOD:** After initialization  $M_0$  is interpolated and compared with the minimum Mach number for which inlet drag will be computed and with the start Mach number to determine which inlet mode to use. Low speed mode is computed in INLDRAG: Subroutine AIRBYP computes external-compression mode performance, and subroutine AIRSPL computes mixed-compression mode. In the two latter cases inlet drag coefficients are interpolated and inlet drag determined. The outlet array is loaded and subroutine is complete.

**USAGE:** CALL INLDRAG (XM, P, WE, WS, DINLET, RF)

XM - Free-stream Mach number

P - Total free-stream pressure  $\text{LB/FT}^2$

WE - Engine corrected airflow, primary  
LB/Sec

WS - Engine corrected airflow, secondary  
LB/Sec

Output DINLET - Inlet Drag LB

Output RF - Inlet recovery factor

Input from COMMON

XMMIN - Minimum Mach for inlet drag calculation

AC - Capture area -  $\text{ft}^2$

Inlet Tables 1, 2B, 3, 4 and 5

Output in COMMON

OUTINL (10)

SUBROUTINES CALLED: AIRBYP AIRSPL AREAF  
TABU1 TABU2

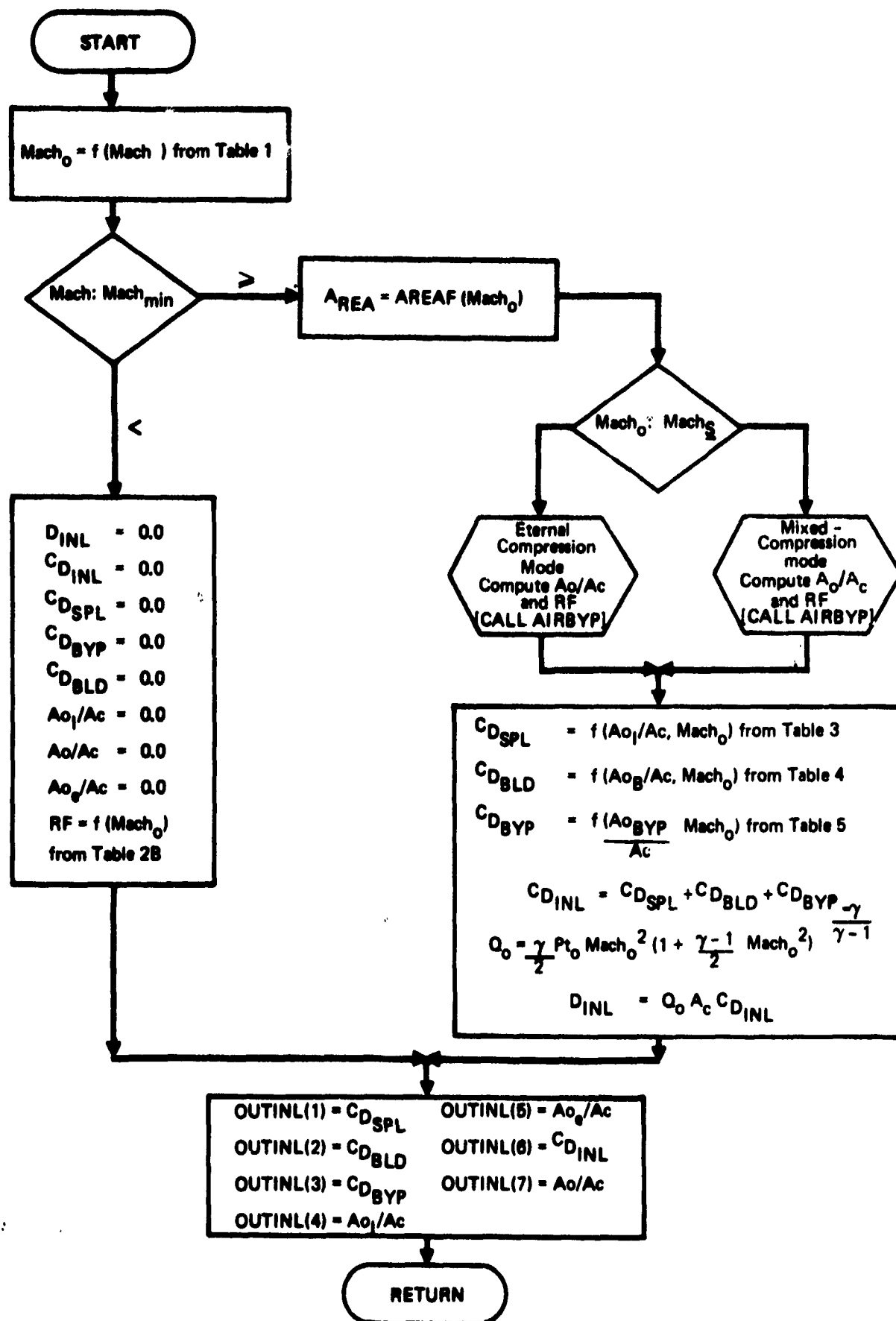


Figure 3: FLOW CHART FOR SUBROUTINE INLDRAG

SUBROUTINE INLDAG(XM,P,WE,MS,DIMLET,RF)

COMMON/OUTINL/OUTINL(10)

COMMON/XMACHS/XMACHS

COMMON/XMIN/XMIN

COMMON/AREAVL/AREV

COMMON/PT2PT0/PT2PT0

COMMON/TAB1/TAB1(10),TAB1V(10),NT1

COMMON/TAB2/TAB2(10),TAB2V(10),NT2

COMMON/TAB3/TAB3(10),TAB3V(10),NT3,NTY3

COMMON/TAB4/TAB4(10),TAB4V(10),NT4,NTY4

COMMON/TAB5/TAB5(10),TAB5V(10),NT5,NTY5

COMMON/TAB6/TAB6(10),TAB6V(10),NT6,NTY6

COMMON/TAB7/TAB7(10),TAB7V(10),NT7,NTY7

COMMON/TAB8/TAB8(10),TAB8V(10),NT8,NTY8

COMMON/TAB9/TAB9(10),TAB9V(10),NT9,NTY9

COMMON/TAB10/TAB10(10),TAB10V(10),NT10,NTY10

COMMON/TAB11/TAB11(10),TAB11V(10),NT11,NTY11

COMMON/TAB12/TAB12(10),TAB12V(10),NT12,NTY12

COMMON/TAB13/TAB13(10),TAB13V(10),NT13,NTY13

COMMON/TAB14/TAB14(10),TAB14V(10),NT14,NTY14

COMMON/TAB15/TAB15(10),TAB15V(10),NT15,NTY15

COMMON/TAB16/TAB16(10),TAB16V(10),NT16,NTY16

COMMON/TAB17/TAB17(10),TAB17V(10),NT17,NTY17

COMMON/TAB18/TAB18(10),TAB18V(10),NT18,NTY18

COMMON/TAB19/TAB19(10),TAB19V(10),NT19,NTY19

COMMON/TAB20/TAB20(10),TAB20V(10),NT20,NTY20

COMMON/TAB21/TAB21(10),TAB21V(10),NT21,NTY21

COMMON/TAB22/TAB22(10),TAB22V(10),NT22,NTY22

COMMON/TAB23/TAB23(10),TAB23V(10),NT23,NTY23

COMMON/TAB24/TAB24(10),TAB24V(10),NT24,NTY24

COMMON/TAB25/TAB25(10),TAB25V(10),NT25,NTY25

COMMON/TAB26/TAB26(10),TAB26V(10),NT26,NTY26

COMMON/TAB27/TAB27(10),TAB27V(10),NT27,NTY27

COMMON/TAB28/TAB28(10),TAB28V(10),NT28,NTY28

COMMON/TAB29/TAB29(10),TAB29V(10),NT29,NTY29

COMMON/TAB30/TAB30(10),TAB30V(10),NT30,NTY30

COMMON/TAB31/TAB31(10),TAB31V(10),NT31,NTY31

COMMON/TAB32/TAB32(10),TAB32V(10),NT32,NTY32

COMMON/TAB33/TAB33(10),TAB33V(10),NT33,NTY33

COMMON/TAB34/TAB34(10),TAB34V(10),NT34,NTY34

COMMON/TAB35/TAB35(10),TAB35V(10),NT35,NTY35

COMMON/TAB36/TAB36(10),TAB36V(10),NT36,NTY36

COMMON/TAB37/TAB37(10),TAB37V(10),NT37,NTY37

COMMON/TAB38/TAB38(10),TAB38V(10),NT38,NTY38

COMMON/TAB39/TAB39(10),TAB39V(10),NT39,NTY39

COMMON/TAB40/TAB40(10),TAB40V(10),NT40,NTY40

COMMON/TAB41/TAB41(10),TAB41V(10),NT41,NTY41

COMMON/TAB42/TAB42(10),TAB42V(10),NT42,NTY42

COMMON/TAB43/TAB43(10),TAB43V(10),NT43,NTY43

COMMON/TAB44/TAB44(10),TAB44V(10),NT44,NTY44

COMMON/TAB45/TAB45(10),TAB45V(10),NT45,NTY45

COMMON/TAB46/TAB46(10),TAB46V(10),NT46,NTY46

COMMON/TAB47/TAB47(10),TAB47V(10),NT47,NTY47

COMMON/TAB48/TAB48(10),TAB48V(10),NT48,NTY48

COMMON/TAB49/TAB49(10),TAB49V(10),NT49,NTY49

COMMON/TAB50/TAB50(10),TAB50V(10),NT50,NTY50

COMMON/TAB51/TAB51(10),TAB51V(10),NT51,NTY51

COMMON/TAB52/TAB52(10),TAB52V(10),NT52,NTY52

COMMON/TAB53/TAB53(10),TAB53V(10),NT53,NTY53

COMMON/TAB54/TAB54(10),TAB54V(10),NT54,NTY54

COMMON/TAB55/TAB55(10),TAB55V(10),NT55,NTY55

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00-102  
003103

RETURN  
END

SUBPROGRAM LENGTH  
CC2231

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

100 - 00052 200 - 00053 300 - 00056 400 - 00143

EXTERNALS AND TABS

TABU1 - SC010U AREAF - SC0200 AIRSPL - SC0300 AIRBYP - SC0400  
TABU2 - SC0500 RBAEXA - SC0600 END. - SC0700

BLACK NAMES AND LENGTHS

OUT14L - 00012 XMACHS - 00001 XMMIN - 00001 AREAVL - 00001  
PT2PTJ - 00001 TAB1 - 00025 TAB28 - 00025 TAB3 - 000172  
TAB4 - 000172 TAB5 - 000172 AC - 00005 MC - 00002  
XMACH - 00001 GAMA - 00001 PT - 00001 XNZERO - 00001  
ACAC - 00001

VARIABLE ASSIGNMENTS

ABAC - 000000013 ABADT - 000000013 AC - 000000013 AIAC - 000000013  
AIRCT - 000000013 ARZA - 000000013 AVAC - 000000013 AVACT - 000000013  
ALAC - 000000021 AVEAC - 000000013 COBLO - 000176 COBYP - 000177  
COSPL - 000175 COT3 - 000000013 COT4 - 000000013 COT5 - 000000013  
GAMA - 000000013 NT43 - 000000013 NT44 - 000000013 NT45 - 000000013  
NTV3 - 000000013 NTV4 - 000000013 NTV5 - 000000013 NT1 - 000000013  
NT28 - 000000013 OUTIN - 000000013 PT - 000000013 PT2PT0 - 000000013  
QZRO - 00001 TAB1X - 000000013 TAB1Y - 000000013 TAB28X - 000000013  
TAB28Y - 000000013 WCEVG - 000000013 WCEVC - 000000013 XMACM - 000000013  
XMACHS - 000000013 XMMIN - 000000013 XNZERO - 000000013  
XM4 - 000000013 XM5 - 000000013

START OF CONSTANTS

CC104

START OF TEMPORARIES

CC157

START OF INDIRECTS

CC175

SPACE REQUIRED TO COMPLETE

CC3310

SUBJECT: SUBROUTINE SIZINL

PURPOSE: SUBROUTINE SIZINL computes inlet capture area.

USAGE: CALL SIZINL

Inputs in COMMON/IDESIGN/ design Mach and  
airflow.

Tables 1, 2B and 2C.

Output: AC  $\text{ft}^2$

SUBJECT: FUNCTION AREAF

PURPOSE: 
$$\text{AREAF} = \frac{.013858 \left( 1 + \frac{\gamma - 1}{2} \text{Mach}^2 \right)^{\frac{\gamma + 1}{2(\gamma - 1)}}}{\text{Mach} \sqrt{\gamma}}$$

USAGE: A = AREAF (XMACH)

XMACH local Mach number

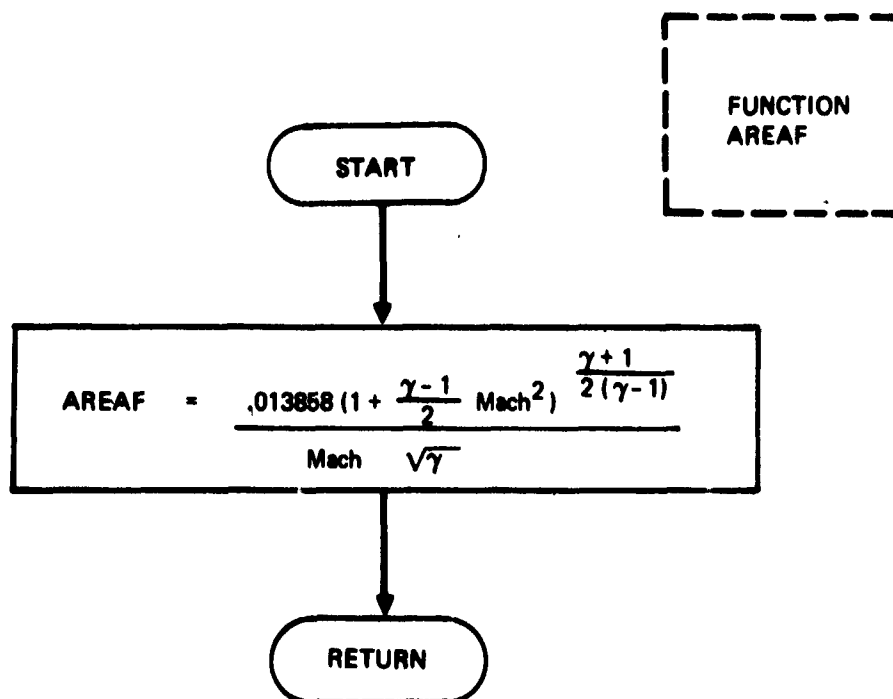
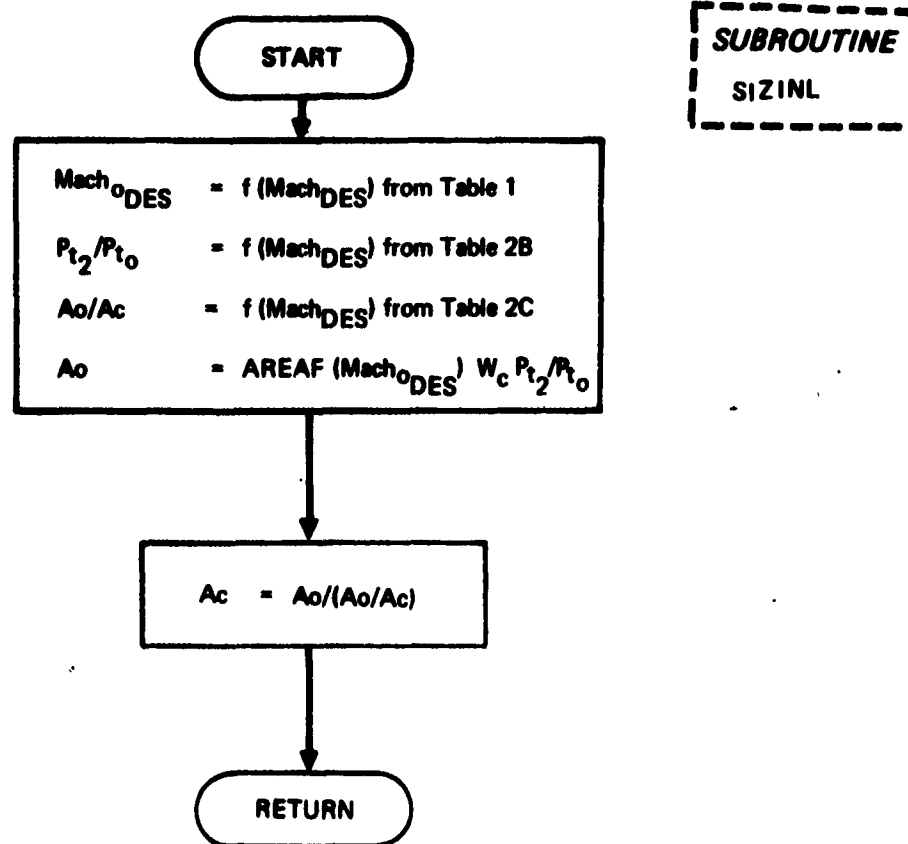


Figure 4: FLOW CHART FOR SUBROUTINE SIZINL AND FUNCTION AREAF

```

000032  SUBROUTINE SIZINL
000032  COMMON/DESIGN/XMODES,MCENGU,MCSECQ
000032  COMMON/TAB1/TAB1X(10),TAB1Y(10),NT1
000032  COMMON/TAB28/TAB28X(10),TAB28Y(10),NT28
000032  COMMON/TAB2C/TAB2CX(10),TAB2CY(10),NT2C
000032  COMMON/AC/AC,ACEAC,A08YAC,A08AC,AJAC
000032  XMODES=TAJUI(XMODES,TAB1X,TAB1Y,NT1)
000035  PTP2RC=TAJUI(XMODES,TAB28X,TAB28Y,NT28)
000041  AJACRC=TAJUI(XMODES,TAB2CX,TAB2CY,NT2C)
000045  AJ=AREAF(XMODES)*(MCENGU+MCSECQ)*PTP2RC
000045  AC=AJ/AJACRC
000046  WRITE(6,1) AC,XMODES,MCENGU,MCSECQ,PTP2RC,AJACRC,A0
000051  1 FORMAT('0AC =',F0.3,10X,7E12.4)
000051  RETURN
000052  END

```

SUBPROGRAM LENGTH  
00005

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

1 - 00005

EXTERNALS AND TABS

TAB1 - SC100 AREAF - SC0200 OUTPIC.- S0030C END. - S0J40J

BLOCK NAMES AND LENGTHS

DESIGN - 00003 TAB1 - 000025 TAB2B - 000025 TAB2C - 000025

AC - 000005

VARIABLE ASSIGNMENTS

AC - 00000005 A0 - 000064 A0ACRC - 000063 MT1 - 000024C02  
MT2B - 00002403 MT2C - 00002400 PTP2RC - 000062 TAB1K - 000000C02  
TAB1V - 000012032 TAB2BK - 00000003 TAB2BY - 00001203 TAB2CX - 000000C04  
TAB2CV - 00001204 MC-V60 - 00000001 MCSECJ - 000000C01 XMDER - 000000C01  
XMDUES - 000061

START OF CONSTANTS

000053

START OF TEMPORARIES

000056

START OF INDIRECTS

000051

SPACE REQUIRED TO COMPILE

035-10

SUBJECT: SUBROUTINE AIRBYP

PURPOSE: SUBROUTINE AIRBYP Computes recovery and mass flow ratios for external compression mode inlets.

METHOD: AIRBYP matches the recovery and mass flow from Table 2A to that obtained from function DEMAND. Table 2A was enriched to 41 points per array when input by SUBROUTINE TABIN. AIRBYP first interpolates in this table to develop a curve of  $RF = f(A_0/A_C)$  at the input Mach number.

The 41st point of this table represents the choked flow point, in Maximum  $(A_0/A_C)$ . DEMAND is called to compute  $(A_0/A_C)$  for the RF at the choked point. This  $A_0/A_C$  is compared to the  $A_0/A_C$  of the choked point. If the  $A_0/A_C$  from DEMAND is greater than the maximum  $A_0/A_C$  then the inlet is choked and RF must be found such that  $DEMAND(RF) = A_0/A_{C_{MAX}}$ . A Newton-Raphson iteration is used to solve this case. Otherwise the inlet is not choked and a solution for  $A_0/A_C$  exists less than the maximum. A Regula Falsi iteration is used to match the recovery and mass flow.

In either case buzz and distortion limits are checked and the other mass flow ratios computed.

USAGE: CALL AIRBYP

Inputs in COMMON include Mach number, air flow, capture area and inlet tables. Other COMMON blocks are output.

|              |        |        |         |
|--------------|--------|--------|---------|
| SUBPROGRAMS: | DEMAND | FACINT | IFIND   |
|              | TABU1  | TABU2  | WARNING |

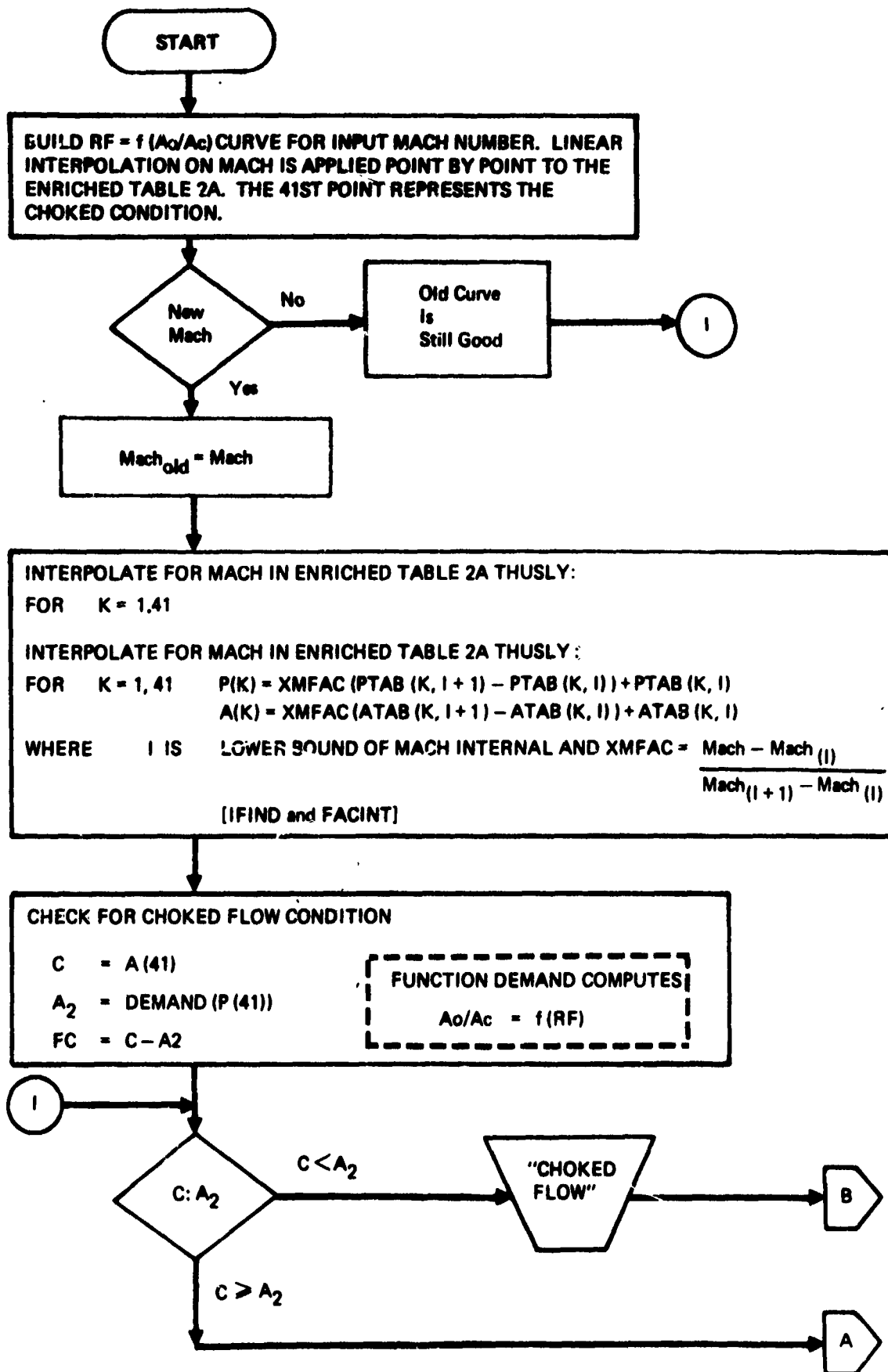
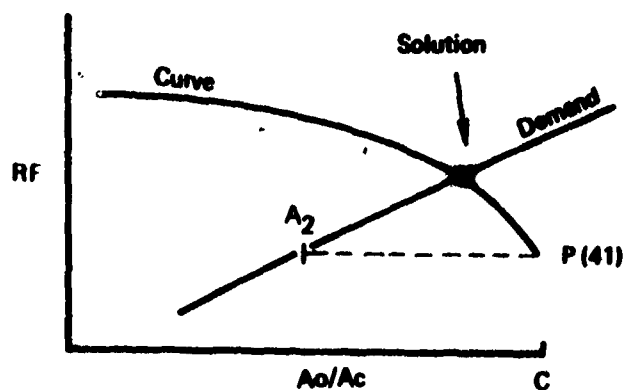


Figure 5: FLOW CHART FOR SUBROUTINE AIRBYP



**REGULA FALSI  
ITERATION  
TO FIND  
INTERSECTION**

**NON-CHOKED FLOW**

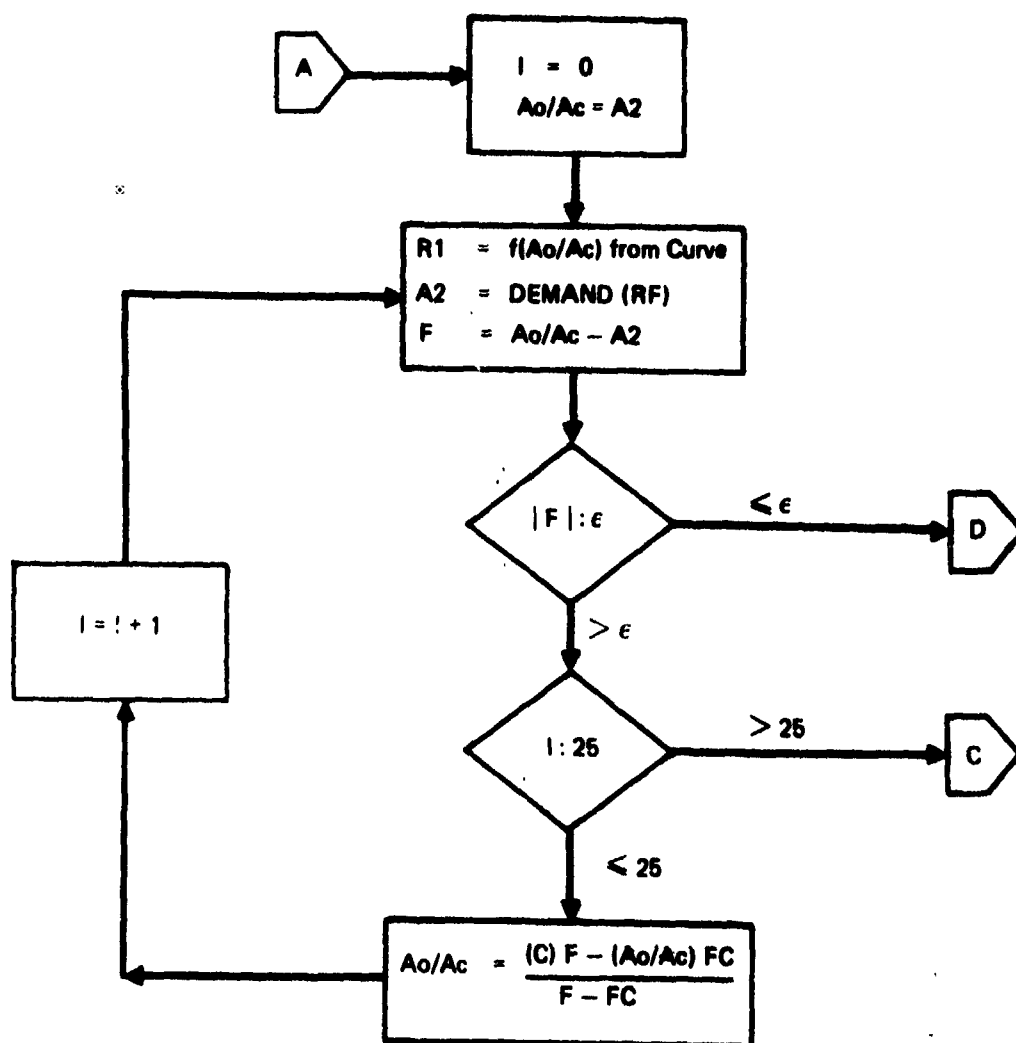
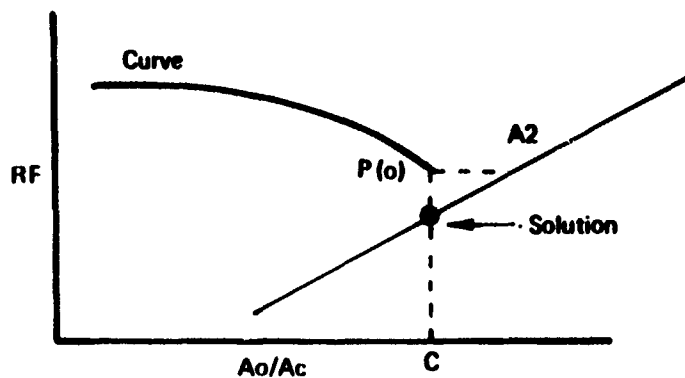


Figure 5: FLOW CHARTS FOR SUBROUTINE AIRBYP (Cont)



**NEWTON-RAPHSON  
ITERATION TO FIND  
INTERSECTION**

**CHOKED FLOW**

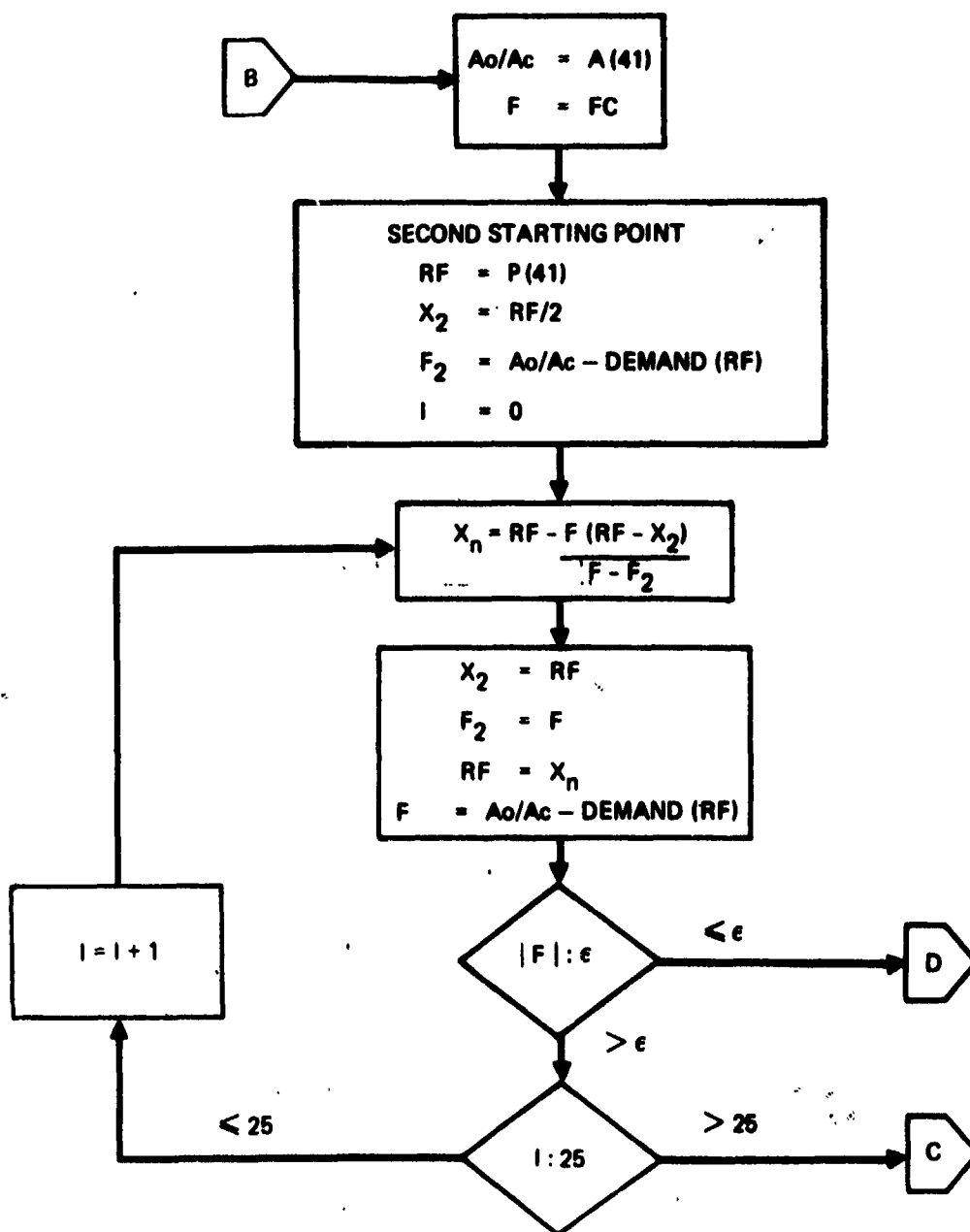


Figure 5: FLOW CHART FOR SUBROUTINE AIRBYP (Cont)

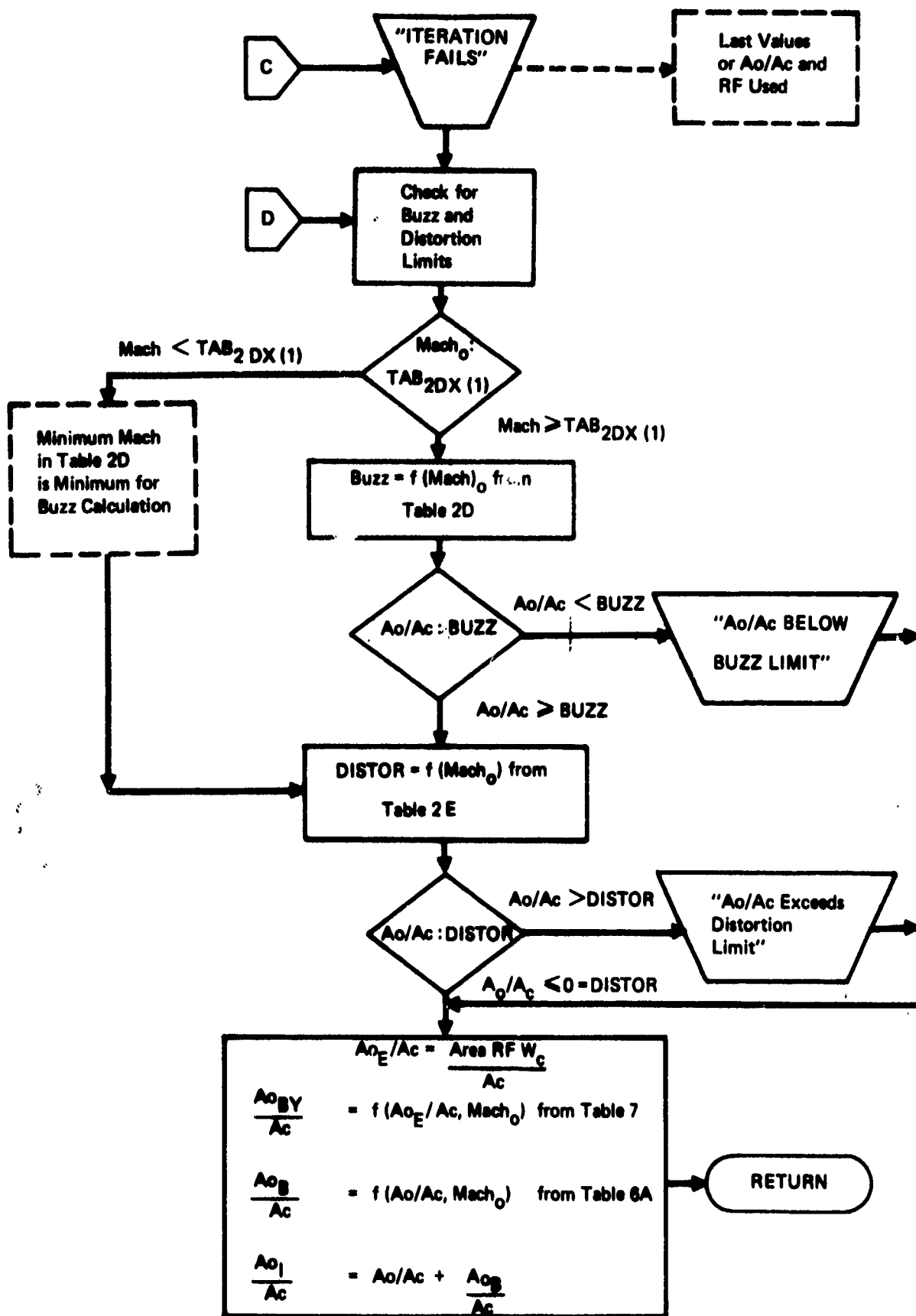


Figure 5: FLOW CHART FOR SUBROUTINE AIRBYP (Concluded)

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```

SUBROUTINE AIRBYP
COMMON/PT2PT0/PT2PT0
COMMON/AREAVL/AREA
COMMON/MC/MCENG,MCSEC
COMMON/AMRA7/GAMMA
COMMON/XMZERO/XMZERO
COMMON/TAB2A1/ XH2A1(10),ARRAY1(200),NTX2A1,NTY2A1(10)
COMMON/ENRICH/ ATAB(41,10),PTAB(41,10)
COMMON/AC/AC,ACEAC,A08YAC,A03AC,A01AC
COMMON/TAB5A/TAB5A(10),TAB5Y(10),TAB5Z(10,10),NTX6,NTY6
COMMON/TAB7/TAB7X(10),TAB7Y(10),TAB7Z(10,10),NTX7,NTY7
COMMON/TAB20/TAB20X(10),TAB20Y(10),NT20
COMMON/TAB2E/TAB2EX(10),TAB2EY(10),NT2E
COMMON/XMACH/XMACH
COMMON/PT/PT
COMMON/AB3AC/AB3AC
DIMENSION A(41),P(41)
INTEGER SEARCH
DATA TOL/.005/
DATA OLDM3/-999./
C      BUILD PT2/PT0 = F(AG/AC) AT XMZERO
      NA=41
      IFLAG=1*ITD(XMZERO,XH2A1,NTX2A1,I)
      AMFAC=FACINT(XMZERO,XH2A1(I),IFLAG)
      N1=NTY2A1(I)
      IF (N1.EQ.1) GO TO 2500
      IF (XMZERO.EQ.OLDM3) GO TO 510
      OLDM3=XMZERO
      IF (AMFAC)100,300,100
      100  A2=NTY2A1(I+1)
      200  ZJC <=1.41
      P(K)=AMFAC*(PTAB(K,I+1)-PTAB(K,I))+PTAB(K,I)
      A(K)=AMFAC*(ATAB(K,I+1)-ATAB(K,I))+ATAB(K,I)
      200  CONTINUE
      300  DO J=1,41
      300  P(J)=PTAB(K,I)
      300  A(K)=ATAB(K,I)
      400  CONTINUE
      C      SEARCH FOR INTERSECTION
      C      FIND SOLUTION INTERVAL
      500  C=A(NA)
      500  A2=DEMAX(P(NA))
      500  FC=U-A2
      500  IF (C.LT.A2) 50 TO 2000
      500  ICONT=C
      500  A2=A2
      600  REGULA=FALSE
      675  PT2PIC=TABU1(AB3AC,A,P ,NA)
      600  A2=DEMAX(PT2PT0)
      600  F=AGAC-A2
      600  IF (ABS(F).LE.TOL) GO TO 3003

```

RUN VERSION JUL 71 22.46.30. 72/08/23.

```

000106 IF (ICOUNT,GT,25) GO TO 2900
000111 ICOUNT=ICOUNT+1
000112 A3AC=(C*F-A0AC*FGJ)/(F-FC)
000117 GO TO 675
C SOLUTION FOR PT2/PTC SUCH THAT DEMAND=MAX A0/AC
000120 2000 A0AC=A(NA)
000122 CALL WARNING
000123 WRITE(6,*)
000127 + FORMAT(' CHOKED FLOW CONDITIONS')
000127 F=FC
000131 PT2PTC=P(NA)
000133 X2=X3*PT2PTJ
000134 F2=A3AC-DEMAND(X2)
000140 ICOUNT=0
000141 2100 ANEXT=PT2PTC-F*(PT2PTJ-X2)/(F-F2)
000147 X2=PT2PTJ
000150 F2=F
000152 PT2PTC=ANEXT
000152 F=A3AC-DEMAND(PT2PTJ)
000155 IF (ABS(F).LT,TOL) GO TO 3000
000160 IF (ICOUNT,GT,25) GO TO 2900
000164 ICOUNT=ICOUNT+1
000165 GO TO 2100
000165 2500 PT2PTJ=XFAC*(PTAB(1,1)+1)-PTAB(1,1)+PTAB(1,1)
000175 GO TO 3000
000175 2900 CALL WARNING
000176 ADEN=DEMAND(PT2PTJ)
000201 4RT=(6,3) PT2PTJ,A0AC,XDEM
000212 3 FORMAT(' ITERATION TO MATCH PT2/PTJ AND A0/AC DID NOT CONVERGE
PT2/PTJ=8.4, 5X*A37AC*F8.4,5X,DEMAND*F8.4)
3000 IF (XZERO.LT,TAB2DX(1)) GO TO 3010
000215 BUZZL=TA3UI(XMZRO,TAB2DX,TAB2DY, NT20 )
000221 IF (A3AC,GE,BUZZL) GO TO 3010
000224 CALL WARNING
000224 WRITE(6,1) A0AC,BUZZL
000234 1 FORMAT(' A0/AC BELOW BUZZ LIMIT. A0/AC*F8.4,5X*BUZZ LIMIT*F8.4)
GO TO 3020
000234 3010 DISTJK=TA3UI(XMZRO,TAB2EX,TAB2EY, NT2E)
000235 IF (A3AC,LE,DISTOR) GO TO 3020
000241 CALL WARNING
000243 WRITE(6,2) A0AC,DISTOR
000244 2 FORMAT(' A0/AC EXCEEDS DISTORTION LIMIT. A0/AC*F8.4,5X,DISTORTIO
IN LIMIT*F8.4)
000254 3020 A3=AC=AREA *PT2PTJ*WGENG/AC
000250 A3BAC=TA3U2(ACEAC,XMZRO,TAB7X,TAB7Y,TAB7Z, NTX7,NTY7,10,10)
000271 A3BAC=TA3U2(ADAC,XMZRO,TAB6X,TAB6Y,TAB6Z, NTX6,NTY6,10,10)
000302 A3IAC=A3AC+A0BAC
000304 RETURN
000304 END

```

SUBPROGRAM LENGTH  
000521

FUNCTION ASSIGNMENTS

|                       |      |          |      |          |               |
|-----------------------|------|----------|------|----------|---------------|
| STATEMENT ASSIGNMENTS |      |          |      |          |               |
| 1 - 000334            | 2    | - 000337 | 3    | - 000314 | 4 - 000307    |
| 100 - 000022          | 300  | - 000046 | 500  | - 000051 | 675 - 000073  |
| 200 - 000120          | 2100 | - 000141 | 2500 | - 000155 | 2900 - 000175 |
| 300 - 000212          | 3010 | - 000235 | 3020 | - 000250 |               |

EXTERNALS AND TAGS

|                 |                 |                 |                |
|-----------------|-----------------|-----------------|----------------|
| IPINJ - S00100  | FAINJ - S00200  | DEMANJ - S00300 | TABU1 - S00400 |
| WARFING- S00500 | OUTPIC.- S00600 | TABU2 - S00700  | END. - S01000  |

BLOCK NAMES AND LENGTHS

|                 |                 |                 |                |                |
|-----------------|-----------------|-----------------|----------------|----------------|
| PI2PTC - 000001 | AREAVL - 000301 | MC              | 000302         | GAMMA - 000501 |
| AMZENO - 000001 | TAB2A1 - 000335 | ENRICH - 001404 | AC             | 000005         |
| TAB3A - 000172  | TAB7 - 000172   | TAB20 - 000025  | TAB2E - 000025 |                |
| AMACH - 000001  | PT - 000001     | AGAC - 000001   |                |                |

VARIABLE ASSIGNMENTS

|                    |        |             |        |             |                    |
|--------------------|--------|-------------|--------|-------------|--------------------|
| A - 000352         | AC     | - 000000010 | AREA   | - 000000012 | ARRAY2 - 000012006 |
| ATAB - 000000007   | AGAZ   | - 000000017 | ADMAC  | - 000000010 | ADMAC - 000000010  |
| AGEAC - 000000010  | AGIAC  | - 000000010 | A2     | - 000000010 | BUZZLM - 000517    |
| C - 000500         | DISTJR | - 000520    | F      | - 000512    | FC - 000510        |
| F2 - 000514        | I      | - 000511    | ICOUNT | - 000511    | IFLAG - 000500     |
| K - 000525         | NA     | - 000525    | NTX2A1 | - 000525    | NTX6 - 0005170011  |
| NTX7 - 000517      | NTX2A1 | - 000525    | NTX6   | - 000517    | NTX7 - 0005170012  |
| NTX9 - 000525      | NTX2   | - 000525    | M1     | - 000525    | M2 - 000504        |
| OLCHJ - 000570     | P      | - 000523    | PTA3   | - 000523    | PT2713 - 000523001 |
| SEARCH - 000574    | TAB20K | - 000574    | TAB20V | - 000574    | TAB2EX - 000000014 |
| TAB2EV - 000012014 | TAB3A  | - 000012014 | TAB6V  | - 000012014 | TAB52 - 000012011  |
| TAB7A - 000012012  | TAB7V  | - 000012012 | TAB7Z  | - 000012012 | TOL - 000475       |
| MCING - 000000003  | AGIAC  | - 000000003 | AMFAC  | - 000000003 | AMZLRO - 000000005 |
| AMZAI - 000000006  | AMZAT  | - 000000006 | X2     | - 000513    |                    |

START OF CONSTANTS

000335

START OF TEMPORARIES

000350

START OF INDIRECTS

000352

SPACE REQUIRED TO COMPILE

037130

**SUBJECT:** SUBROUTINE AIRSPL

**PURPOSE:** SUBROUTINE AIRSPL computes recovery and mass flow ratios for mixed-compression mode inlets.

**METHOD:** The various mass flow ratios are computed from the input airflow and by interpolation in Tables 6B and 2C. Recovery comes from Table 2B. If bypass mass flow is negative; recovery is recomputed so that the bypass mass flow is zero. A message stating that the inlet is undersized results.

**USAGE:** CALL AIRSPL

Inputs in COMMON include Mach number, air flow, capture area, and inlet tables. Other COMMON blocks are output.

**SUBPROGRAMS:** TABUL WARNING

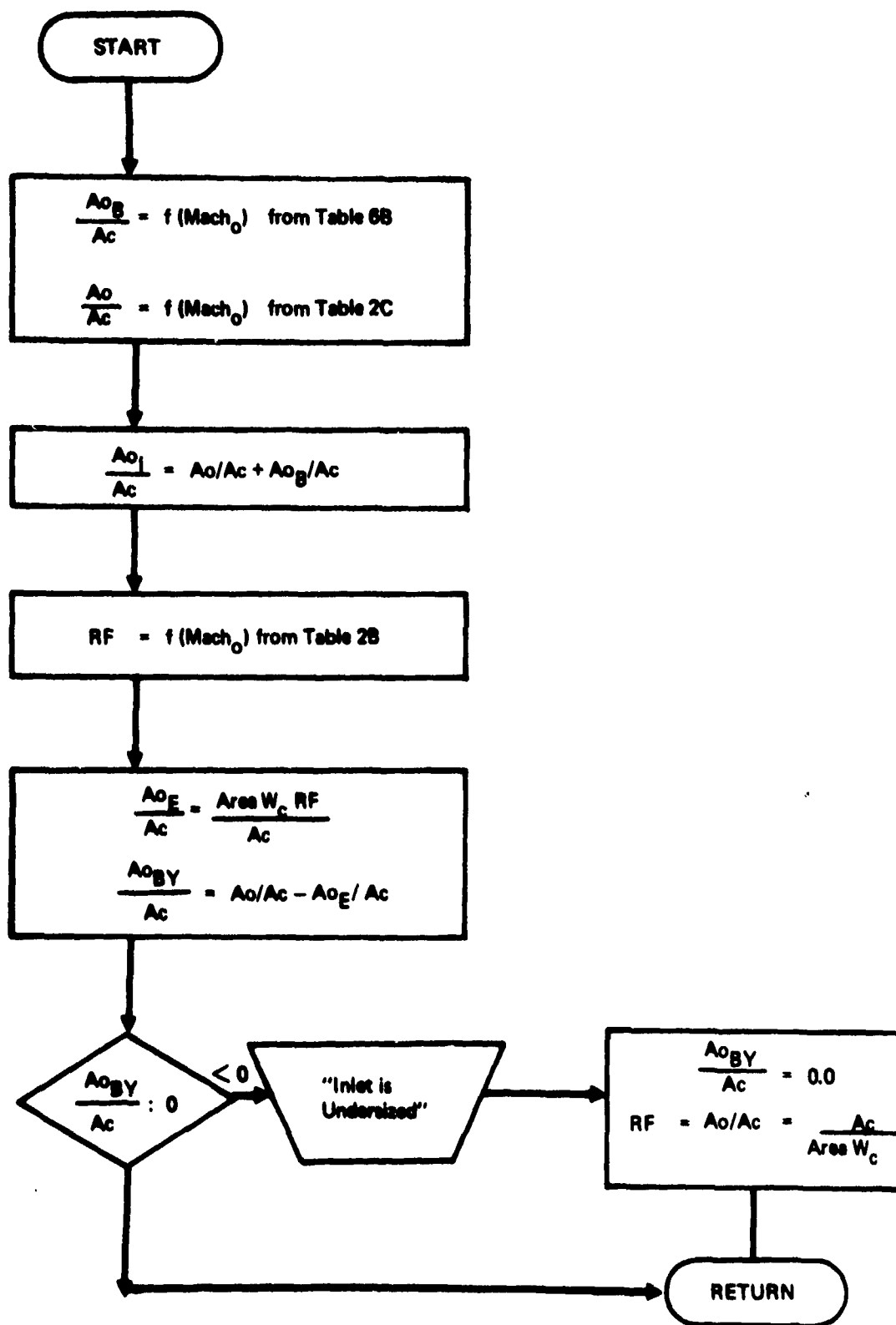


Figure 6: FLOW CHART FOR SUBROUTINE AIRSPL

```

SUBROUTINE AIRSPL
COMMON/PT2PT0/PT2PT0
COMMON/AREAVL/AREA
COMMON/XMACH/XMACH
COMMON/PT/PT
COMMON/XMZERO/XMZERO
COMMON/AC/AC,ACAC,ADYAC,AQAC,AQIAC
COMMON/AC/ACENG,MCSEC
COMMON/JANNA/JANNA
COMMON/TA863/TA863X(10),TA863Y(10),NT68
COMMON/TA828/TA828X(10),TA828Y(10),NT28
COMMON/TA82C/TA82CX(10),TA82CY(10),NT2C
COMMON/TA82E/TA82EX(10),TA82EY(10),NT2E
COMMON/TA82D/TA82DX(10),TA82DY(10),NT2D
COMMON/AJAC/AJAC
AC=TA8J1(XMZERO,TA863X,TA863Y,NT68)
AQAC=TA8U1(XMZERO,TA82CX,TA82CY,NT2C)
AQIAC=AJAC+AQAC
20 PT2PT=TA8U1(XMZERO,TA828X,TA828Y,NT28)
ACENG=AREA
AC=AYAC-AJAC-AQAC
IF (ACGTAG.GE.0.) GO TO 30
CALL WARMING
PSAVE=PT2PT0
AC8YAC=0
PT2PT0=AJAC*(AC/AREA)/(MCENG+MCSEC)
WRITE(6,1) AQAC,AQIAC,PSAVE,PT2PT0
1 FORMAT(' INLET IS UNDERSIZED FOR OPERATION WITH THE SCHEDULED SPIL
ALAGE AND BLEED*/3X,AQ/AC*F7.4,5X,AQI/AC*F7.4,5X,AQENG/AC*F7.4,5X,AQRECOVERY REDUCE
80 FRJH*F7.4,3H TO,F7.4)
30 RETURN
END

```

SUP-ROGRAM LENGTH  
000077

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

1 - 000056 20 - 000014 30 - 000052

EXTERNALS AND TAGS

TA301 - 000100 WARNING- 000200 OUTPUTC- 000300 END- 000400

BLOCK NAMES AND LENGTHS

PT2PTC - 000001 AREAVL - 000001 XNACH - 000001 PT - 000001  
XN2LRO - 000001 AC - 000005 MC - 000002 GAMMA - 000001  
TA303 - 000025 TAB2B - 000025 TAB2C - 000025 TAB2E - 000025  
TAB2J - 000025 ACAS - 000001

VARIABLE ASSIGNMENTS

AC - 00000006 AREA - 00000002 A0AC - 000000016 A0BAC - 000000006  
AC3VAC - 00000006 ACEAC - 00000006 A0IAC - 00000006 NT2B - 000000012  
NT2C - 000000013 NT5B - 000000011 PSAVE - 000000076 PT2PTB - 000000001  
TAB2BX - 000000012 TAB2BY - 000000012 TAB2CX - 000000013 TAB2CY - 000000013  
TAB2JX - 000000015 TAB2DY - 000000015 TAB2EX - 000000014 TAB2EY - 000000014  
TAB3BX - 000000011 TAB3BY - 000000011 MCENG - 000000017 MCSEC - 000000007  
XN2LRO - 00000006

START OF CONSTANTS

000054

START OF TEMPORARIES

000076

START OF INDIRECTS

000076

SPACE REQUIRED TO COMPLETE

000000

SUBJECT: SUBROUTINE DRG

PURPOSE: SUBROUTINE DRG computes bottail drag for convergent-divergent nozzle.

METHOD: The built in nozzle data tables are defined in the DATA statements of this routine. Boattail angle is computed; then Mach is interrogated. If Mach is less than .9 the subsonic procedure, SUBBT, is used. Similarly if Mach is greater than or equal to 1.0 the supersonic procedure is used. If Mach is in the range from .9 to 1.0, then the subsonic procedure is used with Mach equal to .9 and the supersonic procedure with Mach equal to 1.0. Final results are obtained by interpolating between the two sets of results using Mach as the independent variable. This provides a smooth transition between the two Mach regimes.

USAGE: CALL SUBROUTINE (DMDG, DBDJ, LDJ, EMF, EMJD, PTPF, THETA, GAM, ICØN)

|       |                                                   |
|-------|---------------------------------------------------|
| DMDJ  | Ratio of maximum to jet diameter                  |
| DBDJ  | Ratio of base to jet diameter                     |
| LDJ   | Ratio of length to jet diameter                   |
| EMF   | Freestream Mach number                            |
| EMJD  | Jet design Mach number                            |
| PTPF  | Ratio of Jet total to free-stream static pressure |
| THETA | Boattail trailing edge angle - degrees            |
| GAM   | Ratio of specific heats                           |
| ICØN  | = 0 circular are boattail<br>= 1 conical boattail |

Output in COMMON/A/

SUBPROGRAMS:            ATAN            SUBBT            SUPBT

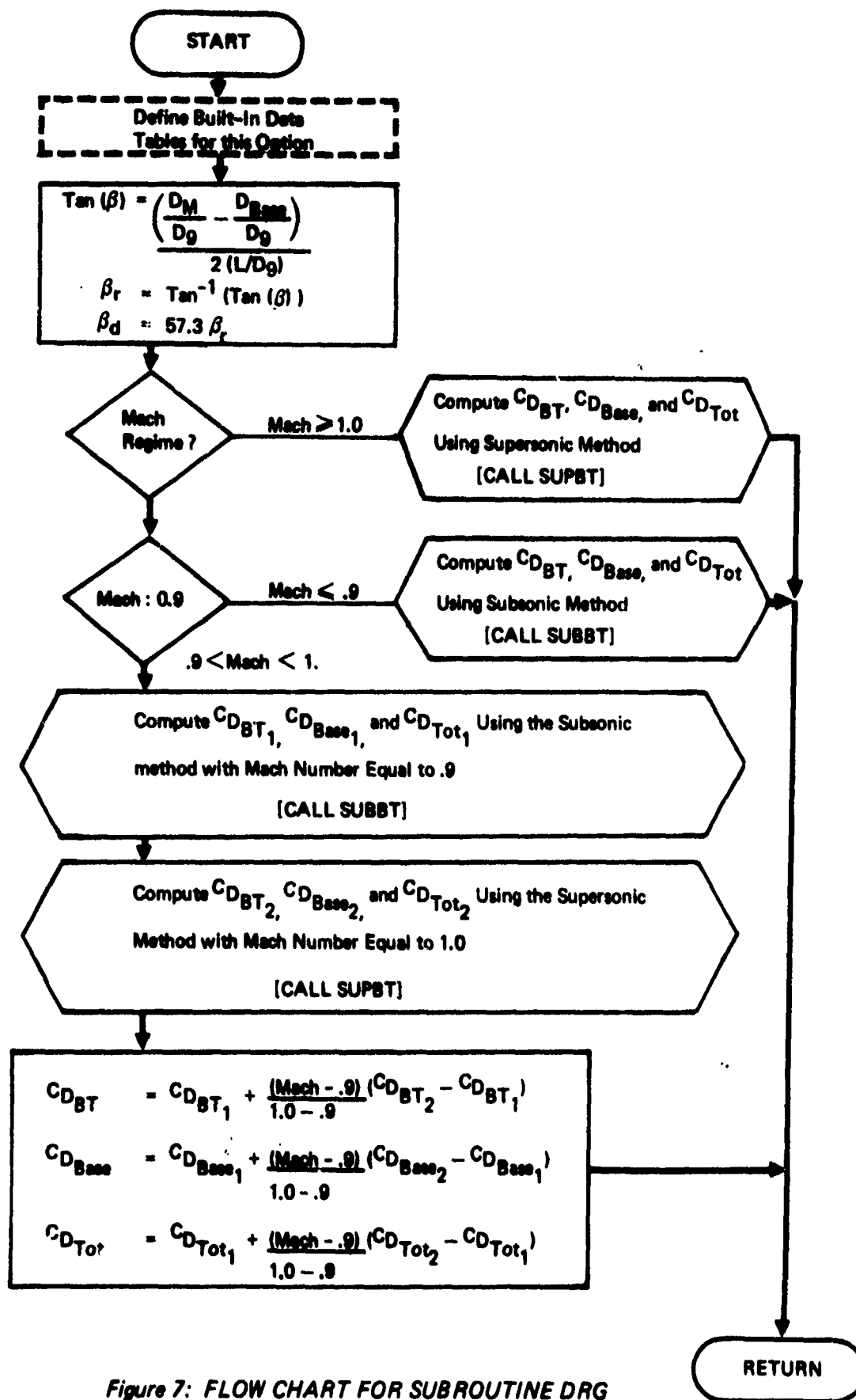


Figure 7: FLOW CHART FOR SUBROUTINE DRG

0000014 COMMON/AVCD,CDBS,CUBT,BETAD

0000014 COMMON/AVCD,CDBS,CUBT,BETAD

[illegible]

JJCC 14 JIMENSION TBP4(55), TBP6(35), TBP9(45), TBP10(35), TBP11(33)

6J0014  
EQUIVALENCE(Y94 (1),T9F4(1,1))

000014 EQUIVALENCE(TBP6 (1),TBP6(1,1))

**EQUIVALENCE(TBP9 (1),TBF9(1,1))**

[illegible]

0050:14 \_\_\_\_\_ EQUIVALENCE(TBP11(1),TRF11(1,1))

3 - 1 37871

063614 DATA NT1/ 3 /

0JJC14 DATA T81 / 1.66,1.57,2.60 /

003314 JATA T&F 1 / 1.40, .67, .33 /

TABLE 2 •  $B = F(G)$ 

CGJC 14  
DATA NT2 / 20 /

000014 JAYA TB2 / .06,

|   |      |      |       |       |       |       |        |
|---|------|------|-------|-------|-------|-------|--------|
|   | .70, | .90, | 1.00, | 1.50, | 2.00, | 2.50, | 3.00 / |
| I | .56, | .60, | .70,  | .80,  | .90,  | 1.00, | 1.50,  |

DATA T6=2 /2.15,2.65,1.90,1.63,1.45,1.35,1.20,1.11,1.05,1.00,

**C**      **TABLE 3 • K=F(PB/PF)**

DATA NT3 / 10 /

DATA T13 / 1.0

000014 JATA 1873 / .823

TABLE 4 - CDBZ=F (THETA,DB/DUM)

DATA NTK4,NTY4 / 5,11 /

COCC14 JATA Tbx

CCJUL14 DATA TdV4 / .00, .13, .21,

CC0014 DATA 1B2+ / .CC00, .0

0  
9  
0  
-  
7  
-

**Figure 1**

|   |              |
|---|--------------|
| 6 | JUL 15, 1970 |
| 0 | JUL 30, 1970 |

[illegible]

**על**

[illegible]

0  
1957  
1958

I .0235, .00



- 800  
 - 850  
 - 900  
 - 925  
 - 950

280,

**12 DEGREES**

1.

**F (PTP/PF)**

KAJ/57.29578/

0 106  
/07/

BOAT TAIL DRAG

050

6

**J. E. H.**

11

**J. MF**

33

1

• 11 •

三

• 2011

1

[illegible]

114

# WILL A

1  
2  
3  
4

**Abstract**

# SUPERSONIC BOATTAIL AND BASE DRAG

**SUPERSONIC BOATTAIL AND BASE DRAG**

**SUPERSONIC BOATTAIL AND BASE JTAG**

**SUPERSONIC BOATTAIL AND BASE DRAG**

**SUPERSONIC BOATTAIL AND BASE DRAG**

# SUPERSONIC BOATTAIL AND BASE DRAG

**SUPERSONIC BOATTAIL AND BASE DRAG**

**SUPERSONIC BOATTAIL AND BASE JET**

**SUPERSONIC BOAT TAIL AND BASE DRAG**

## SUPERSONIC BOATTAIL AND BASE DRAG

RUN VERSION JUL 71 22.46.30. 72/08/23.

000132 100 CONTINUE  
000132 CALL SUBPT(OMD,J,DBD,J,EMF,EMJ,P,PF,GAM,TANB)

000140 500 CONTINUE  
000140 RETURN

000161 EMU  
000161 .....

RUN VERSION JUL 71 22.46.30. 72/08/23.

SUBPROGRAM LENGTH  
000174

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS  
50 - 000120 100 - 000132 500 - 000140

EXTERNALS AND TAGS  
ATA - 000100 SUBST - 000200 SUPST - 000300 ENO. - 000400

BLOCK NAMES AND LENGTHS  
A - 000004 ORSTJ - 000676

VARIABLE ASSIGNMENTS

|       |   |           |       |   |           |        |   |           |        |   |           |
|-------|---|-----------|-------|---|-----------|--------|---|-----------|--------|---|-----------|
| BEA   | - | 000164    | BEAU  | - | 000003001 | CD     | - | 000000001 | COBS   | - | 000001001 |
| COBS1 | - | 000167    | COBS2 | - | 000172    | COBT   | - | 000002001 | COBT1  | - | 000166    |
| COBT2 | - | 000171    | CO1   | - | 000170    | CO2    | - | 000173    | EMS    | - | 000165    |
| GA4   | - | 000001    | IC3N  | - | 000002    | NTX10  | - | 000443002 | NTX11  | - | 000524002 |
| NTX4  | - | 000105002 | NTX6  | - | 000233002 | NTX3   | - | 000346002 | NTY10  | - | 000444002 |
| NTY11 | - | 000525002 | NTY3  | - | 000106002 | NTY5   | - | 000234002 | NTY9   | - | 000347002 |
| NT1   | - | 000003002 | NT12A | - | 000577002 | NT12B  | - | 000624002 | NT13   | - | 000651002 |
| NT2   | - | 000307002 | NT3   | - | 000600002 | NT5    | - | 000216002 | NT7    | - | 000314002 |
| NT3   | - | 000333002 | RAJ   | - | 000162    | TAN3   | - | 000153    | TBF1   | - | 000004002 |
| TBF1J | - | 000461002 | TBF11 | - | 000543002 | TBF12A | - | 000612002 | TBF12B | - | 000637002 |
| TBF13 | - | 000664002 | TBF2  | - | 000334002 | TBF3   | - | 000073002 | TBF4   | - | 000127002 |
| TBF5  | - | 000225002 | TBF5  | - | 000251002 | TBF7   | - | 000324002 | TBF8   | - | 000341002 |
| TBF9  | - | 000369002 | TJ313 | - | 000461002 | TBP11  | - | 000541002 | TBP4   | - | 000127002 |
| TBP6  | - | 000251002 | TBP9  | - | 000366002 | TBX10  | - | 000445002 | TBX11  | - | 000526002 |
| TBX4  | - | 000127002 | TBX5  | - | 000235002 | TBX9   | - | 000350002 | TBY10  | - | 000452002 |
| TBY11 | - | 000533002 | TBY4  | - | 000114002 | TBY6   | - | 000242002 | TBY9   | - | 000355002 |
| TB1   | - | 000312002 | TB12A | - | 000603002 | TB12B  | - | 000625002 | TB13   | - | 000652002 |
| TB2   | - | 000100002 | TB3   | - | 000661002 | TB5    | - | 000217002 | TB7    | - | 000315002 |
| TB9   | - | 000334002 | TNCTA | - | 000000    |        |   |           |        |   |           |

START OF CONSTANTS

000142

START OF TEMPORARIES

000152

START OF INDIRECTS

000162

SPACE REQUIRED TO COMPILE

043336

D-\*\*\*\*\*VARIABLES EXCEED VALUES IN DATA STATEMENT

000142

SUBJECT: SUBROUTINE CDCØNV

PURPOSE: SUBROUTINE CDCØNV monitors the convergent-divergent nozzle boattail drag computation.

METHOD: CDCØNV computes the required input values for SUBROUTINE DRG from the TEM-333 inputs. If the supersonic procedure is to be used i.e., Mach  $\geq 1.0$ , these inputs include the design Mach number of the nozzle which is solved for by iteration. DRG is called; then boattail drag computed from the CD obtained.

Note: The set DRG, SUBBT, and SUPBT were in existence prior to TEM-333, hence the incorporation of this routine into the logic.

USAGE: CALL CDCØNV

Input through COMMON/ABIN/ and COMMON/AMAX/  
Output includes  $D_s$  for interference routine

Flags PLUG = 0.0; BTTAB = 0.0 causes this subroutine to be called.

SUBPROGRAMS:           AEXHST           DRG           SQRT           WARNING

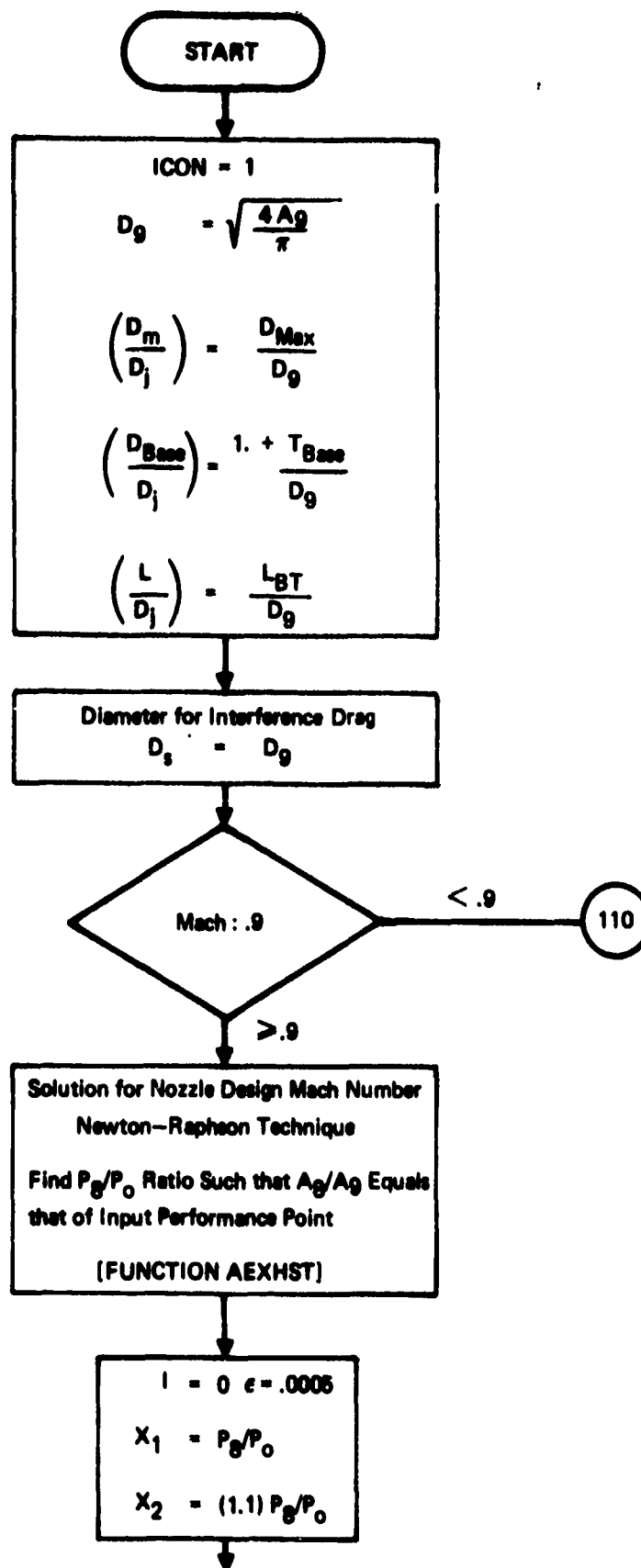


Figure 8: FLOW CHART FOR SUBROUTINE CDCONV

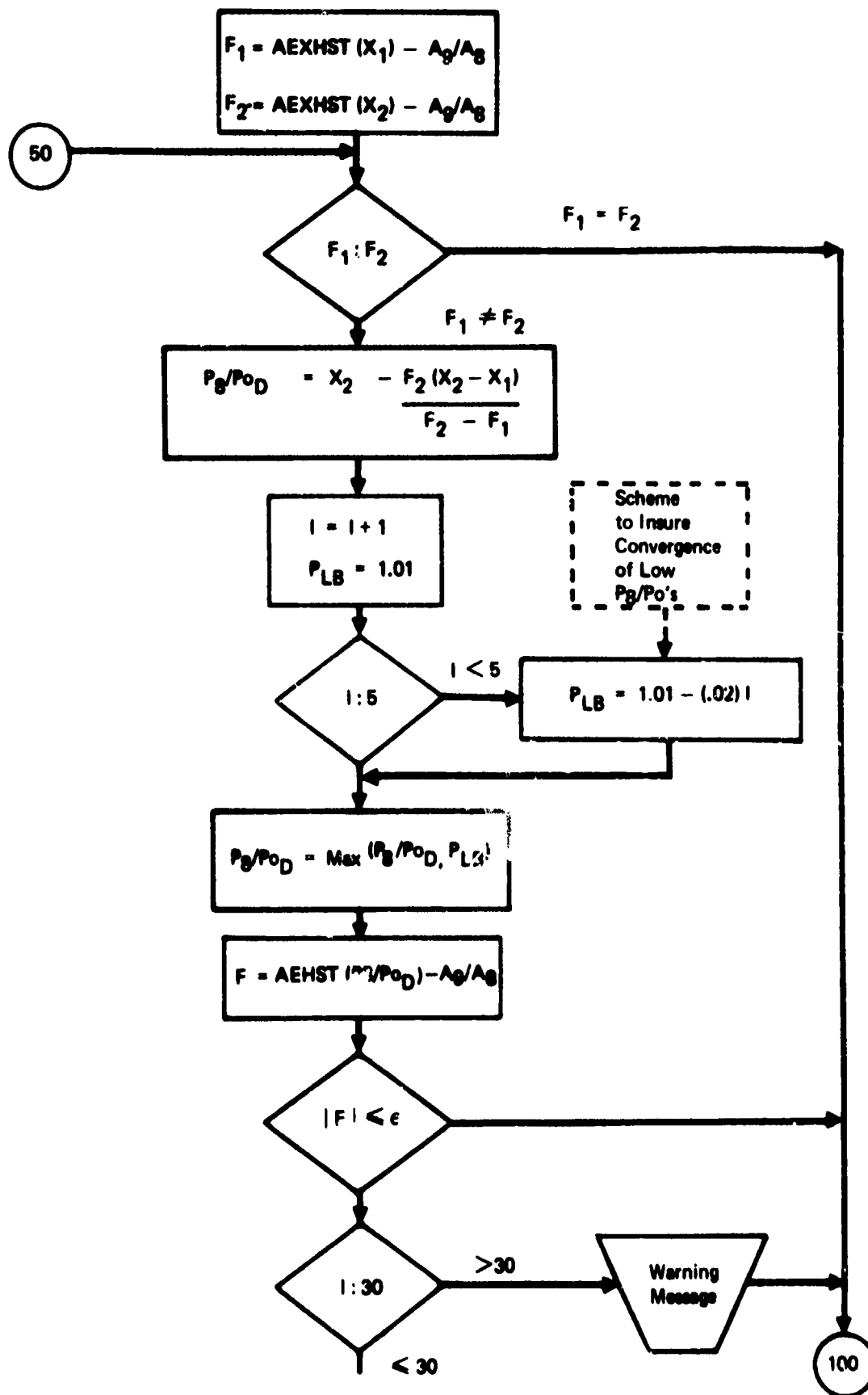


Figure 8: FLOW CHART FOR SUBROUTINE CDCONV (Cont)

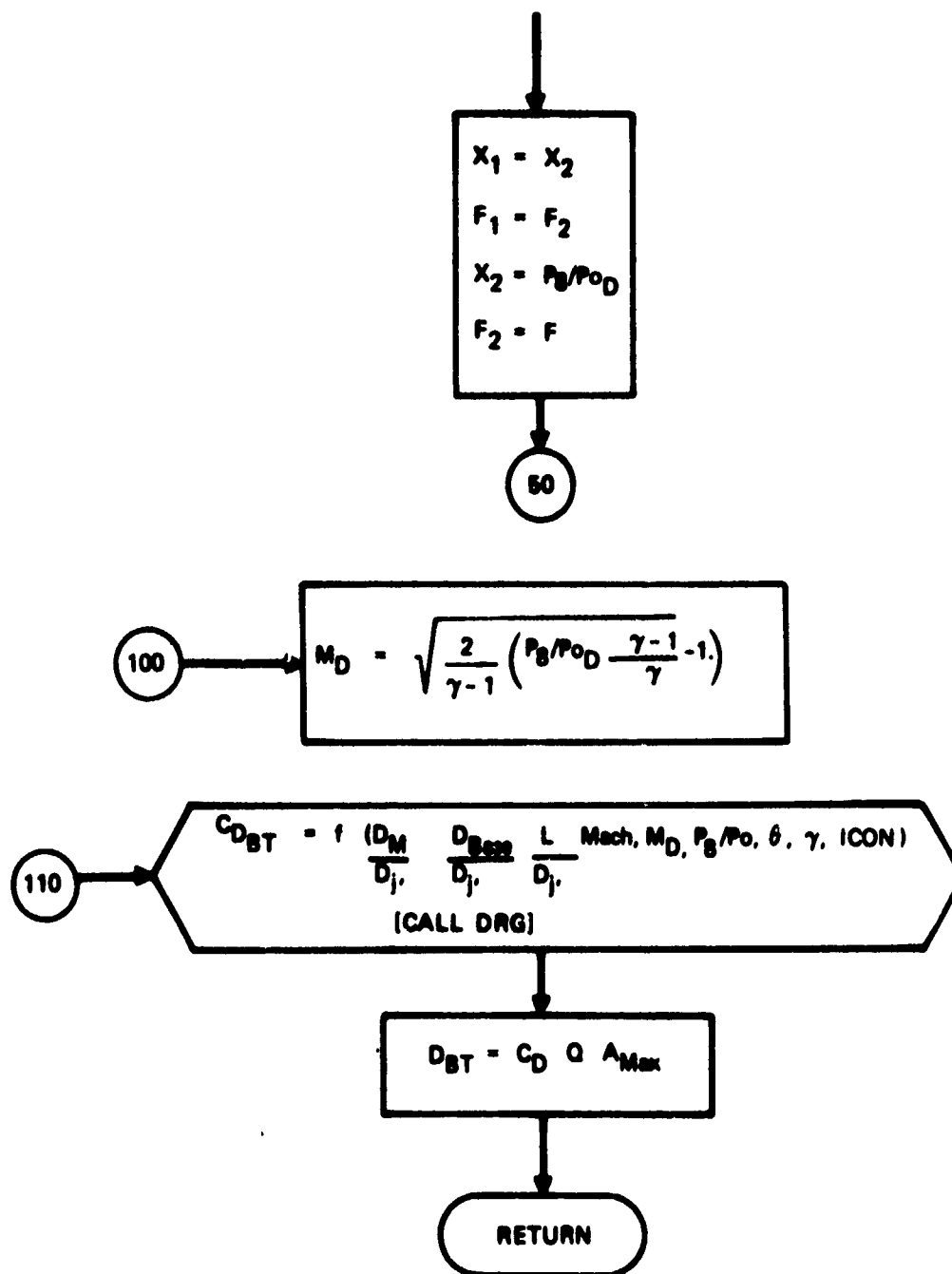


Figure 8: FLOW CHART FOR SUBROUTINE CD CONV (Concluded)

RUN VERSION JUL 71 22.46.44. 72/08/23.

```

SUBROUTINE C0CONV
COMMON/USPACE/USPACE
COMMON/AF/CO,A(3)
COMMON/AVAX/AMAX
COMMON/ABINP/ AE3, A8, AE18, A10, P7Q0, P17Q0, FGIP, FGIF, PC,
      GAMMAP, GAMMAF, XM, PAMB, 3, A9, A19, CFG, DMEP,
      DMZF, PLUG, FLAMIX, OMAX, THICK8, ZLPLUG, ZLBVAL,
      S, ABASE, BTAB, THETA
      FUTURE(11), NVAR
COMMON/ABORAG/ DBTAIL, DMI, DBASE
TOL=.0035
ICOM=1
J9=SQRT(A9/.785)
USPACE=D9
DMDJ=UMAX/D9
J8DJ=1.0+THICK8/D9
ZLQJ=ZLBVAL/D9
A3A8=A9/A8
P7Q0S=P7Q0
IF (XM-.1.9) GO TO 110
I=0
X1=P7Q0
F1=AXHST(1.0,GAMMAP,X1)-A9A3
X2=1.1P7Q0
F2=AXHST(1.0,GAMMAP,X2)-A9A3
50 IF (F2-E2,F1) GO TO 110
P7Q0S=X2-F2*(X2-X1)/(F2-F1)
I=I+1
PLIMIT=1.31
IF (I-L1,3) PLIMIT=1.10-FLOAT(I)*.02
P7Q0S=AXA1(P7Q0S,PLIMIT)
F=AXHST(1.0,GAMMAP,P7Q0S)-A9A8
IF (ABS(F).LE.TOL) GO TO 100
IF (I.GT.30) GO TO 90
X1=X2
F1=F2
X2=P7Q0S
F2=F
90 TJ 50
93 CALL WARNING
WRITE(6,1) P7Q0S
1 FORMAT(1X ITERATION FOR P0/P0 DESIGN FAILED TO CONVERGE.* F8.4,* US
      AED TO COMPUTED NOZZLE DESIGN EXIT MACH NUMBER*)
100 EMJ=SQRT(2./((GAMMAP-1.)*( 7Q0S)*((GAMMAP-1.)/(GAMMAP)-1.0)))
110 CONTINUE
CALL JK5(JM3J,DMJ,ZLQJ,XM,EMJ,P7Q0,THETA,GAMMAP,ICOM)
JBTALL=CJ*J*AMAX
RETURN
END

```

SUBPROGRAM LENGTH  
C0022C

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS  
1 - C00100 50 - 000043 90 - 000110 100 - 000117  
111 - 000135

EXTERNALS AND TAGS  
SORT - S00100 ALHST - S00200 WARNING- S00300 OUTPIC.- SC0400  
RBR-EX.- S00500 ORG - S00600 END. - S00700

BLOCK NAMES AND LENGTHS  
OSPACE - C00301 A - C00304 AMAX - C00301 ABINP - C00051  
ABY-IC - C00303

VARIABLE ASSIGNMENTS

A - C0000002 AMAX - C0000003 A8 - C0000003 A9 - C0000004  
A940 - C0000005 GO - C0000006 U80J - C0000007 DBTAIL - C0000008  
CHAX - C0000009 UMDJ - C0000010 OSPACE - C0000011 D9 - C0000012  
EYJJ - C0000013 F - C0000014 FUTURE - C0000015 F1 - C0000016  
F2 - C0000017 GARYAP - C0000018 I - C0000019 ICON - C0000020  
PLIMIT - C0000021 PTJUS - C0000022 P7QU - C0000023 C34 P7Q00S - C0000024  
Q - C0000025 THETA - C0000026 C-G034C04 THICK8 - C0000027 C14 TOL - C0000028  
IN - C0000029 X1 - C0000030 X2 - C0000031 ZLBTAL - C0000032  
ZLCA - C0000033

START OF CONSTANTS

C00150

START OF TEMPORARIES

C00174

START OF INDIRECTS

C00177

SPACE REQUIRED TO COMPLETE

C00000

SUBJECT: SUBROUTINE PLUGMX

PURPOSE: SUBROUTINE PLUGMX computes boattail drag for a plug nozzle, mixed flow.

METHOD: Boattail angle is computed from the maximum diameter, exhaust diameter, and plug length. Then Mach is checked and either the subsonic or supersonic method applied. Input tables 4.2.2 and 4.2.3 support the supersonic procedure. Boattail drag is returned.

USAGE: CALL SUBROUTINE PLUGMX

Input from COMMON/ABIN/ and COMMON/AMAX/  
Output includes  $D_s$  for interference routine

Flags set such that:            PLUG = 1.0  
                                 FLWMIX = 0.0  
                                 BTTAB = 0.0

Will cause this routine to be called

SUBPROGRAMS:            AEXHST            ATAN            SQRT  
                         TABU1            TABU2

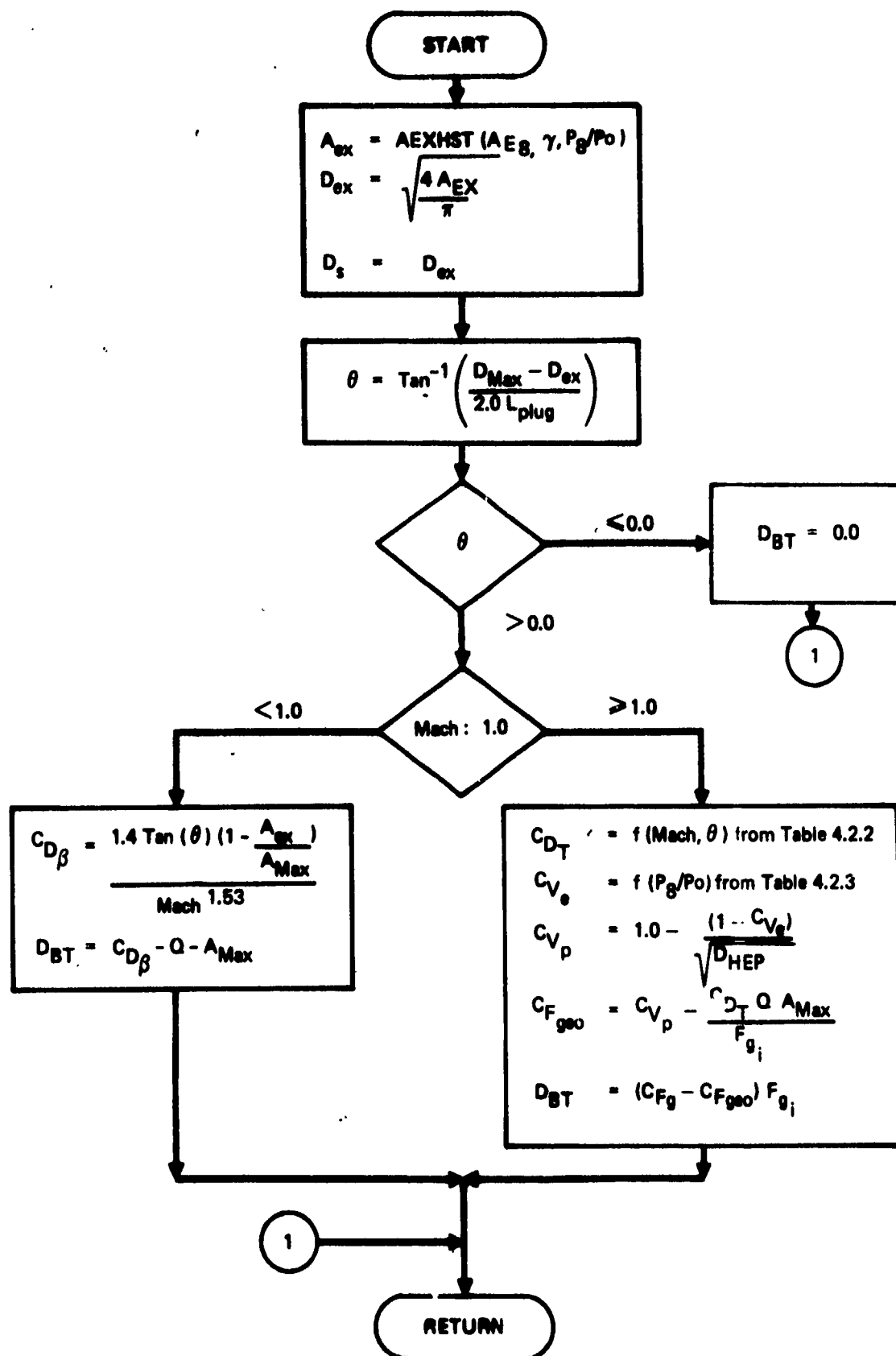


Figure 9: FLOW CHART FOR SUBROUTINE PLUGMX

```

SUBROUTINE PLUGMA
COMMON/ANAX/ANAX
COMMON/SPACE/SPACE
COMMON/ABINP/ AEG, AB, AE18, A19, P7Q0, P17Q0, FGIP, FGIF, PC,
A GAMMAP, GAMMAF, XM, PAMB, Q, A9, A19, CFG, DMHP,
B DMHF, PLUG, FLMMIX, DNAX, THICK8, ZLPLUG, ZLBTAL,
C S, ABASE, BITAB, T4ETA
J, FUTURE(11), NVAR
COMMON/ABJRG/ DBTAIL, UNI, DBASE
COMMON/ABTAB3/ABTX3(10), ABTY3(10), NTX3
COMMON/ABTAB2/ABTX2(10), ABTY2(10), ABTZ2(10,10), NTX2, NTY2
AEXJET=AEKMT(AEG,GAMMAP,P7Q0)
DEKJET=32RT(AEXJET/.705)
SPACE=DEKJET
TANTHA=.5*(DNAX-DEKJET)/ZLPLUG
THETA=ATAN(TANTHA)*57.296
IF (THETA.GT.0.0) GO TO 150
DBTAIL=0.0
GO TO 777
100 IF (AM.E.1.0) GO TO 200
CDBETA=1.+TANTHA*(1.0-AEXJET/ANAX)/(XM*.1.53)
DBTAIL=CDBETA*Q*ANAX
GO TO 777
200 COT=1/AGJ2(XM,THETA,ABTX2,ABTY2,ABTZ2, NTX2,NTY2,13,10)
CDBETA=1/(P7Q0,ABTX3,ABTY3, NTX3)
CVP=1.-((1.0-CVE)/SQRT(DMHP))
C=GE0=CVP-COT*Q*ANAX/FGIP
JBTAIL=(CFG-CFGE0)*FGIP
777 RETURN
END

```

SUBPROGRAM LENGTH  
00120

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

100 - 000024 200 - 000041 777 - 000074

EXTERNALS AND TAGS

AEKXST - S00103 SQRT - S00200 ATAN - S00306 RBAREX.- S00400  
TASU2 - S00500 TABJ1 - S00600 END. - S00700

BLOCK NAMES AND LENGTHS

AMAX - 000001 USPACE - 000101 ABIMP - 000051 ABDRAG - 000003  
ABTA83 - 000025 ABTA82 - 000172

VARIABLE ASSIGNMENTS

ABTK2 - 00000006 ABTK3 - 00000005 ABTV2 - 00012006 ABTV3 - 00012005  
ABT22 - 00002406 AEXJET - 000110 AEO - 00000003 AMAX - 00000301  
COBETA - 000113 CUF - 000114 CFC - 00002003 CFCEO - 000117  
CVE - 000115 CVP - 000116 DBTAIL - 00000004 DEJJET - 000111  
DHBP - 00002103 DMX - 00002503 DSPACE - 00000002 FGIP - 00000603  
FUTURE - 00003503 GAYMAP - 00011003 NTX2 - 00017006 NTX3 - 00002405  
NTV2 - 00017100 P700 - 00000403 Q - 00011503 TANTMA - 000112  
THETA - 00033403 XM - 00001303 ZLPLUG - 00002703

START OF CONSTANTS

000376

START OF TEMPORARIES

000105

START OF INDIRECTS

000110

SPACE REQUIRED TO COMPLETE

030600

SUBJECT: SUBROUTINE PLUGNM

PURPOSE: SUBROUTINE PLUGNM computes boattail drag for a plug nozzle, non-mixed flow.

METHOD: Boattail angle is computed from the maximum diameter, the exhaust diameter and the plug length. Then Mach is checked and either the subsonic or supersonic method applied. Input tables 4.2.2 and 4.2.3 support the supersonic procedure.

Boattail drag is returned.

USAGE: CALL SUBROUTINE PLUGNM

Input from COMMON/ABIN/ and COMMON/AMAX)  
Output includes  $D_s$  for interference routine

Flags set such that:            PLUG = 1.0  
                                 FLWMIX = 0.0  
                                 BTTAB = 0.0

Will cause this routine to be called

SUBPROGRAMS:            AEXHST            ATAN            SQRT  
                         TABU1            TABU2

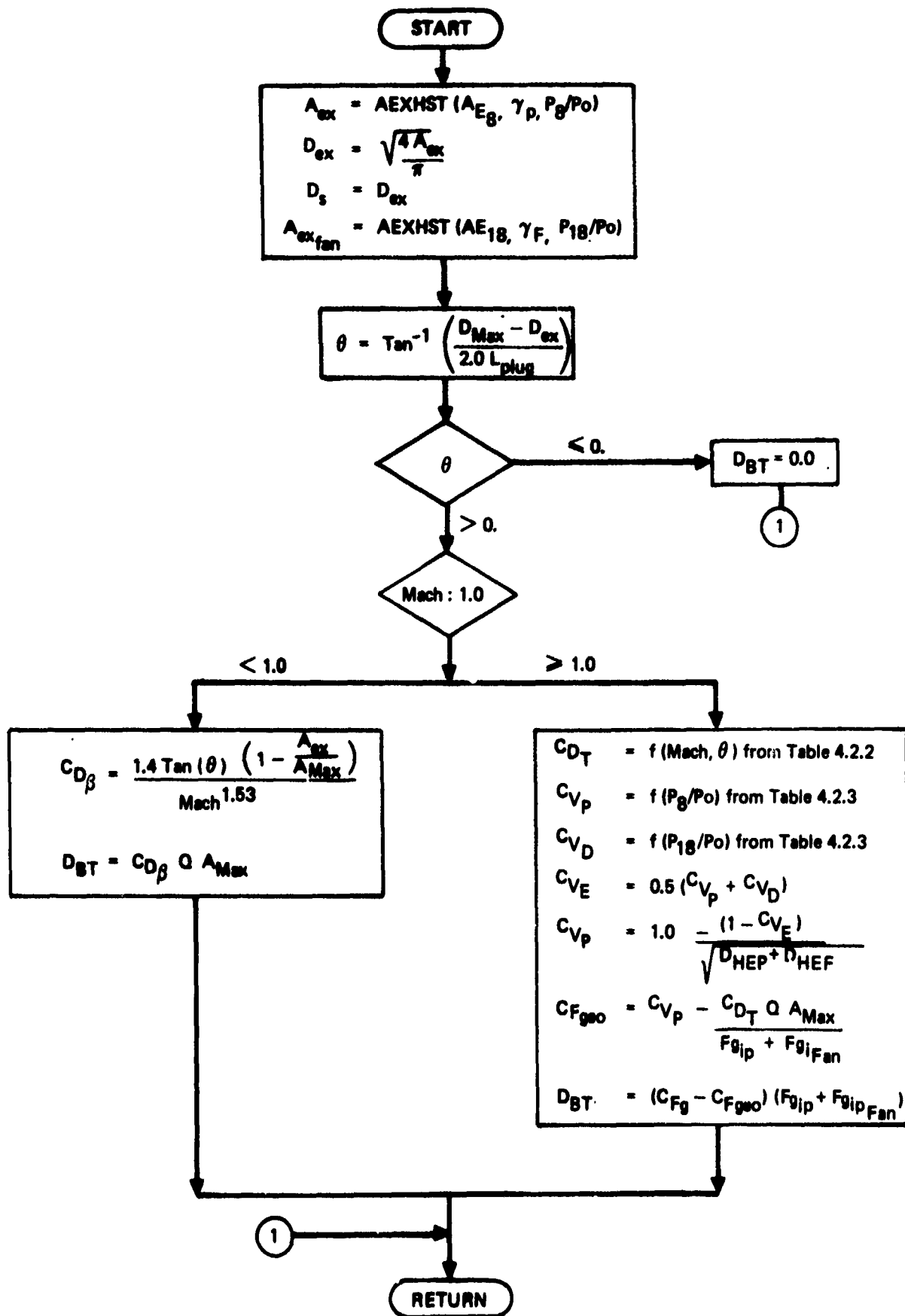


Figure 10: FLOW CHART FOR SUBROUTINE PLUGNM

```

000032      SUBROUTINE PLUGNM
COMMON/ABINP/ AEG, AB, AE18, A18, P7Q0, P17Q0, FGIP, FGIF, PG,
A      GAMMAP, GAMMAF, XM, PAMB, 2, A9, A19, CFG, DNEP,
B      DNEF, PLUG, FLMMIX, DMAX, THICKB, ZLPLUG, ZLBTAL,
C      S, ABASE, BTAB, THETA
D      FUTURE(11), NVAR
000032      COMMON/AX/AMAX
000032      COMMON/AB3RAG/ CBTAIL, UNI, JBASE
000032      COMMON/SPACE/OSPACE
000032      COMMON/ABTAB2/ABT2(10), ABT2(10), ABT2(10,10), NTX2, NTY2
000032      COMMON/ABTAB3/ABT3(10), ABT3(10), ABT3(10), NTX3
000032      AEXFAN=AXMST(AE18, GAMMAF, P17Q0)
000036      AEXPRM=AXMST(AE18, GAMMAF, P7Q0)
000041      AEXJET=AXPRM+AXFAN
000043      JEXJET=3277(AEXJET/785)
000047      DSPACE=DEKJET
000050      TANTHA=5*(DMAX-JEXJET)/ZLPLUG
000052      THETA=ATAN(TANTHA)*57.296
000056      IF (THETA.GT.0.0) GO TO 100
000058      DGTAIL=0
000060      GO TO 777
000062      100 IF (AM.JE.1.0) GO TO 200
000064      CBTAIL=1.4*TANTHA*(1.0-AEXJET/AMAX)/(XN*1.53)
000066      JBTAIL=CBTAIL*Q*AMAX
000068      GO TO 777
000070      200 CBT=ABT2(X4,THETA,ABT2,ABT2,ABT2,
000072      CVP=ABT1(P7Q0,ABT3,ABT3, NTX3)
000074      CVD=ABT1(P17Q0,ABT3,ABT3, NTX3)
000076      CDE=.5*(CVP+CVD)
000078      CVP=1.0-(1.0-CVD)/SORT(DNEP+DNEF)
000080      CFGE2=CVP-COT*Q*AMAX/(FGIP+FGIF)
000082      JBTAIL=(CFG-CFGE2)*(FGIP+FGIF)
000084      777 RETRN
000086      END

```

RUN VERSION JUL 71 22.46.44. 72/08/23.

SUBPROGRAM LENGTH  
000145

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

100 - 000331 200 - 000346 777 - 000115

EXTERNALS AND TAGS

ABRST - S00130 SURT - S00203 ATAM - S00300 RBAREX.- S00400  
TAGJ2 - S00500 TAGU1 - S00600 END. - S00700

BLOCK NAMES AND - ENDS

ABINP - 000351 AMAX - 000301 ABDRAG - 000003 DSPACE - 000001  
ABTAB2 - 000172 ABTAB3 - 000025

VARIABLE ASSIGNMENTS

ABTX2 - 000000005 ABTX3 - 000000006 ABTX2 - 00012005 ABTX3 - 00012006  
ABTX2 - 000020005 AEXFAN - 000132 AEXJET - 000134 AEXPRM - 000133  
AELB - 000020001 AEF - 000020001 AMAX - 000000002 CDT - 000140  
COTAIL - 000137 CFS - 000020001 CFE2 - 000144 CVD - 000142  
CUE - 000143 CWP - 000141 DRTALC - 000000003 DEXJET - 000135  
DUEF - 000020001 DUEP - 000020001 DMAX - 000020001 DSPACE - 000000004  
FGLF - 000070001 FGLP - 000070001 FUTURE - 000035001 GAMMAF - 00012001  
CA4MAP - 000110001 MTR2 - 000170005 MTR3 - 000020006 NTY2 - 00017005  
P17J0 - 000000001 P720 - 000000001 L - 000015001 TANHA - 000136  
TMEIA - 000030001 AN - 000013001 ZLPLUS - 000027001

START OF CONSTANTS

000117

START OF TEMPORARIES

000126

START OF INDIRECTS

000132

SPACE REQUIRED TO COMPLETE

032700

SUBJECT: SUBROUTINE ABINPT

PURPOSE: SUBROUTINE ABINPT reads the nozzle performance data deck, cards 4.1 to 4.2.6.

METHOD: The input deck is read. The thickness of the annular base is doubled to account for top and bottom when compared to the total jet diameter. If  $A_{10}$  was input the table of  $Mach_9$  vs.  $A_8/A_9$  needed by subroutine CABTAB and the  $P_8/P_{AMB}$  lower thrust are computed. Tables not indicated by the input flags are not read.

USAGE: CALL ABINPT

All COMMON blocks present are defined by calling this subprogram.

SUBPROGRAMS:           TABL1           TABL2           TABL3



22.46.44. 72/08/23.

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1\*ENGINE TYPE DESIGNATION\*F17.1/\* MAXIMUM DIAMETER - IN\*F10.1.20X,  
 2\*NOZZLE BASE OUTER DIAM - IN\*F13.1/\* OVERALL PLUG LENGTH - IN\*F15,  
 31,20X,\*NOZZLE BOATTAIL LENGTH - IN\*F13.1/\* NOZZLE SPACING - IN\*  
 4\*F20.1,20X,\*BASE FLOW AREA - SQ IN\*F10.1/\* BOATTAIL DRAG TABLE FLAG  
 5\*15.1,20X,\*BOATTAIL TRAILING EDGE ANGLE - DEG\*F6.2/\* PRIMARY SPE  
 6CIFIC HEAT RATIO\*F11.2,20X,\*A10 - SQ FT\* F29.2 )

4 FORMAT (\*BASE DRAG TABLE\*)  
 5 FORMAT (\*INTERFERENCE DRAG TABLE\*)  
 6 FORM T \*BOATTAIL DRAG TABLE\*)  
 END

CCJ177  
 CCJ177  
 CCJ177  
 CCJ177

SUBPROGRAM LENGTH  
CC0333

FUNCTION ASSIGNMENTS

| STATEMENT ASSIGNMENTS |   |        |    |   |        |    |   |        |    |   |        |
|-----------------------|---|--------|----|---|--------|----|---|--------|----|---|--------|
| 1                     | - | 000231 | 2  | - | 000233 | 3  | - | 000235 | 4  | - | 000312 |
| 5                     | - | 000314 | 6  | - | 000322 | 7  | - | 000206 | 8  | - | 000213 |
| 9                     | - | 000054 | 10 | - | 000070 | 11 | - | 000222 | 15 | - | 000157 |

EXTERNALS AND TAGS

|        |        |         |         |        |      |        |        |   |        |
|--------|--------|---------|---------|--------|------|--------|--------|---|--------|
| INPTC- | SC0100 | OUTPIC- | SC0200  | TABL2  | -    | SC0300 | TABL1  | - | SC0400 |
| TABL3  | -      | SC0500  | RBAREX- | SC0600 | END. | -      | SC0700 |   |        |

BLOCK NAMES AND LENGTHS

|          |        |          |        |          |        |          |        |
|----------|--------|----------|--------|----------|--------|----------|--------|
| NOZARR - | 000050 | ABTAB1 - | 000172 | ABTAB2 - | 000172 | ABTAB3 - | 000025 |
| ABTAJ4 - | 000025 | ABTAB5 - | 000172 | ABTAB6 - | 002011 | PSPAL -  | 000001 |
| AREA10 - | 000062 | XMACH9 - | 000024 |          |        |          |        |

VARIABLE ASSIGNMENTS

|        |   |          |        |   |          |        |   |          |        |   |          |
|--------|---|----------|--------|---|----------|--------|---|----------|--------|---|----------|
| A      | - | 00000001 | ABTAB1 | - | 00000002 | ABTAB2 | - | 00000003 | ABTAB3 | - | 00000004 |
| ABTAB4 | - | 00000005 | ABTAB5 | - | 00000006 | ABTAB6 | - | 00000007 | AREA10 | - | 00000008 |
| ABTAB7 | - | 00000009 | ABTAB8 | - | 00000010 | ABTAB9 | - | 00000011 | GM1    | - | 00000012 |
| GP1    | - | 00000013 | GP1GM1 | - | 00000014 | X      | - | 00000015 | MTX1   | - | 00000016 |
| MTX2   | - | 00000017 | MTX3   | - | 00000018 | MTX4   | - | 00000019 | MTX5   | - | 00000020 |
| MTX6   | - | 00000021 | MTX7   | - | 00000022 | MTX8   | - | 00000023 | MTX9   | - | 00000024 |
| MTX5   | - | 00000025 | MTX6   | - | 00000026 | PAPAL  | - | 00000027 | XMACH9 | - | 00000028 |

START OF CONSTANTS

CC0230

START OF TEMPORARIES

CC0325

START OF INDIRECTS

CC0327

SPACE REQUIRED TO COMPLETE

CC0326

SUBJECT: SUBROUTINE SUBBT

PURPOSE: SUBROUTINE SUBBT computes boattail drag for a convergent-divergent nozzle when Mach < .9.

METHOD: The quantity  $D_J^2 / (D_B + D_M)$  is tested. If it is greater than 0.25 boattail drag is determined directly from built in tables XI and XII. If not, an empirical method to develop base and boattail drag is used.

USAGE: CALL SUBBT (DMDJ, DBDJ, EMF, PTPF, THETA, ICØN, GAM)

DMDJ Ratio of maximum to jet diameter

DBDJ Ratio of base to jet diameter

EMF Free-stream Mach number

PTPF Ratio of jet total to free-stream static pressure

THETA Boattail trailing edge angle - degrees

GAM Ratio of specific heats

ICØN { = 0 circular arc boattail  
= 1 conical boattail

SUBPROGRAMS: CABTAB TABU1 TABU2

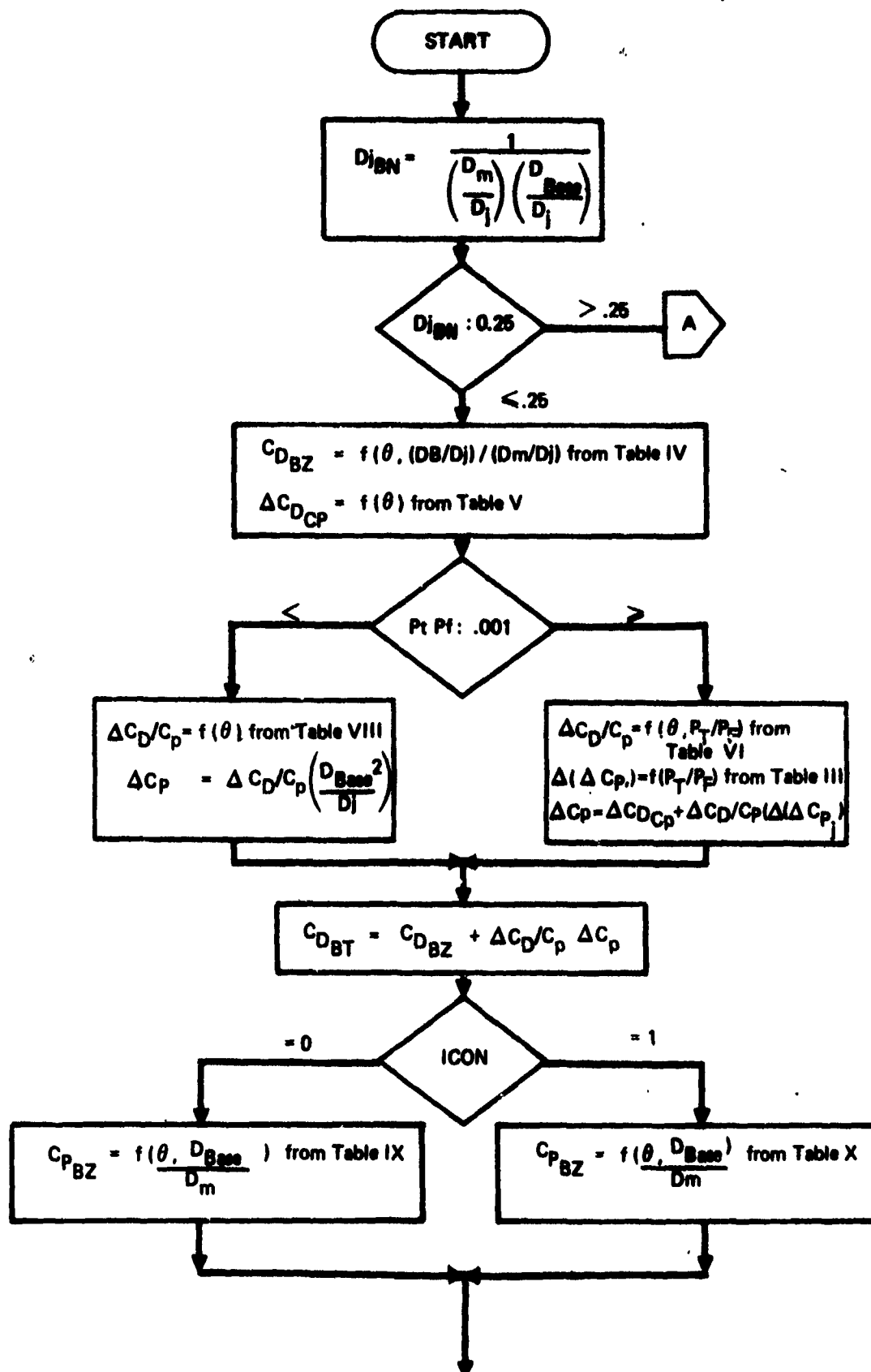


Figure 11: FLOW CHART FOR SUBROUTINE SUBBT

$$D_{B_{jm}} = \frac{(D_{B_{m}})^2}{D_j} - 1$$

$$\frac{C_{D_{BS}}}{\left(\frac{D_m}{D_j}\right)^2} = -D_{B_{jm}} (C_{P_{BZ}} + \Delta C_P)$$

$$C_D = C_{D_{BT}} + C_{D_{BS}}$$

RETURN

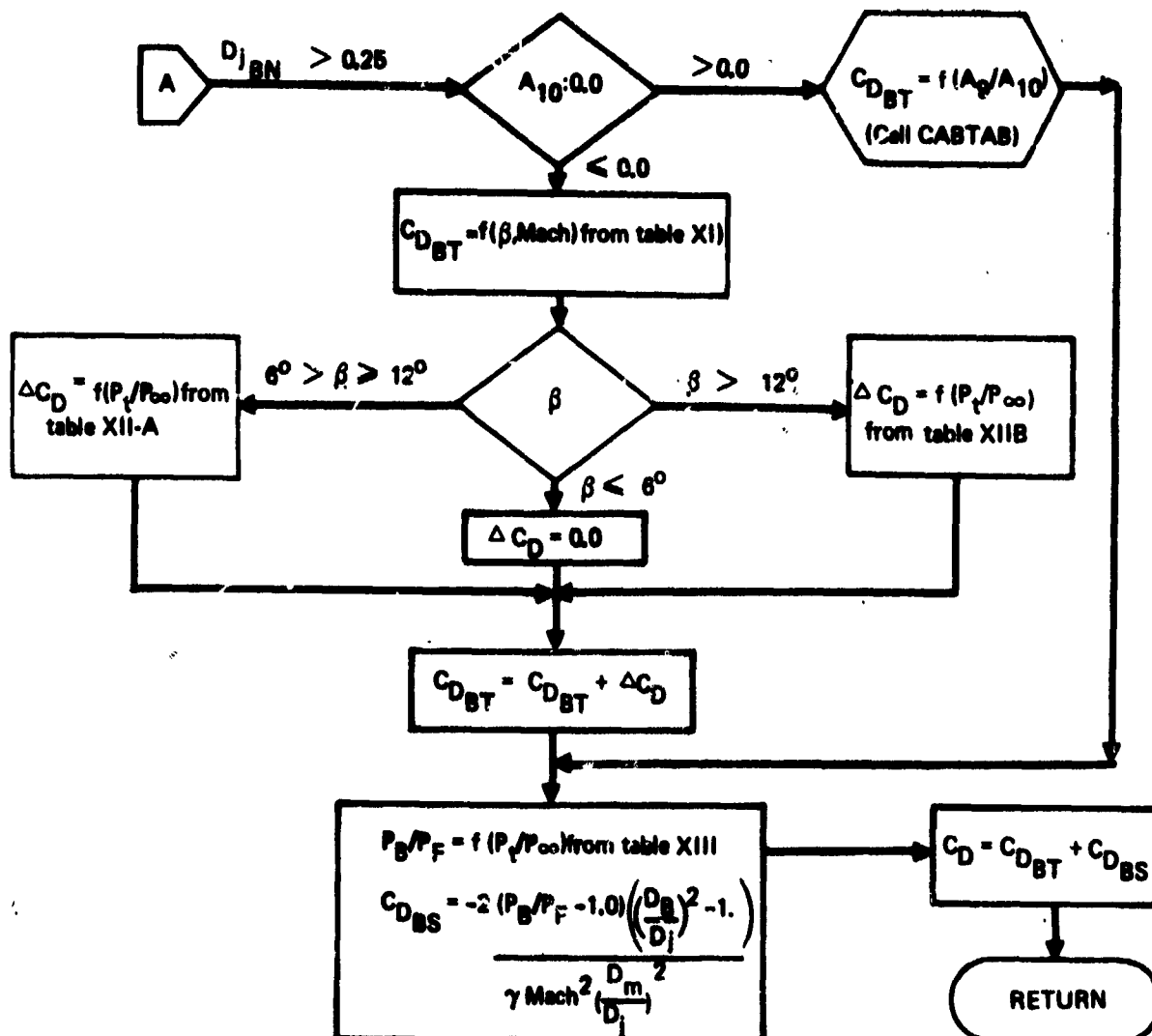


Figure 11: FLOW CHART FOR SUBROUTINE SUBBT (Cont)

RUN VERSION JUL 71 22.46.44. 72/38/23.

SUBROUTINE SUBBT(OMJ,OBQJ,EMF,PTPF,THETA,ICON,GAM)

COMMON/AREA10/AREA10,BVA16  
COMMON/A/CO,CDBS,CDBT,BETA0

CJ0C12 COMMON/DRGTB/NT1,T01(3),T0F1(3),NT2,T02(20),T0F2(20),NT3,T03(10),  
T0F3(10),NT4,T04(5),T0F4(11),T0F4(5,11),NT5,  
T0F5(5),T0F5(6),NT6,T06(5),T0F6(7),T0F6(5,7),  
NT7,T07(7),T0F7(7),NT8,T08(5),T0F8(5),NT9,NTY9,  
T0X9(5),T0Y9(9),T0F9(9),T0F9(5,9),NTX10,NTY10,T0X10(5),  
T0Y10(7),T0F10(5,7),NTX11,NTY11,T0X11(5),T0Y11(6),  
T0F11(5,6),NT12A,T0L2A(10),T0F12A(10),NT12B,T0L2B(10),  
T0F12B(10),NT13,T0L3(10),T0F13(10)

00C12 REAL LDJ.

CJ0C12 DJEM=1/(OMJ\*OBQJ)  
CJ0C14 IF (DJEM.GT..25) GO TO 500  
CJ0C17 OBQJ=OBQJ/DJEM  
CJ0C20 CDB2=TAJ2(THETA,OBQJ,T0X4,T0Y4,T0F4,NTX4,NTY4,5,11)  
CJ0C24 ODCP=TAJ2(THETA,T05,T0F5,NT5)  
CJ0C28 IF (PTPF.GE..C0) GO TO 100  
CJ0C33 OCPJ=TAJ1(THETA,T08,T0F8,NT8)  
CJ0C36 OCPJ=OCPJ/OBQJ\*\*2  
CJ0C39 GO TO 200

100 CONTINUE  
CJ0C60 ODCP=TAJ2(THETA,PTPF,T0X6,T0Y6,T0F6,NTX6,NTY6,5,7)  
CJ0C63 OCPJ=TAJ1(PTPF,T07,T0F7,NT7)  
CJ0C74 OCPJ=OCPJ/OCPJ\*OJDM  
CJ0C133 CONTINUE  
CJ0C136 CDBT=CDB2+OCPJ\*OCPJ

CJ0C111 IF (ICON.EQ.1) GO TO 300  
CJ0C113 CPBZ=TAJ2(THETA,OBQJ,T0X9,T0Y9,T0F9,NTX9,NTY9,5,9)  
CJ0C127 GO TO 400

300 CONTINUE

\*NOTE\* TABLE 10 - MAXIMUM THETA = 0 DEGREES

400 CONTINUE  
CJ0C130 CPBZ=TAJ2(THETA,OBQJ,T0X10,T0Y10,T0F10,NTX10,NTY10,5,7)  
CJ0C145 OJDM=(OBQJ\*OBQJ-1)/(OMJ\*OMJ)  
CJ0C145 OJDM=OJDM\*OBQJ-1/(OMJ\*OMJ)  
CJ0C150 CDBS=OBQJ\*(CPBZ+OCPJ)  
CJ0C153 CJ=CJ+SA\*OJDM  
CJ0C155 GO TO 600

500 CONTINUE  
CJ0C156 IF (AREA10.GT.0.0) GO TO 700  
CJ0C161 CJ=TAJ2(BETA0,EMF,T0X11,T0Y11,T0F11,NTX11,NTY11,5,6)  
CJ0C175 UC=0.0

RUN VERSION JVL 71 22.46.44. 72/38/23.

003176 IF (BETAJ.LE.6.0) GO TO 550  
003231 IF (BETAJ.GT.12.0) GO TO 525  
003234 OCJ=IABJ(PTPF,T812A,T8F12A,NT12A)  
003232 GO TO 553  
003233 700 CALL CANTAB(CD8T,EMF)  
003235 GO TO 575  
003221 525 JCQ=IABJ(PTPF,T812B,T8F12B,NT12B)  
003230 550 CJBT=CD+JCD

003232 575 CONTINUE  
003232 W8PF=IABJ(PTPF,I313,T8F13,NT13)  
003241 CJBS=-2.\*(P8PF-1.)\*(O8QJ+O8QJ-1.)/(CAN\*EMF\*EMF\*DMQJ+DMQJ)

000253 CJ=CJBT+2335

000255 600 CONTINUE  
000255 RETURN  
000256 END

RUN VERSION JUL 71 22.46.44. 72/08/23.

SUBPROGRAM LENGTH  
C0313

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

|     |   |        |     |   |        |     |   |        |     |   |        |
|-----|---|--------|-----|---|--------|-----|---|--------|-----|---|--------|
| 100 | - | 000060 | 200 | - | 000106 | 300 | - | 000130 | 400 | - | 000145 |
| 500 | - | 000156 | 525 | - | 000221 | 550 | - | 000236 | 575 | - | 000252 |
| 601 | - | 000255 | 700 | - | 000213 |     |   |        |     |   |        |

EXTERNALS AND TAGS

|       |   |        |       |   |        |        |   |        |      |   |        |
|-------|---|--------|-------|---|--------|--------|---|--------|------|---|--------|
| TAB02 | - | S00100 | TABJ1 | - | S00200 | CABTAB | - | S00300 | END. | - | S03400 |
|-------|---|--------|-------|---|--------|--------|---|--------|------|---|--------|

BLOCK NAMES AND LENGTHS

|        |   |        |   |   |        |       |   |        |
|--------|---|--------|---|---|--------|-------|---|--------|
| AREA1C | - | 000302 | A | - | 000304 | DRGTB | - | 000676 |
|--------|---|--------|---|---|--------|-------|---|--------|

VARIABLE ASSIGNMENTS

|        |   |          |       |   |          |        |   |          |        |   |           |
|--------|---|----------|-------|---|----------|--------|---|----------|--------|---|-----------|
| AREA1C | - | 00030001 | BLTAD | - | 00030002 | CD     | - | 00000002 | CD8S   | - | 000001002 |
| CU3T   | - | 00030002 | CD8Z  | - | 000301   | CP8Z   | - | 000307   | DBDM   | - | 000300    |
| DBJM   | - | 000310   | OCJ   | - | 000311   | OCUCP  | - | 000332   | DCP    | - | 000304    |
| DCPJ   | - | 000306   | OCPCJ | - | 000303   | OCPCJ  | - | 000305   | DJ8M   | - | 000277    |
| GA4    | - | 000000   | LWJ   | - | 000276   | MTX10  | - | 00044303 | MTX11  | - | 00052403  |
| MTX4   | - | 00010003 | MTX5  | - | 00023303 | MTX3   | - | 00034003 | MTX10  | - | 00044403  |
| MTX11  | - | 00052503 | MTX4  | - | 00010003 | MTX5   | - | 00023403 | MTX9   | - | 00034703  |
| MT12A  | - | 00057703 | MT12B | - | 00062403 | MT13   | - | 00065103 | MT5    | - | 00021603  |
| MT7    | - | 00031403 | MT5   | - | 00033303 | P8PF   | - | 000312   | T8F1   | - | 00000403  |
| T8F11  | - | 00040103 | T8F11 | - | 00054103 | T8F12A | - | 00061203 | T8F12B | - | 00063703  |
| T8F13  | - | 00060403 | T8F2  | - | 00034003 | T8F3   | - | 00073003 | T8F4   | - | 00012703  |
| T8F5   | - | 00022503 | T8F5  | - | 00025103 | T8F7   | - | 00032403 | T8F8   | - | 00034103  |
| T8F9   | - | 00030003 | T8A10 | - | 00044503 | T8X11  | - | 00052603 | T8X4   | - | 00010703  |
| T8A5   | - | 00023503 | T8A9  | - | 00035003 | T8Y10  | - | 00045203 | T8Y11  | - | 00033303  |
| T8F4   | - | 00011403 | T8F5  | - | 00024203 | T8Y3   | - | 00035503 | T81    | - | 00000103  |
| T8A4A  | - | 00060103 | T8A2A | - | 00062503 | T813   | - | 00065203 | T82    | - | 00001003  |
| T83    | - | 00061003 | T85   | - | 00021703 | T87    | - | 00031503 | T88    | - | 00033403  |

START OF CONSTANTS

C0257

START OF TEMPORARIES

C0272

START OF INDIRECTS

C0276

SPACE REQUIRED TO COMPLETE

C3700

**SUBJECT:** SUBROUTINE SUPBT

**PURPOSE:** SUBROUTINE SUPBT computes boattail and base drag for a convergent-divergent nozzle when Mach > 1.0.

**METHOD:** Boattail drag is computed using Table I, then if a base has been defined base drag is computed and added to compute a total drag.

**USAGE:** CALL SUPBT (DMDJ, DBDJ, EMF, EMJD, PTPF, GAM, TANB)

DMDJ      Ratio of maximum of jet diameter

DBDJ      Ratio of base to jet diameter

EMF        Free-stream Mach number

EMJD      Jet design Mach number

PTPF      Ratio of jet total to free-stream static pressure

GAM        Ratio of specific heats

TANB      Tangent of boattail chord angle

**SUBPROGRAM:**      ALØG      CABTAB      EXP

                      SQRT      TABU1

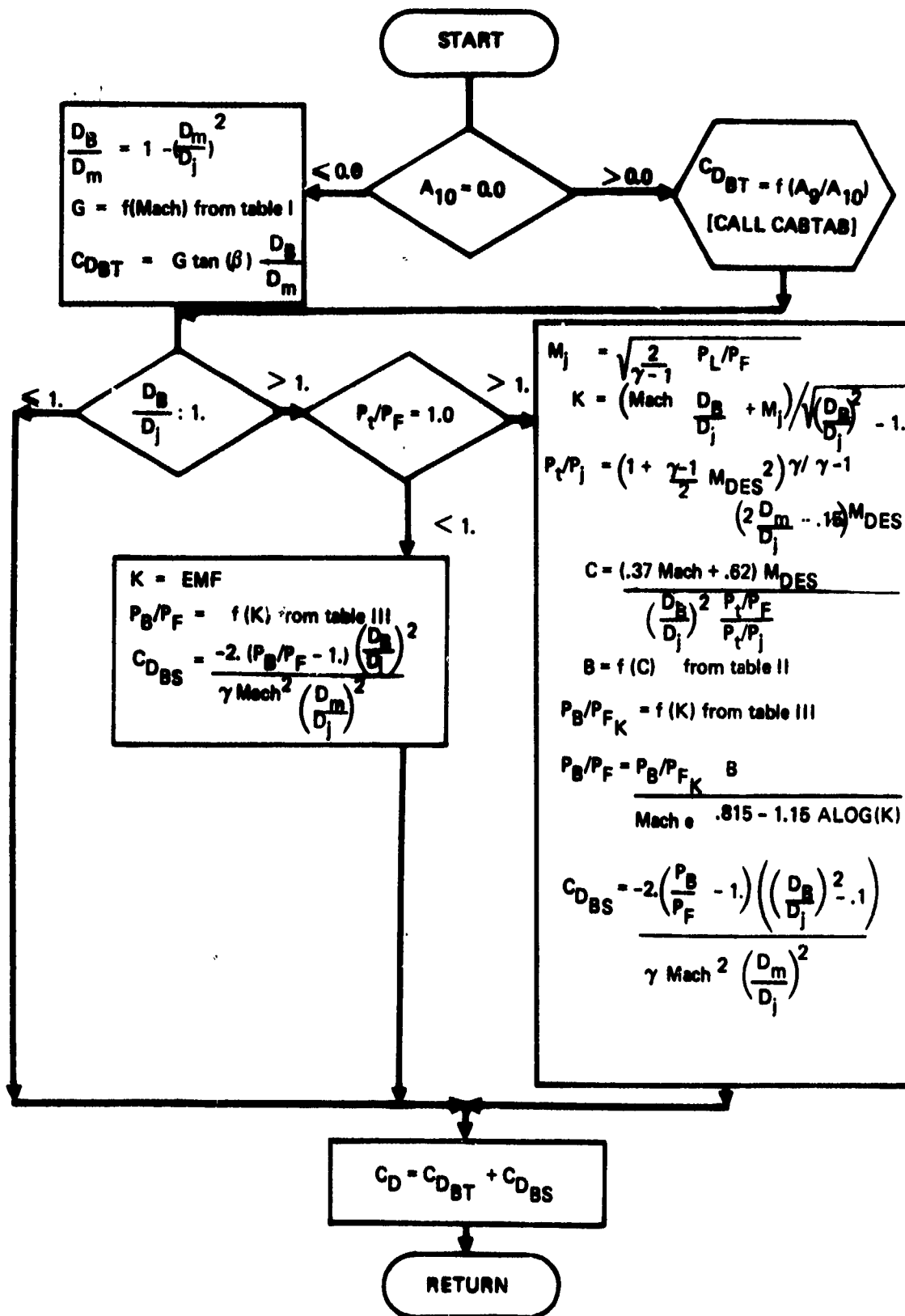


Figure 12: FLOW CHART FOR SUBROUTINE SUPBT

SJERROUTINE SUPBT (OMQJ,OBQJ,EMF,EMJO,PTPF,GAM,TANB)

COMMON/A/CD,CDBS,CDBT,BETA0  
COMMON/A/REA10/AREA10,BYA10

COMMON/AREA10/AREA10,8YA10

|                                                                   |
|-------------------------------------------------------------------|
| COMMON/CRGTB/NT1,TB1(3),TUF1(3),NT2,TB2(20),TBF2(20),NT3,TB3(10), |
| TBF3(10),NTX4,NTY4,TBX4(5),TB4(11),TBF4(5,11),NT5,                |
| TBF5(5),TBF5(6),NTX6,TBX6(5),TBY6(7),TBF6(5,7),                   |
| NT7,TB7(7),TBF7(7),NT6,TB8(5),TBF8(5),NTX9,NTY9,                  |
| TBX9(5),TBY9(5),TBF9(5),TBF3(5,9),NTX10,NTY10,TBX10(5),           |
| TBY10(7),TBF10(5,7),NTX11,NTY11,TBX11(5),TBY11(6),                |
| TBF11(5,6),NT12A,TB12A(10),TBF12A(10),NT12B,TB12B(10)             |
| ,TBF12B(10),NT13,TB13(10),TBF13(10)                               |
| 7                                                                 |

CONF 12 REAL LOJ,K

376612 IF (AREALJ.LE.6.0) GO TO 50

000013  
CALL CANTAB(CD8T,EMF)

510015 OCT 01 09

CONTINUED 12002

12700  
000021

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000000  
000000  
000000

ON 12-9-87 I.  
J8QMF=1-(080J/040J)\*\*2

92 JFF  
G=IADU1(ENF,I01,I3F1,N11)  
3-17-68

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CONTINUE - 103

CGG:4C IF (J40J,LE, 1.1)50 TO 300

06M143 JNDJ2=045J9DMDJ

[illegible]

655645 ----- IF (PIPF .GT. 1.) GO TO 200

|   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|

P8PF=TA3U1(K,T83,T8F3,NT3)

C) ds = -2 • (PAPF-1) • DHDJZ / (GAM • ENF • ENF • DMDJZ)

29309 60 10 333

660-76 243 CONTINUE

$$ZMJ = \sqrt{GM1} * (PTPF ** (GM1/GAM) - 1.1))$$
5120062135  
 $\langle = (EMF \cdot J_{3UJ+EMJ}) / \sqrt{RT(080J2-1.1)}$ 

PTPJ=(1.0,5.0GHZ,MJD)\*((GANGCHI)

[illegible]

3-1037-247-182, 181, 180, 179, 178, 177, 176, 175, 174, 173, 172, 171, 170, 169, 168, 167, 166, 165, 164, 163, 162, 161, 160, 159, 158, 157, 156, 155, 154, 153, 152, 151, 150, 149, 148, 147, 146, 145, 144, 143, 142, 141, 140, 139, 138, 137, 136, 135, 134, 133, 132, 131, 130, 129, 128, 127, 126, 125, 124, 123, 122, 121, 120, 119, 118, 117, 116, 115, 114, 113, 112, 111, 110, 109, 108, 107, 106, 105, 104, 103, 102, 101, 100, 99, 98, 97, 96, 95, 94, 93, 92, 91, 90, 89, 88, 87, 86, 85, 84, 83, 82, 81, 80, 79, 78, 77, 76, 75, 74, 73, 72, 71, 70, 69, 68, 67, 66, 65, 64, 63, 62, 61, 60, 59, 58, 57, 56, 55, 54, 53, 52, 51, 50, 49, 48, 47, 46, 45, 44, 43, 42, 41, 40, 39, 38, 37, 36, 35, 34, 33, 32, 31, 30, 29, 28, 27, 26, 25, 24, 23, 22, 21, 20, 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, 0

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000611

$\rho_{\text{PF}} = \rho_{\text{W}} \bar{K} \cdot B / (E M F \cdot \exp(-1.15 \cdot A \log(K)))$   
 $\rho_{\text{PF}} = 1.2901(K + 103.1873, N13)$

[illegible]

112611 363 CONTINUED

SPHC+LHFC=C7  
CONTINUED  
112629

66-213  
RETURN

417633  
CT3-66  
END

SUBPROGRAM LENGTH-  
00200

## FUNCTION ASSIGNMENTS

## STATEMENT ASSIGNMENTS

|    |          |     |          |     |          |     |          |
|----|----------|-----|----------|-----|----------|-----|----------|
| 50 | - 000021 | 100 | - 000040 | 200 | - 000070 | 300 | - 000211 |
|----|----------|-----|----------|-----|----------|-----|----------|

## EXTERNALS AND TAGS

| CASTAB | EXP    | TAJJI  | ALOG   | SRF | END. | RBAREX. | SR0400 |
|--------|--------|--------|--------|-----|------|---------|--------|
| -      | -      | -      | -      | -   | -    | -       | -      |
| SC0100 | SC0300 | SC0200 | SC0600 | SRF | END. | RBAREX. | SR0400 |

# BLOCK NAMES AND LENGTHS

A - 00004 AREA 10 - 00002 JRGTB - 000676

## VARIABLE ASSIGNMENTS

[illegible]

## START OF CONSTANTS

51215

## CONTACT OF TEMPORARIES

17227

## START OF INDIRECTS

22-243

SPACE REQUIRED TO COMPLETE

36

SUBJECT: SUBROUTINE DRAGAB

PURPOSE: SUBROUTINE DRABAG monitors the afterbody drag calculation.

METHOD: The input array is transferred to the afterbody COMMON block ABINP. A check is made on Mach number. If Mach is equal to zero drag is set equal to zero and no further afterbody calculations performed. If Mach is greater than zero, boattail drag, nozzle interference, and base drag routines are called to compute the various drags. The total airplane drag is returned for nozzle interference and base drag so these are converted to one engine values. The output array is loaded with the various  $C_D$ 's based upon area AMAX (drag may have been computed using a different area).

USAGE: CALL DRAGAB (ABIN, ABOUT)

ABIN (40) - Input array

ABOUT (10) - Output array

The input array is defined as follows:

ABIN

- |    |              |                                                      |
|----|--------------|------------------------------------------------------|
| 1  | AE8          | Primary nozzle effective area - $\text{in}^2$        |
| 2  | A8           | Primary nozzle geometric thrust area - $\text{in}^2$ |
| 3  | AE18         | Fan nozzle effective area - $\text{in}^2$            |
| 4  | A18          | Fan nozzle geometric thrust area - $\text{in}^2$     |
| 5  | $P_8/P_0$    | Primary nozzle pressure ratio                        |
| 6  | $P_{18}/P_0$ | Fan nozzle pressure ratio                            |
| 7  | FGIP         | Primary nozzle ideal thrust (actual mass flow) lb    |
| 8  | FGIF         | Fan nozzle ideal thrust (actual mass flow) lb        |
| 9  | PC           | Power setting                                        |
| 10 | GAMMAP       | Primary flow specific heat ratio                     |

ABIN (continued)

|       |        |                                          |
|-------|--------|------------------------------------------|
| 11    | GAMMAF | Fan flow specific heat ratio             |
| 12    | XM     | Free-stream Mach number                  |
| 13    | PAMB   | Ambient static pressure psia             |
| 14    | Q      | Free-stream dynamic pressure psia        |
| 15    | A9     | Primary nozzle exit area in <sup>2</sup> |
| 16    | A19    | Fan nozzle exit area in <sup>2</sup>     |
| 17    | CFG    | Nozzle internal performance coefficient  |
| 18    | DHEP   |                                          |
| 19    | DHEF   |                                          |
| 20    | PLUG   | Nozzle type designation                  |
| 21    | FLWMIX | Mixed flow flag                          |
| 22    | DMAX   | Maximum diameter, in.                    |
| 23    | THICKB | Total thickness of annular base, in.     |
| 24    | ZLPLUG | Overall plug length, in.                 |
| 25    | ZLBAL  | Nozzle boattail length, in.              |
| 26    | S      | Nozzle centerline spacing, in.           |
| 27    | ABASE  | Base flow area, in <sup>2</sup> .        |
| 28    | BTTAB  | Boattail table flag                      |
| 29    | THETA  |                                          |
| 30    | XDNI   | Number of nozzle interference spacings   |
| 32-40 |        | Not defined                              |

SUBPROGRAMS:

DBASER

DBOATR

DINTFR

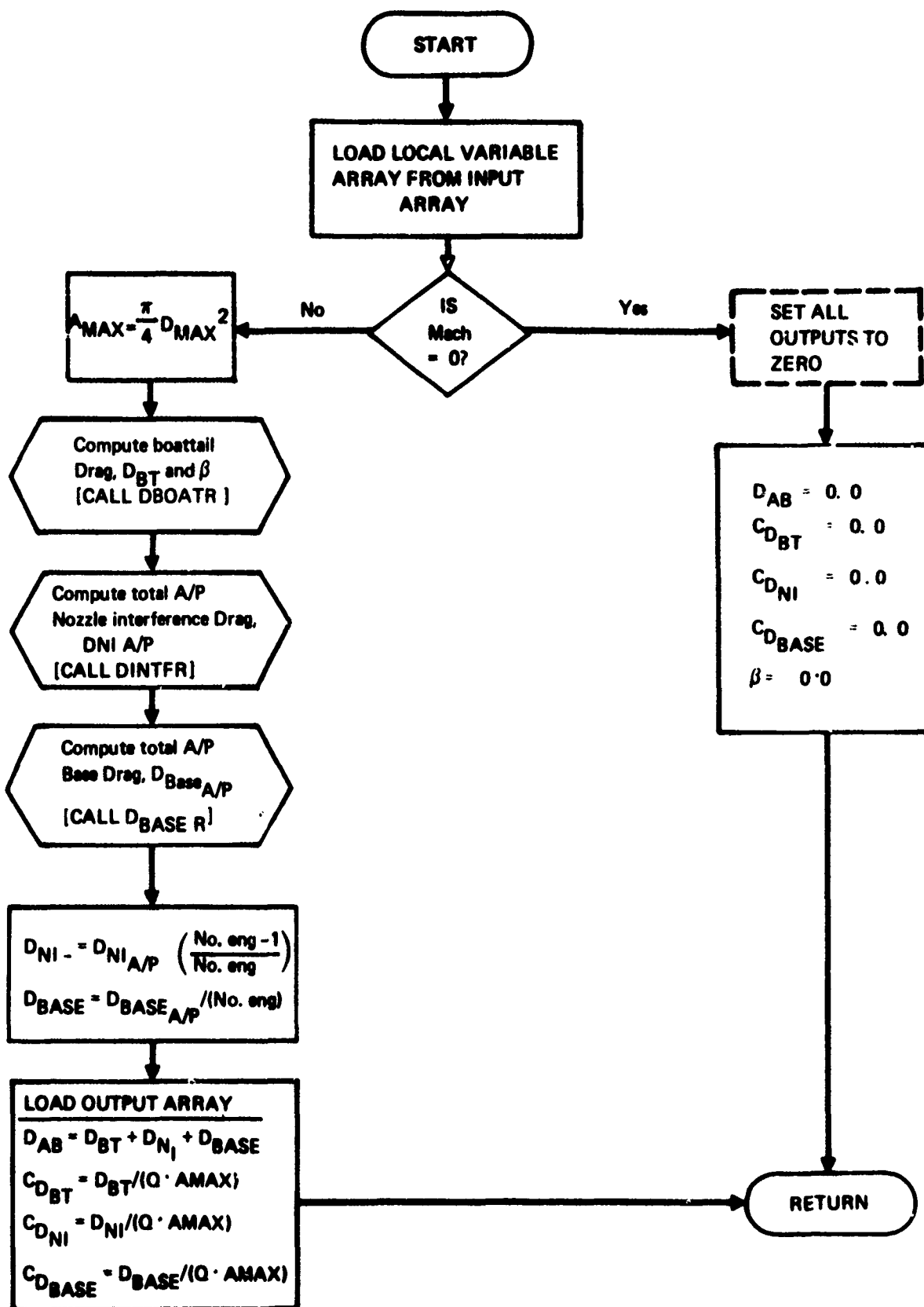


Figure 13: FLOW CHART FOR SUBROUTINE DRAGAB

```

000035 SUBROUTINE DRAGA8(ABIN,ABOUT)
000035 DIMENSION ABIN(40),ABOUT(10)
000035 COMMON/ABINP/ABINP(40),NVAR
000035 COMMON/ADRAG/ DBTAIL, JMI, DBASE
000035 COMMON/AAA(3),BETA0
000035 COMMON/AMAX/AMAX
000035 EQUIVALENCE (ABINP(12),XM), (ABINP(14),Q), (ABINP(30),XONI),
000035 A (ABINP(31),XDBASE), (ABINP(72),OMAX)
000035 DATA NVAR/31/
000035 DATA PI8Y4/.7854/
000035 C RETRIEVE IMPJTS FROM ENGINE PROGRAM
C
C AE8 = ABIN(1)
C
C AE6 = ABIN(2)
C
C AE18 = ABIN(3)
C
C A16 = ABIN(4)
C
C P7Q = ABIN(5)
C
C P7Q3 = ABIN(6)
C
C FGIP = ABIN(7)
C
C FGI = ABIN(8)
C
C PC = ABIN(9)
C
C SAMAP = ABIN(10)
C
C SAMAF = ABIN(11)
C
C XM = ABIN(12)
C
C PAM8 = ABIN(13)
C
C A = ABIN(14)
C
C A9 = ABIN(15)
C
C A19 = ABIN(16)
C
C CFC = ABIN(17)
C
C JMEP = ABIN(18)
C
C JMEF = ABIN(19)
C
C PLUS = ABIN(20)
C
C FLWMA = ABIN(21)
C
C JMA = ABIN(22)
C
C JMA8 = ABIN(23)
C
C ZPLJ5 = ABIN(24)
C
C ZLBTAL = ABIN(25)
C
C S = ABIN(26)
C
C ADASE = ABIN(27)
C
C BTAB = ABIN(28)
C
C DO 10 I=1,NVAR
000035 ABIN(I)=ABIN(I)
000035 10 CONTINUE
000035 IF (AMAX.EQ.0) GO TO 15
000035 15 AMAX=PI8Y4*JMA**2
000035 16 AMAX=1.0/(J*AMAX)
000035 C CALL SUBPROGRAMS TO COMPUTE VARIOUS DRAGS
000035 CALL DBTAIL
000035 CALL JMI*F
000035 CALL DBASE
000035 CALL USC4R
000035 GO TO 20
000035 20 DO 10 J=1,5

```

NOZZLE TYPE DESIGNATION  
ENGINE TYPE DESIGNATION

BOATTAIL TABLE INDICATOR

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000030 18 ABOUT(J)=0.0

000033 RETURN

C STORE OUTPUT TO ENGINE PROGRAM

-20 CONTINUE

000034 ONI=ONI\*ONI

000036 JBASE=JBASE\*XBASE

000037 ABOUT(1)=JB\*TAIL\*ONI\*XBASE

000042 ABOUT(2)=JB\*TAIL\*QAMAX

000043 ABOUT(3)=JBASE\*QAYAX

000044 ABOUT(4)=ONI\*QAMAX

000045 ABOUT(5)=BETAO

000047 RETURN

000047 END

SUBPROGRAM LENGTH  
000056

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS  
15 - 000026 16 - 000030 20 - 000034

EXTERNALS AND TAGS  
DBDATA - 000100 DDATA - 000200 DBASER - 000300 END. - 000400

BLOCK NAMES AND LENGTHS  
ABIMP - 000051 ABIRAC - 000063 A - 000004 AMAX - 000001

VARIABLE ASSIGNMENTS  
AXI - 00000003 ABIMP - 00000001 AMAX - 00000004 BETAD - 00000303  
OBASE - 00000002 DBTAIL - 00000002 DMAX - 00002501 DMI - 00000102  
I - 000053 J - 000055 MVAR - 00005001 PI0Y4 - 000052  
C - 00001501 QAYAK - 000054 YDBASE - 00003501 XONI - 00003501  
XM - 00001301

START OF CONSTANTS  
000050

START OF TEMPORARIES  
000051

START OF INDIRECTS  
000052

SPACE REQUIRED TO COMPLETE  
035400

SUBJECT: SUBROUTINE DBØATR

PURPOSE: SUBROUTINE DBØATR monitors the calculation of  
boattail drag.

METHOD: The input flags PLUG, FLWMIX, and BTTAB are  
interrogated to determine which boattail  
method is desired and the appropriate routine  
selected.

USAGE: CAL DBØATR

Input through COMMON/ABIN/

SUBPROGRAMS: CDCØNV DBTTB PLUGMIX PLUGNM

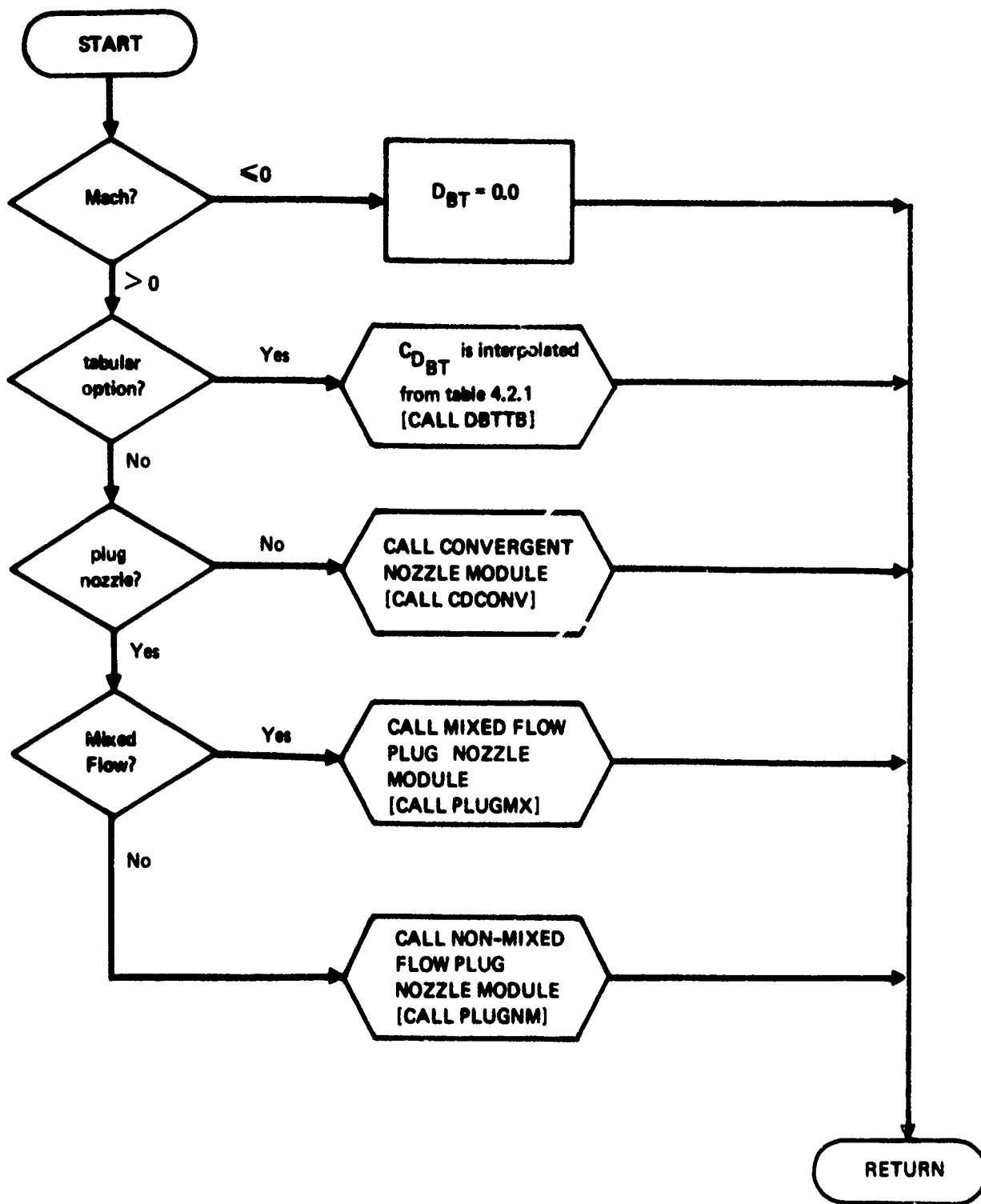


Figure 14: FLOW CHART FOR SUBROUTINE DBOATR

SUBROUTINE DBOATR

A COMMON/ABINP/ AE6, A6, AE16, A16, P700, P1700, FGIF, PG,  
B GAMMAP, GAMMAP, XM, PAMB, Q, A9, A19, CFG, DMFP,  
C UMEF, PLUG, FLWIX, DMAX, THICKB, ZLPLUG, ZLBTAL,  
D S, ABASE, BTIA3, THETA  
FUTURE(11), NVAR

C COMMON/ABDRAG/ DBTAIL, DNI, DBASE  
SELECT PROPER OPTION

DBTAIL=0.0

IF (AM52.0.0) RETURN

IF (BTIA3.EQ.1.0) GO TO 300

IF (PLUS.EQ.0.0) GO TO 200

IF (FLWIX.EQ.1.0) GO TO 100

C NON-MIXED ENGINE FLOW - PLUG NOZZLE

CALL PLJNM

GO TO 400

C MIXED ENGINE FLOW - PLUG NOZZLE

100 CALL PLJMAX

GO TO 400

C C-0 OR CONVERGENT NOZZLE

200 CALL COCONV

GO TO 400

C TABULAR INPJT

300 CALL DBIT3

400 RETURN

END

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SUBPROGRAM LENGTH  
C0J024

## FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS  
100 - 000014 200 - 000016 300 - 000020 400 - 000021EXTERNALS AND TAGS  
PLJGM - SC0100 PLJSHX - SJ0200 C0CJNV - SC0300 081TB - SC0400  
END. - SC0500BLOCK NAMES AND LENGTHS  
ABINP - 000051 ABDRAG - 000003VARIABLE ASSIGNMENTS  
BITAB - 000033C01 OUTAIL - 000000C02 FLW4IX - C00024C01 FUTURE - C00035C01  
PLJ6 - 000023C01 XM - 000013C01START OF CONSTANTS  
000023START OF TEMPORARIES  
C0J024START OF INDIRECTS  
C0J024SPACE REQUIRED TO COMPLETE  
0320JC

SUBJECT: SUBROUTINE CABTAB

PURPOSE: SUBROUTINE CABTAB computes afterbody drag as a function of  $A_9/A_{10}$ ,  $P_9/P_{AMB}$ , and Mach.

METHOD: The drag coefficient is input in tabular form in input Table 4.2.4. Mach and  $A_9/A_{10}$  are known; the suprogram computes  $P_9/P_{AMB}$  after interpolating  $Mach_9 = f(A_9/A_{10})$  from a table generated by the program. The table generated in the input routine ABINP is developed as follows:

For  $Mach_9 = 2.8, 2.6, 2.4 \dots, 1.0$  compute

$$A_9/A_{10} = \left(\frac{\gamma+1}{2}\right)^{\frac{\gamma+1}{2(\gamma-1)}} Mach_9 \left(1 + \frac{\gamma-1}{2} Mach_9^2\right)^{\frac{-\gamma+1}{2(\gamma-1)}}$$

The resulting array of  $A_9/A_{10}$  is strictly increasing; hence serves as an independent variable array with  $Mach_9$  as the dependent array. The subroutine also checks  $P_9/P_0$  against 1 lower bound value of  $P_9/P_{0_{LB}} = 1/(\frac{\gamma+1}{2})^{\frac{\gamma+1}{2(\gamma-1)}}$

The  $C_{D_{AB}}$  obtained from Table 4.2.4 is based on an area  $A_{10}$  whereas the program uses  $A_{MAX}$  (most of the time these two inputs will have the same value), consequently the  $C_D$  is ratioed by  $A_{10}/A_{MAX}$  before returning to the calling program.

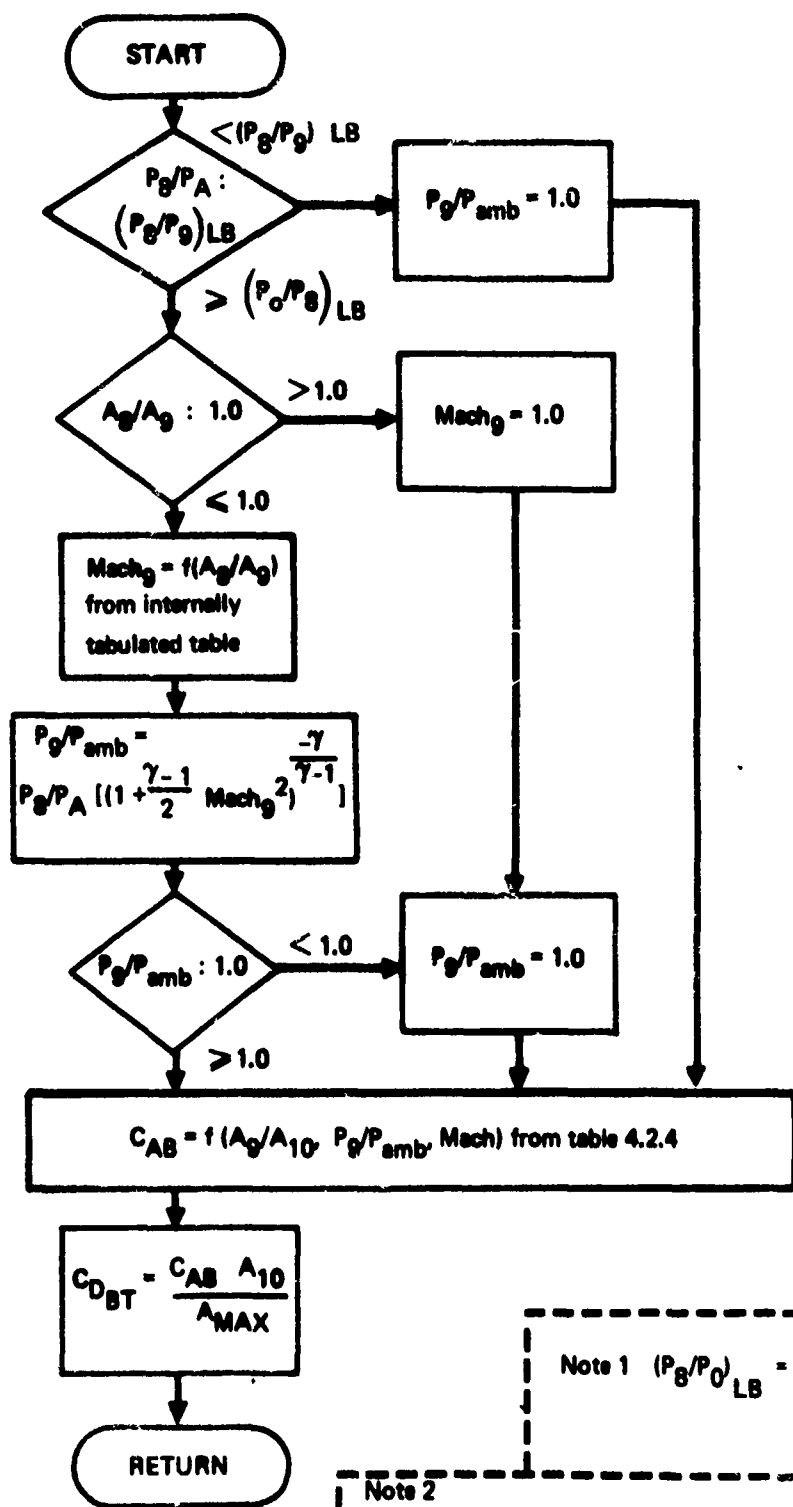
USAGE: CALL CABTAB (CAB, AM)

Output CAB - Afterbody drag coefficient

AM Free-stream Mach number

Input from COMMON/ABINP/, /AMAX/, /AREA10/, /P8PAL/, /XMACH9/, and /ABTAB6/

SUBPRGRAMS: TABU1 TABU3



Note 1  $(P_8/P_0)_{LB} = \frac{1}{\left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}}}$

Note 2

Internal table. For  $Mach_9 = 2.8, 2.6, 2.4, \dots, 1.0$

$$A_8/A_9 = \left(\frac{\gamma+1}{2}\right)^{\frac{\gamma}{2(\gamma-1)}} Mach_9 \left(1 + \frac{\gamma-1}{2} Mach_9^2\right)^{\frac{-\gamma+1}{2(\gamma-1)}}$$

$A_8/A_9$  array will be strictly increasing

Figure 15: FLOW CHART FOR SUBROUTINE CABTAB

```

SUBROUTINE C08TAM(CAB,AM)
COMMON /RACH9/XMACH9(10),A0A9T(10)
COMMON /AREA10/AREA10,BVA10
COMMON /AMAX/AMAX
COMMON /ABIM/ AE6, A0, AE10, A10, P7Q0, P7Q0, FCIF, FCIF, PC,
      GAMMAP, GAMMAP, AM, PANG, Q, A9, A10, CFG, JHEP,
      OMEF, PLUG, FLAMEX, DMAX, THICK8, ZLPLUG, ZLBIAL,
      S, ABASE, BITA3, THETA
      FUTURE(11), NVAR
COMMON /P0PAL/P0PAL
COMMON /R0TA06/A06A(10),AB6Y(10),AB6Z(10),AB6T(10),NTX6,NTY6,
      A NT6
      CULVALENCE(P7Q0,P0PA)
      IF (P0PA-P0PAL) 25,50,50
      25 P0PA=1.0
      GO TO 100
      50 A0A9=A0A9
      IF (A0A9-1.0) 70,60,60
      60 AM9=1.0
      GO TO 70
      70 AM9=TAGJ1(A0A9,A0A9T,XMACH9,10)
      75 P0PA=P0PA*(1.0+0.5*(GAMMAP-1.0)*AM9+2)*(-GAMMAP/(GAMMAP-1.0))
      IF (P0PA<1.0) P0PA=1.0
      100 CAB=TAGJ3(A0A9*9TA10,P0PA,AM,A06X,A06Y,A06Z,A06T,NTX6,NTY6,
      A 10,10,10)
      CAB=CAB*AREA10/AMAX
      RETURN
      END

```

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\*FOLLOWING VARIABLES ARE EQUIVALENCED BUT NOT REFERENCED  
P7Q0

SUBPROGRAM LENGTH  
C00132

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

25 - 000007 50 - 000011 60 - 000015 70 - 000017  
75 - 000023 100 - 000043

EXTERNALS AND TAGS

TABU1 - S00100 RBAEX.- S00200 TABU3 - S00300 END. - S00400

BLOCK NAMES AND LENGTHS

XMACM9 - 000024 AREA10 - 000002 ANAX - 000001 ABINP - 000051  
PAPAL - 000001 AWTAB6 - 000011

VARIABLE ASSIGNMENTS

ABST - 00000006 AB6X - 00000000 AB6Y - 000012C06 AB6Z - 000024C06  
AMAX - 00000003 AM9 - 000001 AREA10 - 000000C02 A6 - 000001C04  
ABA3 - 000003 ABA9T - 000012C01 A3 - 000015C04 BYA10 - 000001C02  
FUTURE - 000035C04 GAMHAP - 000011C04 NTX6 - 000006C06 NTY6 - 000007C06  
NTZ6 - 000010C06 PAPA - 000000C04 PAPAL - 000000C05 PAPA - 000077  
XMACM9 - 000000C01

STATE OF CONSTANTS

C00070

STATE OF TEMPORARIES

C00073

STATE OF INDIRECTS

C00077

SPACE REQUIRED TO COMPLETE

635536

**SUBJECT:** SUBROUTINE DINTFR

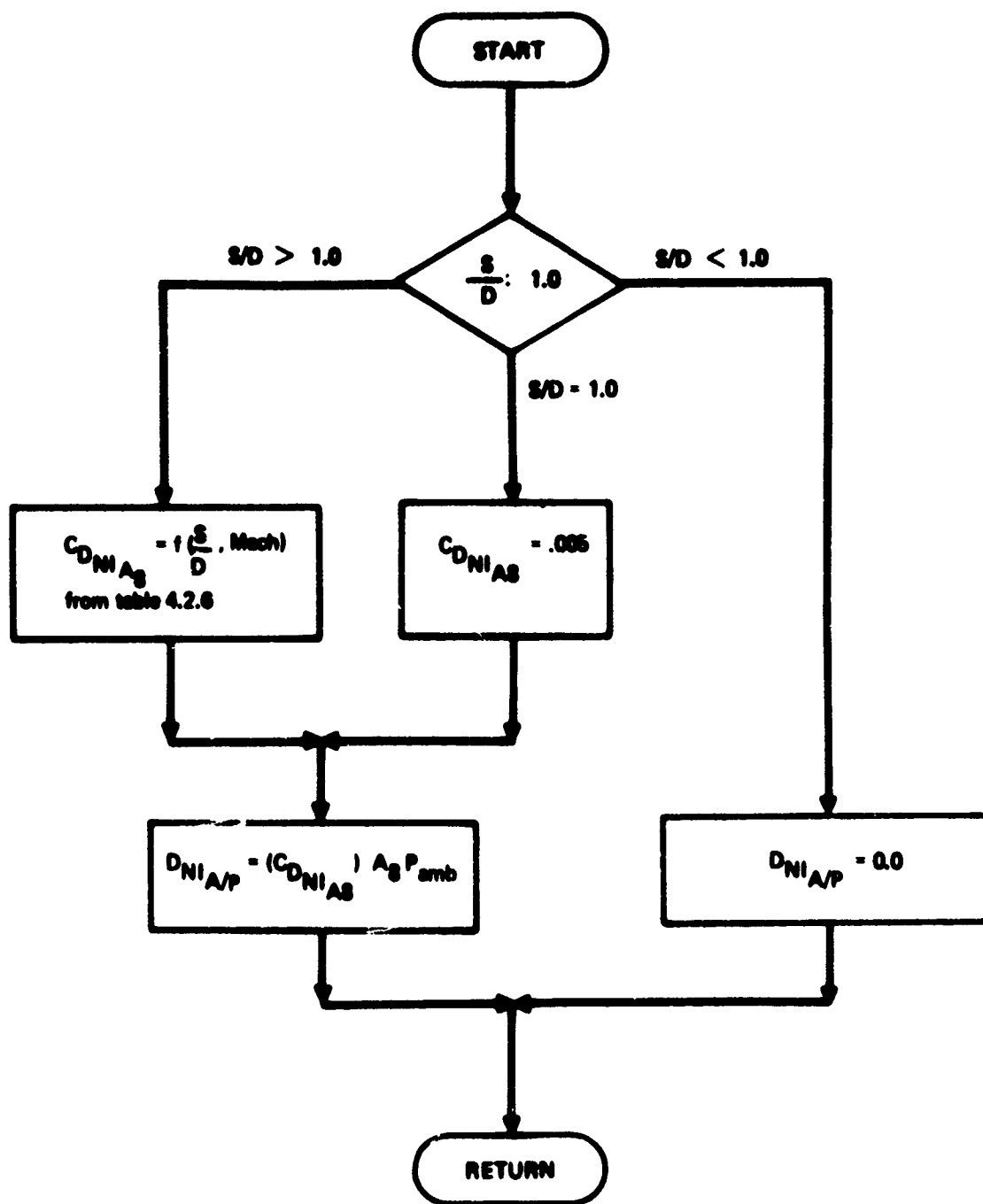
**PURPOSE:** SUBROUTINE DINTFR computes nozzle interference drag.

**METHOD:** The ratio  $S/D$  is interrogated to determine if it is greater than 1.0. If so,  $C_D$  is interpolated from Table 4.2.6 and total interference drag computed.

**USAGE:** CAL DINTFR

Input through ~~CDSIN~~/ABIN/ except  $D$  which is input in ~~CDSIN~~/DSPACG1.  $D$  is an output from the boattail routines except when  $C_{D_{BT}}$  is interpolated from Table 4.2.1. In this latter case  $D \equiv 1.0$ , then nozzle interference drag can be input only as a function of Mach and some constant  $S/D$  ratio where the ratio is input instead of the nozzle centerline spacing for variable  $S$ .

**SUBPROGRAMS:** TABU2



Note: D computed by boattail drag routine

Figure 16: FLOW CHART FOR SUBROUTINE DINTFR

RUN VERSION JUL 71 22.66.44. 72/38/23.

```

000032      SUBROUTINE JINTFR
000032      COMMON/ABDRAG/ DBTAIL, DMI, DBASE
000032      COMMON/ABTAB5/ABTAB5(10),ABTAB5(10),ABTAB5(10),MTXS,MTYS
000032      COMMON/ABIMP/ AE0, AG, AE10, A10, P7Q0, P17Q0, FGIF, PG,
      A      GAMAP, GAMMAF, XM, PAMB, J, A9, A19, CFG, OMEP,
      B      OMEF, PLUG, FLMMIX, OMAX, JHASE, ZLPLUG, ZLBTAL,
      C      S, AWASE, BTAB, T4ETA
      D,      FUTURE(11), NVAR
000032      COMMON/SPACE/DSPACE
000032      DATA DSPACE/1.0/
000032      SRATIO=S/DSPACE
000032      100 IF (SRATIO-1.0) 110,120,130
000032      110 UN1=0.0
000032      120 TO 150
000032      120 CUI=.005
000032      130 TO 140
000032      130 COI=IABJ2(SRATIO,XM,ABTAB5,ABTAB5,MTXS,MTYS,10,10)
000032      140 DMI=4.3*COI*AG*PAMB
000032      150 RETURN
000032      END

```

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SUBPROGRAM LENGTH  
00041

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS  
100 - 000004 110 - 000307 120 - 000011 130 - 000013  
140 - 000025 150 - 000031

EXTERNALS AND TABS  
TABU2 - SCG100 END. - 'SCG200

BLOCK NAMES AND LENGTHS  
ABDRAG - 000003 ABTAB5 - 000172 ABINP - 000051 DSPACE - 000001

VARIABLE ASSIGNMENTS  
ABTX5 - 000000002 ABTX5 - 000024002 AB - 000001003  
COI - 000040 UNI - 000000001 DSPACE - 000000004 FUTURE - 000035003  
NTX5 - 000170002 NTX5 - 000171002 PAM3 - 000014003 S - 000031003  
SRATIO - 000037 XM - 000013003

START OF CONSTANTS  
000033

START OF TEMPORARIES  
000037

START OF INDIRECTS  
000037

SPACE REQUIRED TO COMPILE  
035330

**SUBJECT:** SUBROUTINE DBASER

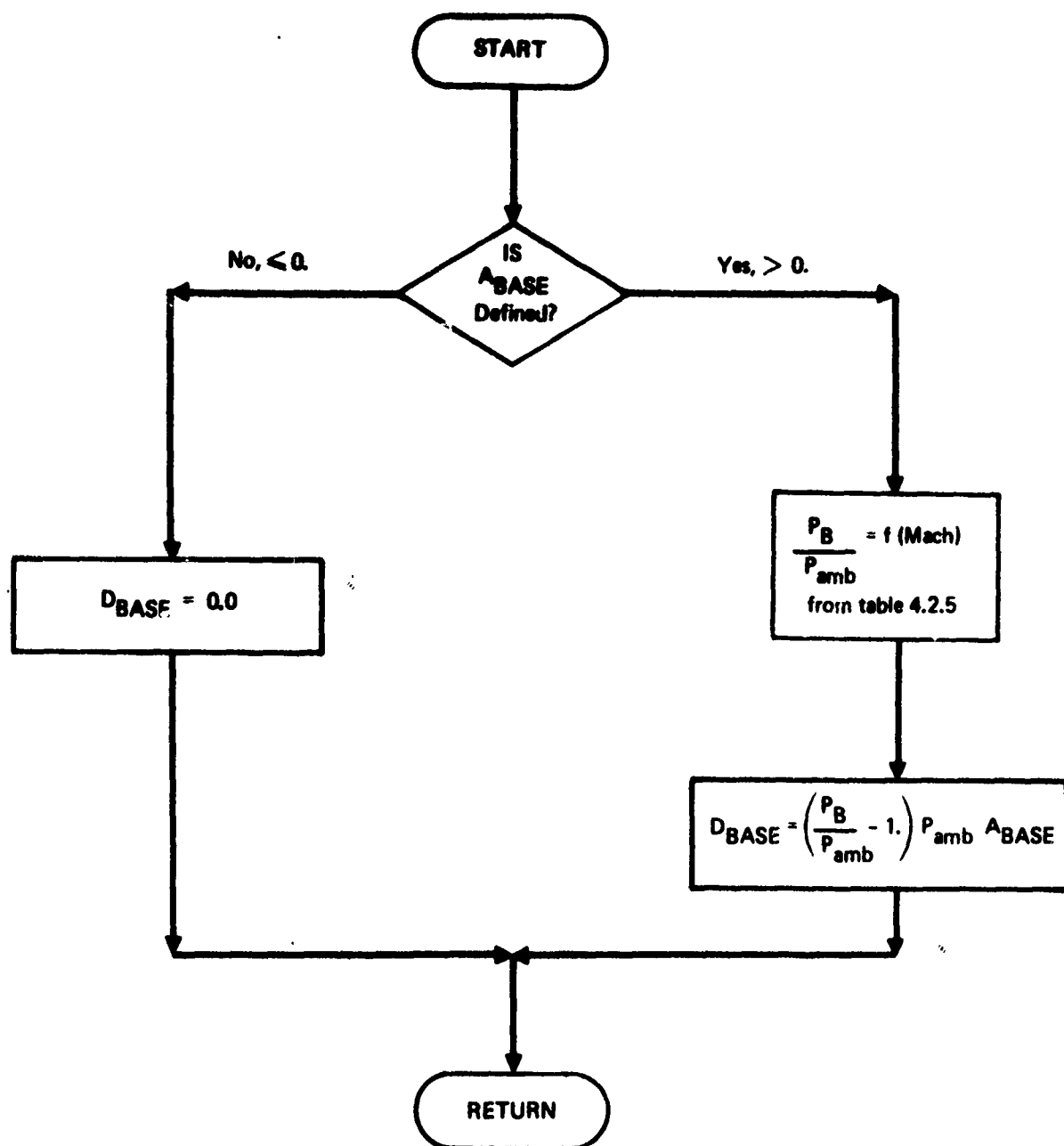
**PURPOSE:** SUBROUTINE DBASER computes total airplane base drag.

**METHOD:** If a base area is input the base pressure ratio is interpolated from Table 4.2.5 and drag computed.

**USAGE:** CALL DBASER

Input form COMMON/ABIN/

**SUBPROGRAMS:** TABU1



Note:  $A_{BASE}$  is input in field 8 of card 4.1.1

Figure 17: FLOW CHART FOR SUBROUTINE DBASER

RUN VERSION JUL 71 22.46.44. 72/08/23.

## SUBROUTINE DBASER

```

000002 COMMON/ABTAB4/ABT4X(10),ABT4Y(10),NT4
000002 COMMON/ABIMP/ AE8, AB, AE19, A18, P7Q0, P17Q0, FGIP, FGIF, PG,
      A GAMMA, GAMMAF, XM, PAMB, Q, A9, A19, CFG, DMEP,
      B DMF, PLUG, FLNIX, DMX, THICK8, ZLPLUG, ZLBTAL,
      C S, ABASE, BTAG, THETA
      U, FUTJRE(11), NVAR
      COMMON/ABORAG/ ORTAIL, ONI, JBASE
000002 IF (ABASE) 10,10,20
000004 10 JBASE=0.3
000005 20 JBASE=0.3
000006 30 JBASE=0.3
000006 20 P2QPM=FA2U1(XM,ABT4X,ABT4Y, NT4)
000006 JBASE=(P2QPM-1.3)*PAMB*ABASE
000006 30 RETURN
000006 END

```

SUBPROGRAM LENGTH  
000021

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS  
10 - 000004 20 - 000006 30 - 000015

EXTERNALS AND TAGS  
TAGU1 - 500100 END. - 500200

BLOCK NAMES AND LENGTHS  
ABTAJ4 - 000025 ABTAP - 000051 ABORAG - 000003

VARIABLE ASSIGNMENTS

ABASE - 000032C02 ABT+X - 000000C01 ABT+Y - 000012C01 OBASE - 000002C03  
FUTURE - 000032C02 MT+ - 000024C01 PAMB - 000014C02 PBOPIAM - 000020  
XM - 000013C02

START OF CONSTANTS  
000017

START OF TEMPORARIES  
000020

START OF INDIRECTS  
000020

SPACE REQUIRED TO COMPILE  
030300

RUN VERSION JUL 71 22.46.44. 72/38/23.

```

SUBROUTINE OBT0
COMMON/AMAX/AMAX
000032 COMMON/ABINP/ AE8, A8, AE18, A18, P7Q0, P17Q0, FGIP, FGIF, PC,
000032 GAMMAF, GAMMAF, XM, PAMB, 2, A9, A19, CFG, DMEP,
A DMEF, PLUG, FLWIX, DMAX, THICK8, ZLPLUG, ZLBTAL,
B S, ABASE, BITA3, TETA
C FUTURE(11), NVAR
D,
000032 COMMON/ABURAG/ OBTAIL, ONI, DBASE
000032 COMMON/ABTAB1/ABTX1(10), ABTY1(10), ABTZ1(10), NTX1, NTY1
000032 COBETA=TABU2(XM,PC,ABTX1,ABTY1,ABTZ1, NTX1,NTY1,10,10)
000014 OBTAIL=COBETA*Q*AMAX
000016 RETURN
000017 END

```



**SUBJECT:** SUBROUTINE FIXDIM

**PURPOSE:** SUBROUTINE FIXDIM determines the dimensions of the nozzle throat and nozzle exit inputs.

**METHOD:** The input flag is interrogated and three flags are returned indicating input type and dimension.

**USAGE:** CALL FIXDIM (FLAG, J, K, L)

FLAG - Input code value

J = 0 area input, = 1 diameter input

K = 0 inches, = 1 feet

L = 0 ignore, = 1 ( $A_9/A_8$ ) input.

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## SUBROUTINE FIXOIM(FLAG,J,K,L)

IFLAG=IFIX(FLAG)

GO TO (1,2,3,4,5), IFLAG

1 J=0

K=0

L=0

RETURN

2 J=0

K=1

L=0

RETURN

3 J=1

K=0

L=0

RETURN

4 J=1

K=1

L=0

RETURN

5 L=1

K=0

J=0

RETURN

END

SUBPROGRAM LENGTH  
000041

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS  
1 - 000020 2 - 000022 3 - 000025 4 - 000030  
5 - 000033

EXTERNALS AND TAGS  
ACCRER. - SC0103 END. - S00200

BLOCK NAMES AND LENGTHS

VARIABLE ASSIGNMENTS  
IFLAG - 000040

START OF CONSTANTS  
000036

START OF TEMPORARIES  
000036

START OF INDIRECTS  
000046

SPACE REQUIRED TO COMPLETE  
035230

**SUBJECT:** SUBROUTINE ATMØS

**PURPOSE:** SUBROUTINE ATMØS computes ambient pressure and temperature using empirical equations for the 1962 U. S. Standard Atmosphere.

**METHØD:** Altitude is tested to determine which region it is in, then the appropriate equations are applied. If altitude exceeds 100,000, an error is assumed and altitude will be divided by ten until it is within the required range.

**USAGE:** CALL ATMØS (ALT, TAMB, PAMB)

ALT - pressure altitude

TAMB - ambient temperature

PAMB - ambient pressure

**SUBPRØGRAMS:** EXP WARNING

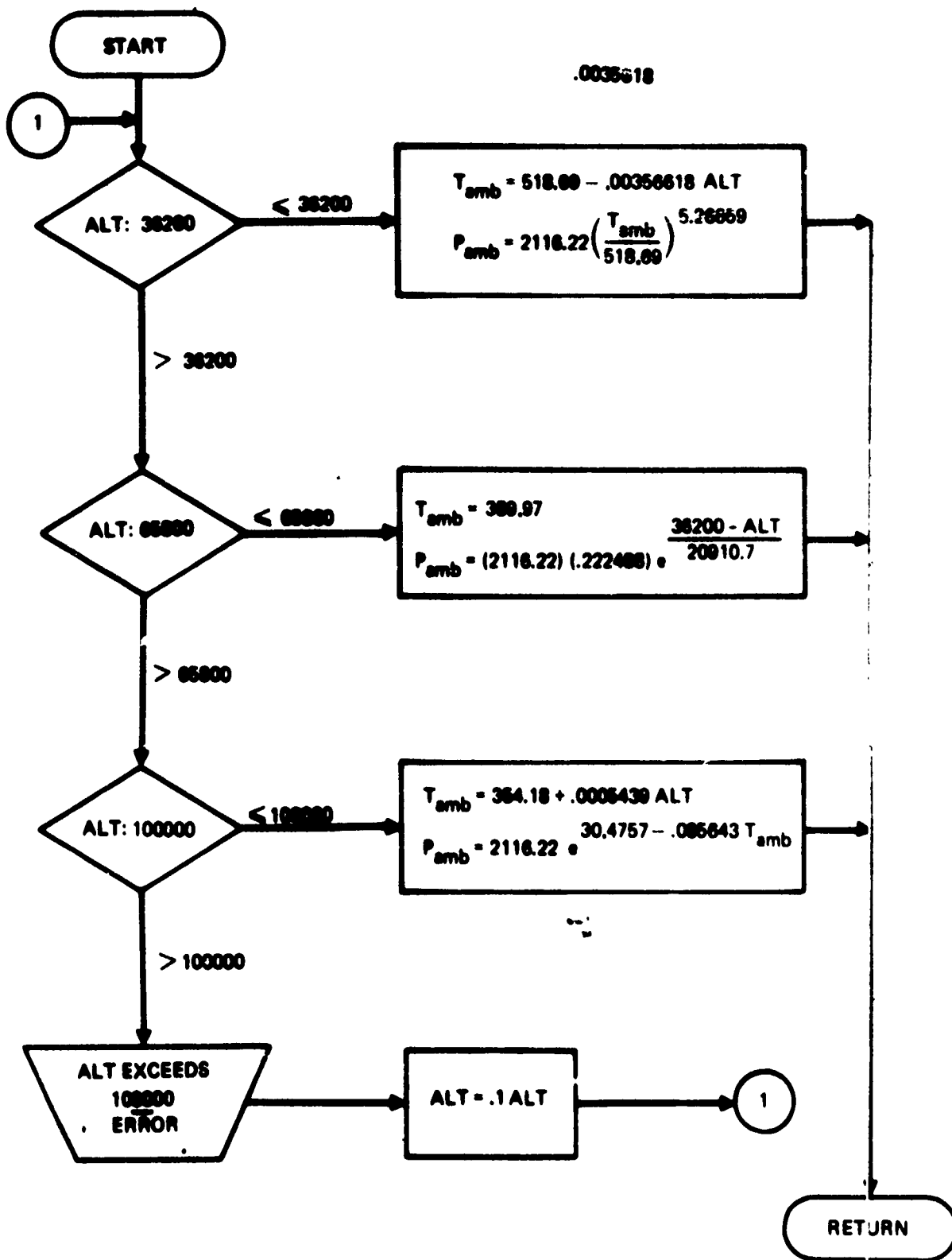


Figure 18: FLOW CHART FOR SUBROUTINE ATMOS

NOV VERSION JUL 71 22.46.30 72/08/23.

SUBROUTINE ATMOS(ALT,TAMB,PA10)

5 IF (ALT.GT.36200.) GO TO 10  
TAMB=519.09-.00356618\*ALT  
PA10=2115.22\*(TAMB/518.63)\*\*5.26659  
GO TO 40

10 IF (ALT.GT.65800.) GO TO 20  
TAMB=389.37  
PA10=2115.22\*.222468\*EXP((36200.-ALT)/20913.7)  
GO TO 40

20 IF (ALT.GT.100000.) GO TO 30  
TAMB=354.19+.0305439\*ALT  
PA10=2115.22\*EXP(30.4757-.063643\*TAMB)  
GO TO 40

30 CALL WARNIN  
ALT=ALT\*.31  
700 FORMAT(IX,  
1E,NOIIFIED TO\*F9.3)

\*ALTITUDE INPUT EXCEEDS 100000 FT. ALTITUDECOMPU290  
COMPU300  
COMPU310

50 TOS  
40 RETURN  
END

COMPU150  
COMPU160  
COMPU170  
COMPU180  
COMPU190  
COMPU200  
COMPU210  
COMPU220  
COMPU230  
COMPU240  
COMPU250  
COMPU260

RUN VERSION JUL 71 22.46.30. 72/08/23.

SUBPROGRAM LENGTH  
000122

FUNCTION ASSIGNMENTS

| STATEMENT ASSIGNMENTS |          |     |          |                         |
|-----------------------|----------|-----|----------|-------------------------|
| 5                     | - 000000 | 10  | - 000021 | 20 - 000035 30 - 000053 |
| 40                    | - 000063 | 700 | - 000106 |                         |

| EXTERNALS AND TAGS |        |     |          |                               |
|--------------------|--------|-----|----------|-------------------------------|
| RRAREX.-           | S00103 | EXP | - S-0200 | WARNING- S00300 END. - S00400 |

BLOCK NAMES AND LENGTHS

VARIABLE ASSIGNMENTS

START OF CONSTANTS  
000062

START OF TEMPORARIES  
000117

START OF INDIRECTS  
000122

SPACE REQUIRED TO COMPILE  
035630

**SUBJECT:** SUBROUTINE PERF

**PURPOSE:** SUBROUTINE PERF controls the calculation of gross thrust.

**METHOD:** Mass flow, enthalpy, pressure, and relative pressure are developed for the nozzle throat. The thermodynamic properties at the throat are computed, then gross thrust computed from propulsive nozzle performance analysis.

**USAGE:** CALL PERF (WFT, WØ, PT8ØPA, TTØ, PAMB, FG, A8)

Input      WFT    -   Fuel flow lb/hr

            WØ     -   Air Flow lb/sec

            PT8ØPA-   Nozzle throat pressure ratio

            TTØ    -   Total temperature degrees R

            PAMB   -   Ambient pressure PSF

Output      FG     -   Gross thrust lbs

            A8     -   Nozzle throat (given) ft<sup>2</sup>

**SUBPROGRAMS:**      CHKRP            GTHRST            PRØFH

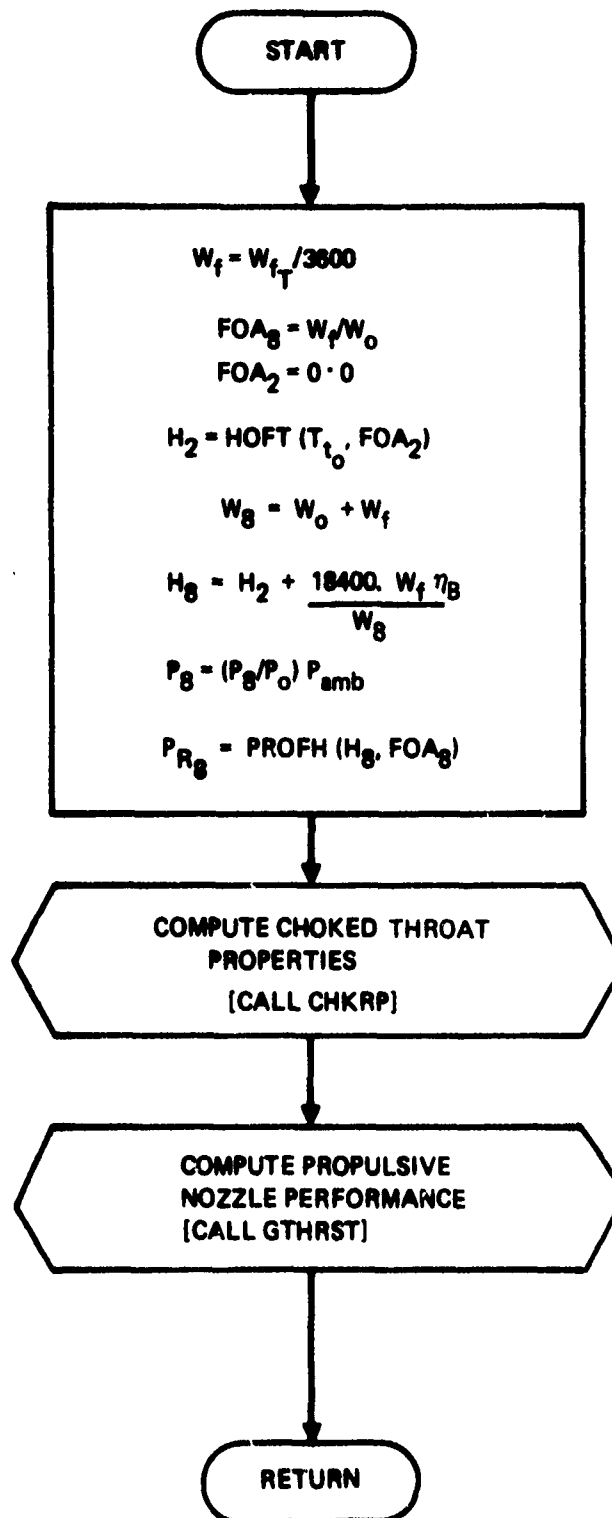


Figure 19: FLOW CHART FOR SUBROUTINE PERF

SUBROUTINE PERF(MFI,H0,PT00PA,TT0,PAMB,FG,A0)

DATA XNB / 995 /

DATA XNOZZ / 1.0 /

DATA FOM2 / 0.0 /

DATA ENWF / 18433. /

DATA CC / 1.0 /

DATA CV / 1.0 /

MF = MF / 3633.

FOA8 = MF / 40

H2 = H0 / (TT0,FOA2).

M3 = M0 + MF

M8 = H2 + ENWF \* MF \* XNB / M6

P8 = PT00PA \* SAM8

PR8 = PR0 \* (M8,FOA8)

CALL CHK2P(P8,M8,PR8,FOA8,PAMB,T8S,C8S,P8S,P8OPAM,P8OP8S)

CALL G1433T(XNOZZ,PR8,P8,M8,M8,FJA8,PAMB,CJ,CD,T8S,P8S,C8S,M9,T9S,

A V9,M9,FG)

RETURN

END

\*DECK COMPUTE

000177  
000100

RUN VERSION JUL 71 22.46.30. 72/06/23.

SUBPROGRAM LENGTH  
000131

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

EXTERNALS AND TAGS  
HO-T - S00100 PROJH - S00200 CHGRP - S00300 GTHRST - S00400  
END. - S00500

BLOCK NAMES AND LENGTHS

| VARIABLE ASSIGNMENTS |          | CV    |          | CDS  |          | CDS |          |
|----------------------|----------|-------|----------|------|----------|-----|----------|
| A8                   | - C00100 | CD    | - 000110 | CV   | - 000111 | CDS | - 000122 |
| ENWF                 | - 000107 | FOA2  | - 000106 | FOA8 | - 000113 | M2  | - 000114 |
| M8                   | - 000110 | W9    | - 000126 | PR4  | - 000120 | P4  | - 000117 |
| POJPM                | - 000124 | POJPS | - 000125 | P8S  | - 000123 | T8S | - 000121 |
| T9S                  | - 000127 | V9    | - 000130 | WF   | - 000112 | W8  | - 000115 |
| XN3                  | - 000104 | XN02Z | - 000105 |      |          |     |          |

START OF CONSTANTS

C001J1

START OF TEMPORARIES

C001J2

START OF INDIRECTS

C001J4

SPACE REQUIRED TO COMPILE

C3551C

**SUBJECT:** SUBROUTINE ØUTGØ

**PURPOSE:** SUBROUTINE ØUTGØ prints a matrix of performance output.

**METHOD:** The output for NALT power settings at a Mach-altitude combination has been stored in the array ØUTP. A FØRMAT is built to print the variable name on both the left and right of the output columns. The matrix is printed and any indicated punching of MARK II data is done.

**USAGE:** CALL ØUTGØ (NALT)

NALT - Number of columns in output matrix = 10.

Input in CØMMØN

|              |                     |
|--------------|---------------------|
| ØUTP (45,10) | output matrix       |
| PCØDE        | punched output flag |
| DA, TE       | date, alphanumeric  |
| TITLE (8)    | run title           |
| MACH         | Mach number         |

Output

|       |                                    |
|-------|------------------------------------|
| IWARN | Error message indicator introduced |
|-------|------------------------------------|

**SUBPRØGRAMS:** MINØ MØD

|        |                                                                             |
|--------|-----------------------------------------------------------------------------|
| C000J3 | SUBROUTINE OUTGO(NALT)                                                      |
| C000J3 | COMMON/RESULT/OUTP(45,10),LABEL(45),NVAR                                    |
| C000J3 | COMMON/PCODE/PCODE                                                          |
| C000J3 | COMMON/DATE/OA,TE                                                           |
| C000J3 | COMMON/TITLE/TITLE(8)                                                       |
| C000J3 | COMMON/NAME/NAME                                                            |
| C000J3 | COMMON/IWARN/IWARN                                                          |
| C000J3 | COMMON/INIS/ MACH,OLDALT,CON                                                |
| C000J3 | DIMENSION FMT(3)                                                            |
| C000J3 | REAL MACH                                                                   |
| C000J3 | JATA NVAR/41/                                                               |
| C000J3 | DATA LABEL / 4MCASE, 3HALI, 2MPS, 3MFNA, 64MFT RF, 4MSFCA, 4HFNRF, OUTGO 90 |
| C000J3 | 14HFAM, 2HRF, 5MRILRF, 6HQINLET, 5HCOSPL, 5HCDBLD, 5KCOBVP,                 |
| C000J3 | 26HCOINL, 4MONOZ, 4MCDBT, 6HCOBASE, 5HCDINT, 8MONOZ REF, 5HPG/P0,           |
| C000J3 | 32HA9, 2HAD, 3MCFG, 4HBETA, 8HFM INPUT, 8HMF INPUT, 9HSFC INPUT,            |
| C000J3 | 57MW INPJ, 5MW ADS, 8HFN/DELTA, 6HMF COR, 7HSFC COR, 4HTAMB,                |
| C000J3 | 44PAPO, 34TT0, 14X, 6HAGE/AC, 6HAOI/AC, 5HAD/AC, 6HSTATUS,                  |
| C000J3 | 6 4+14 /                                                                    |
| C000J3 | DATA BLANK/1H /                                                             |
| C000J3 | KOUT=MINO(NALT,10)                                                          |
| C000J3 | DO 10 I=1,3                                                                 |
| C000J3 | 10 FMT(I)=BLANK                                                             |
| C000J3 | WRITE(16,3) MACH,TITLE,DA,TE                                                |
| C000J3 | IWARN=C                                                                     |
| C000J3 | 3 FORMAT(12H1MACH NUMBER,F7.4,5X,8A10,5X,A10,A2)                            |
| C000J3 | 6 FORMAT(11 )                                                               |
| C000J3 | WRITE (5,0)                                                                 |
| C000J3 | IF (KOUT-10) 20,50,50                                                       |
| C000J3 | GO TO 55                                                                    |
| C000J3 | BUILD FORMAT                                                                |
| C000J3 | 20 ENCODE(3),1,FMT) KOUT                                                    |
| C000J3 | 1 FORMAT(8H(1X,A10,I1,13HF10.3,5X,A10))                                     |
| C000J3 | DO 30 K=1,NVAR                                                              |
| C000J3 | WRITE (5,FMT) LABEL(K),(OUTP(K,J),J=1,KOUT),LABEL(K)                        |
| C000J3 | IF (MOD(K,5).EQ.0) WRITE (6,6)                                              |
| C000J3 | 30 CONTINUE                                                                 |
| C000J3 | GO TO 65                                                                    |
| C000J3 | 50 DO 60 K=1,NVAR                                                           |
| C000J3 | WRITE (5,2) LABEL(K),(OUTP(K,J),J=1,KOUT),LABEL(K)                          |
| C000J3 | IF (MOD(K,5).EQ.0) WRITE (6,6)                                              |
| C000J3 | 60 CONTINUE                                                                 |
| C000J3 | 2 FORMAT(1X,A10,13FI3.3,5X,A10)                                             |
| C000J3 | 55 IF (PCODE) 60,60,70                                                      |
| C000J3 | OUTPUT FOR PUNCH OR PLOTTING PROGRAM                                        |
| C000J3 | 70 IF (MEM-ST.0) WRITE(7,150) (OUTP(3,J),J=1,KOUT)                          |
| C000J3 | IF (PCODE-1.0) 74,74,76                                                     |
| C000J3 | 74 WRITE (7,151) (OUTP(4,J),J=1,KOUT)                                       |
| C000J3 | WRITE (7,151) (OUTP(5,J),J=1,KOUT)                                          |
| C000J3 | GO TO 60                                                                    |
| C000J3 | 76 WRITE (7,151) (OUTP( 4,J),J=1,KOUT)                                      |
| C000J3 | WRITE (7,151) (OUTP( 5,J),J=1,KOUT)                                         |
| C000J3 | WRITE (7,151) (OUTP(29,J),J=1,KOUT)                                         |
| C000J3 | 80 RETURN                                                                   |
| C000J3 | OUTGO150                                                                    |
| C000J3 | OUTGO170                                                                    |
| C000J3 | OUTGO180                                                                    |
| C000J3 | OUTGO290                                                                    |
| C000J3 | OUTGO300                                                                    |
| C000J3 | OUTGO310                                                                    |
| C000J3 | OUTGO320                                                                    |
| C000J3 | OUTGO330                                                                    |
| C000J3 | OUTGO340                                                                    |
| C000J3 | OUTGO350                                                                    |
| C000J3 | OUTGO360                                                                    |
| C000J3 | OUTGO370                                                                    |
| C000J3 | OUTGO380                                                                    |
| C000J3 | OUTGO390                                                                    |
| C000J3 | OUTGO400                                                                    |
| C000J3 | OUTGO410                                                                    |
| C000J3 | OUTGO420                                                                    |
| C000J3 | OUTGO430                                                                    |
| C000J3 | OUTGO440                                                                    |
| C000J3 | OUTGO450                                                                    |
| C000J3 | OUTGO460                                                                    |
| C000J3 | OUTGO470                                                                    |
| C000J3 | OUTGO480                                                                    |
| C000J3 | OUTGO490                                                                    |
| C000J3 | OUTGO500                                                                    |
| C000J3 | OUTGO510                                                                    |
| C000J3 | OUTGO520                                                                    |
| C000J3 | OUTGO530                                                                    |
| C000J3 | OUTGO540                                                                    |
| C000J3 | OUTGO550                                                                    |

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000271 153 FORMAT(10F7.2)  
 000271 151 FORMAT(10F7.0)  
 000271 END

OUTG0550  
 OUTG0560  
 OUTG0570

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SUBPROGRAM LENGTH  
000337

FUNCTION ASSIGNMENTS

|                       |    |          |     |          |     |          |
|-----------------------|----|----------|-----|----------|-----|----------|
| STATEMENT ASSIGNMENTS |    |          |     |          |     |          |
| 1 - 000305            | 2  | - 000312 | 3   | - 000275 | 6   | - 000303 |
| 10 - 000311           | 20 | - 000337 | 30  | - 000105 | 50  | - 000110 |
| 60 - 000144           | 65 | - 000147 | 70  | - 000151 | 74  | - 000172 |
| 76 - 000224           | 80 | - 000270 | 150 | - 000326 | 151 | - 000322 |

EXTERNALS AND TABS

OUTPTC.- S00100 OUTPTS.- S30200 END. - S00300

BLOCK NAMES AND -LENGTHS

|                 |                |               |                |
|-----------------|----------------|---------------|----------------|
| RESULT - 000703 | PCODE - 000001 | DATE - 000002 | TITLE - 000010 |
| MEMM - 000001   | INARM - 000001 | IMS - 000003  |                |

VARIABLE ASSIGNMENTS

|                   |                   |                  |                   |
|-------------------|-------------------|------------------|-------------------|
| BLANK - 000332    | OA - 000000003    | FMT - 000327     | I - 000334        |
| INARM - 000000006 | J - 000336        | K - 000335       | KOUT - 000333     |
| TABLE - 000702001 | HASHM - 000000007 | MEMM - 000000005 | NVAR - 000757001  |
| OUTP - 000000001  | PCODE - 000000002 | TE - 000001003   | TITLE - 000000004 |

START OF CONSTANTS

000272

START OF TEMPORARIES

000323

START OF INDIRECTS

000327

SPACE REQUIRED TO COMPILE

0360J0

**SUBJECT:** SUBROUTINE WARNING

**PURPOSE:** SUBROUTINE WARNING identifies the point to which the warning which follows applies.

**METHOD:** If no warning message has been written since the last printing of an output matrix, a heading is printed. In any event, the case number, Mach, altitude, and power setting is printed. The calling subprogram will then print the appropriate message.

**USAGE:** CALL WARNING

Input in COMMON

|       |                    |
|-------|--------------------|
| IWARN | Error message flag |
|-------|--------------------|

|      |             |
|------|-------------|
| CASE | Case number |
|------|-------------|

|     |          |
|-----|----------|
| ALT | Altitude |
|-----|----------|

|      |             |
|------|-------------|
| MACH | Mach number |
|------|-------------|

|    |               |
|----|---------------|
| PS | Power Setting |
|----|---------------|

Output: STATUS      Error flag for case.

|        |                                                  |
|--------|--------------------------------------------------|
| 000002 | COMMON/INARV/INARM                               |
| 000002 | COMMON/OJTS/CASE,ALT,PS,OUTS(37),STATUS,EXTRA(4) |
| 000002 | COMMON/INS/ MACH,INS(2)                          |

DATA IMA2N/D/

IF (VARNUM=0) WRITE(6) \*  
FORMAT(1H1,49X,24H... WARNING MESSAGES \*\* )

IN ARN: I  
W2 I T E (6, 2) CASE, MACH, ALT, PS

21

## RETURN

END

**FOI**

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SUBPROGRAM LENGTH  
003046

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

1 - 00031 2 - 030036

EXTERNALS AND TAGS

OUTPC.- S00106 END. - S00200

BLOCK NAMES AND LENGTHS

INRN - 000301 OUTS - 000055 INS - 000003

VARIABLE ASSIGNMENTS

ALT - 000031C02 CASE - 000000C02 EXTRA - 000051C02 INS - 000001C03  
INRN - 000000C01 MACH - 000000C03 OUTS - 000003C02 PS - 000002C02  
STATUS - 000050C02

START OF CONSTANTS

030027

START OF TEMPORARIES

000046

START OF INDIRECTS

030046

SPACE REQUIRED TO COMPILE

035330

**SUBJECT:** SUBROUTINE STORE

**PURPOSE:** SUBROUTINE STORE moves the results for a single case to the output matrix.

**METHOD:** The COMMON block OUTF contains the output for the case just computed with the individual variables in exactly the order to be printed. This data is transferred to COMMON block OUTP.

**USAGE:** CALL STORE (NALT)

NALT        -        number of cases at current  
Mach altitude = 10

OUTF (45) -        output for NALT<sup>TH</sup> case.

NVAR        -        number of OUTF locations  
being used.

Output        OUTP (RT,10)        Output matrix.

```

000033 SUBROUTINE STORE(NALT)
000033 COMMON/INS/ MACH,DLOALT,COM
000033 COMMON/OUTS/OUTS(45)
000033 COMMON/RESULT/OUTP(45,10),LABLE(45),NVAR
000033      DO 13 K=1,NVAR
000033      10 OUTP(K,NALT)=OUTS(K)
000033      RETURN
000033      END

```

STORE 60  
STORE 70  
STORE 80  
STORE 90

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SUBPROGRAM LENGTH  
C00C20

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS  
10 - 00C005

EXTERNALS AND TAGS  
END. - S00100

BLOCK NAMES AND LENGTHS  
INS - 00C003 OUTF - 030055 RESULT - 000760

VARIABLE ASSIGNMENTS  
K - 00C017 LABEL - 00070203 NVAR - 00075703 OUTF - 000000C03  
OUTS - 00C000C02

START OF CONSTANTS  
C00C16

START OF TEMPORARIES  
C00C16

START OF INDIRECTS  
C00C17

SPACE REQUIRED TO COMPLETE  
C35200

7

**SUBJECT:** SUBROUTINE CHKR

**PURPOSE:** SUBROUTINE CHKR calculates the thermodynamic properties at the throat and the total/static pressure ratio at the sonic condition.

**METHOD:** FUNCTION CØFH is called to compute sonic velocity. Then enthalpy is computed using the entry total enthalpy and the source velocity. Critical static temperature and relative pressure are computed as functions of enthalpy and fuel-air ratio. Pressure is derived from entry pressure and the relative pressure.

**USAGE:** CALL CHKR (P1, H1, PR1, FØA1, PAM, TC, C, PC, P1ØPAM, PIPCC)

|        |                                           |
|--------|-------------------------------------------|
| P1     | Entry total pressure PSF                  |
| H1     | Entry total enthalpy, BTU/lb <sub>M</sub> |
| PR1    | Entry relative pressure                   |
| FØA1   | Entry fuel-air ratio                      |
| PAM    | Ambient static pressure, PSF              |
| TC     | Critical static temperature, degrees R    |
| C      | Critical sonic velocity ft/sec            |
| PC     | Critical static pressure, PSF             |
| P1ØPAM | P1/PAM                                    |
| PIPCC  | P1/PC                                     |

**SUBPROGRAMS:** CØFH PRØFH TØFH

RUN VERSION JUL 71 22.46.30. 72/38/23.

```

SUBROUTINE CHKRP(P1,H1,PR1,FOA1,PAM,TC,G,PC,P1OPAM,P1PCC)
CHKRP
CHKRP
C** THIS SUBROUTINE CALCULATES THERMODYNAMIC PROPERTIES AT THE THROAT
C** OF A CHOKED NOZZLE, AND THE TOTAL-TO-STATIC PRESSURE RATIO AT
C** THE SONIC CONDITION.
C
C** THE NUMBER 1 IN A FORTRAN NAME REFERS TO THE NOZZLE INLET SIDE
C
C** P = TOTAL PRESSURE, PSF
C** H1 = ENTRY TOTAL ENTHALPY, BTU/LBM
C** PR = RELATIVE PRESSURE
C** FOA = FUEL/AIR RATIO
C** PAM = AMBIENT STATIC PRESSURE, PSF
C** TC = CRITICAL STATIC TEMPERATURE, DEGREES R.
C** G = CRITICAL SONIC VELOCITY, FT/SEC
C** PC = CRITICAL STATIC PRESSURE, PSF
C** P1OPAM = P1/PAM
C** P1PCC = P1/PC
C
C** COFH IS A FUNCTION SUBROUTINE WHICH RETURNS CRITICAL SONIC
C** VELOCITY AS A FUNCTION OF TOTAL ENTHALPY AND FUEL/AIR RATIO
C
000015 G= COFH(H1,FOA1)
000022 MC= H1- C**C*.193706E-4
C
C** .193706E-4 = 1/(2) (G SUB 0) (J)
C
000025 TC=TOFH(MC,FOA1)
000033 PRC= PROFH(MC,FOA1)
000041 P1PCC= P1/PRC
000042 P2= P1/P1PCC
000044 P1OPAM= P1/PAM
000046 REIUM
000047 END

```

RUN VERSION JUL 71 22.46.30. 72/06/23.

SUBPROGRAM LENGTH  
000000

## FUNCTION ASSIGNMENTS

## STATEMENT ASSIGNMENTS

EXTERNALS AND TAGS TOF4 - S00200 PROFM - S00300 END. - S00400  
COFM - S00100

## BLOCK NAMES AND LENGTHS

VARIABLE ASSIGNMENTS  
C - 000000 MC - 000053 PC - 001001 PRC - 000054  
PIOPAM - 000002 PIPCO - 000103

## START OF CONSTANTS

000000

## START OF TEMPORARIES

000001

## START OF INDIRECTS

000000

## SPACE REQUIRED TO COMPILE

035110

SUBJECT: SUBROUTINE GTHRST

PURPOSE: SUBROUTINE GTHRST computes the performance of propulsive nozzles.

METHOD: Outlet conditions are computed, then nozzle ideal exit velocity. Nozzle throat static pressure is compared to ambient pressure to determine which temperature, pressure, and velocity to use in the calculation of nozzle throat area. Gross thrust is computed by the appropriate equation.

USAGE: CALL GTHRST (XNØZZ, PR1, P1, H1, W1, FØA1, PAM, CV, CD, TCS, PCS, VC, H2, T2S, V2, A, FG)

XNØZZ - 1.0 for convergent-divergent nozzle;  
2.0 for convergent nozzle.

P121 Nozzle inlet relative pressure

P1 Nozzle inlet total pressure PSF

H1 Nozzle inlet total enthalpy BTU/LB<sub>M</sub>

W1 Nozzle inlet mass flow LB/SEC

FØA1 Nozzle inlet fuel-air ratio

PAM Ambient static pressure PSF

CV Nozzle velocity coefficient

CD Discharge coefficient

TCS Nozzle throat static temperature degrees R

PCS Nozzle throat static pressure PSF

VC Nozzle throat velocity ft/sec

Output H2 Nozzle outlet static enthalpy BTH/LB<sub>M</sub>

T2S Nozzle outlet static temperature degrees R

Output (continued)

V2      Nozzle ideal exit velocity ft/sec

A      Nozzle throat area ft<sup>2</sup>

FG      Gross thrust lb

SUBPROGRAMS:

AREA

HØFPR

SQRT

TØFH

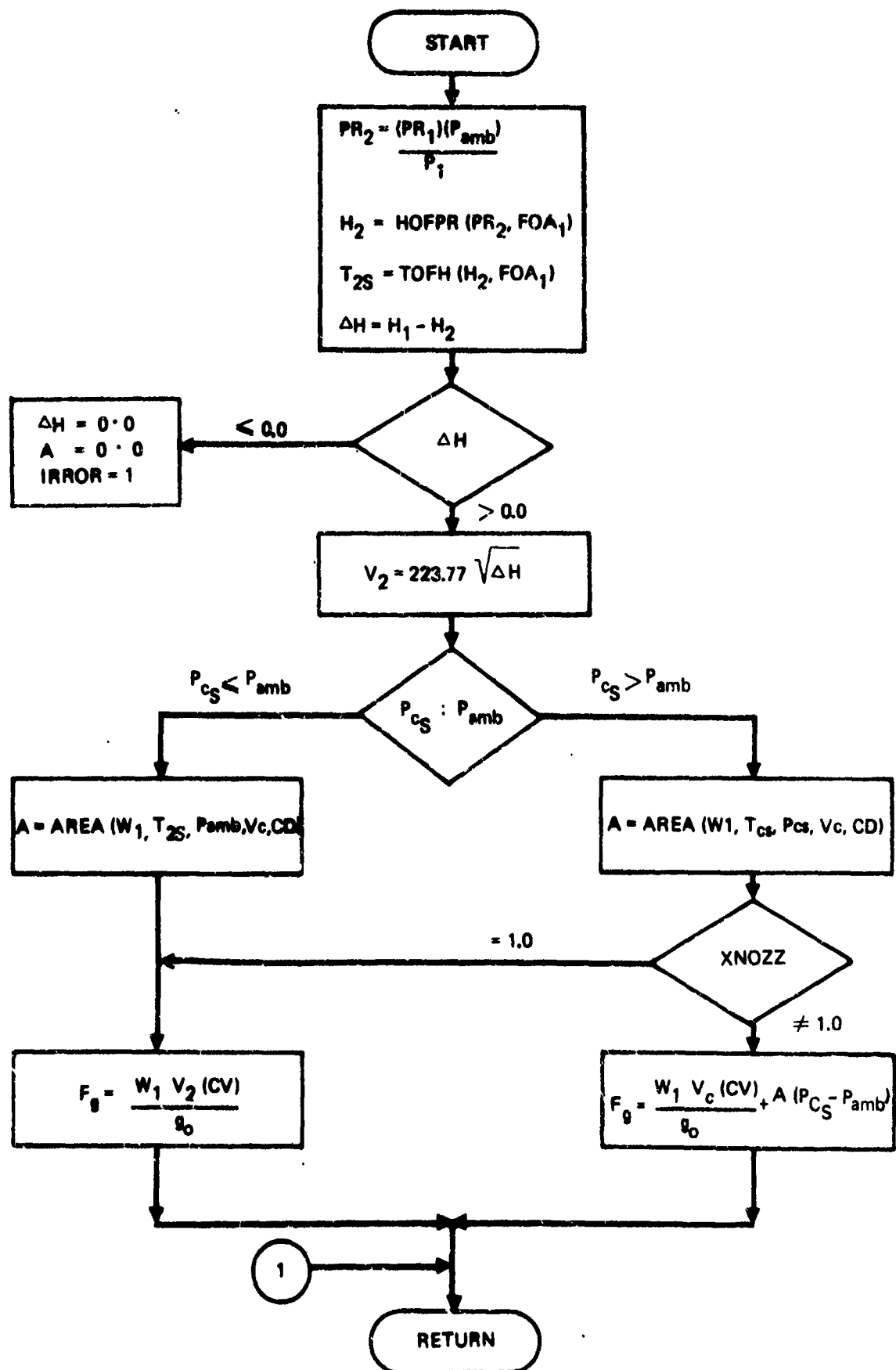


Figure 20: FLOW CHART FOR SUBROUTINE GTHRST

SUBROUTINE GTHRST(NOZZ,PR1,P1,M1,M1,FOA1,PAM,CV,CD,  
TCS,PCS,VC,M2,T2S,V2,A,FG)

KR03

GTHRST

GTHRST

GTHRST

GTHRST

GTHRST

GTHRST

GTHRST

GTHRST

GTHRST

GTHRST

GTHRST

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1969

FEBRUARY 1970

INPUTS

ICHOKE = 1 FOR NOZZLE UNCHOKED, = 2 FOR NOZZLE CHOKED

INOZZ = 1 CONVERGENT-DIVERGENT NOZZLE, = 2 CONVERGENT NOZZLE

PR1 = NOZZLE INLET RELATIVE PRESSURE

PAM = AMBIENT STATIC PRESSURE, PSF

P1 = NOZZLE INLET TOTAL PRESSURE, PSF

FOA1 = NOZZLE INLET FUEL TO AIR RATIO

M1 = NOZZLE INLET TOTAL ENTHALPY, BTJ/LBM

M1 = NOZZLE INLET MASS FLOW, LBM/SEC

CV = NOZZLE VELOCITY COEFFICIENT

AC = NOZZLE THROAT AREA, SQUARE FEET

PCS = NOZZLE THROAT STATIC PRESSURE, PSF

VC = NOZZLE THROAT VELOCITY, FT/SEC

TCS = NOZZLE THROAT STATIC TEMPERATURE, DEG. R.

OUTPUTS

M2 = NOZZLE OUTLET STATIC ENTHALPY, BTU/LBM

T2S = NOZZLE OUTLET STATIC TEMPERATURE, DEG. R.

V2 = NOZZLE IDEAL EXIT VELOCITY, FT/SEC

FG = GROSS THRUST, LBF.

A = NOZZLE THROAT AREA, SQUARE FEET.

THIS SUBROUTINE CALCULATES PERFORMANCE FOR THE PRIMARY AND

SECONDARY PROPULSIVE NOZZLES.

COMMON / ERMS / IRROR(5)

PR2 = PR1 \* PAM / P1

M2 = 40FPR(PR2,FOA1)

T2S = TCFM(M2,FOA1)

DELH = M1 - M2

IF(DELH .GT. 0.) GO TO 3

DELH = 0.

IRROR(5) = 1

A = J.

RETURN

3 V2 = 223.77 \* Sqrt(DELH)

223.77 = ((2)(G SUB 0)(J))\*\*.5

.031081 = 1. / (G SUB C)

IF (PCS .GT. PAM) GO TO 10

A=AREA(M1,T2S,PAM,V2,CD)

5 FG = .031081 \* M1 \* V2 \* CV

RETURN

A=AREA(M1,TCS,PCS,VC,CD)

10 IF (ANOZZ.EQ.1.) GO TO 5

END

RUN VERSION JUL 71

22.46.30. 72/08/23.

PAGE 002

CC0117  
CO.130  
00J131

FG=031081\*CV\*W1\*VC\*A\*(PCS-PAM)  
RETURN  
END

KR03  
GTHRST  
GTHRST

RUN VERSION JUL 71 22.46.30. 78/08/23.

SUBPROGRAM LENGTH  
001142

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS  
3 - 00053 5 - 00077 10 - 000104

EXTERNALS AND TAGS  
HOFR - SC0100 TOFM - S00200 SORT - S00300 AREA - S00400  
END. - S00500

BLOCK NAMES AND LENGTHS  
ERYCS - 000005

VARIABLE ASSIGNMENTS  
A - 00011 CD - 000402 CV - 000001 DELH - 000141  
FG - 00012 M2 - 000006 IRRJR - 00000001 PAM - 000000  
PCS - 00004 PR2 - 000140 TCS - 000003 T2S - 000007  
VC - 000005 V2 - 000010

START OF CONSTANTS  
000132

START OF TEMPORARIES  
000135

START OF INDIRECTS  
000140

SPACE REQUIRED TO COMPLETE  
035600

**SUBJECT:** SUBROUTINE DATA

**PURPOSE:** SUBROUTINE DATA provides a card image output of all data cards input to TEM-333.

**METHOD:** Data cards are read from TAPE1 (INPUT), written on TAPE5 and OUTPUT. A card count is provided. Upon sensing an end-of-file of TAPE1, TAPE5 is end-filed and rewound. All subsequent input is from TAPE5. The INPUT file is equivalent to TAPE1 to provide a logical number for the EOF test.

**USAGE:** CALL DATA

INPUT file must be in desired position when subroutine is called.

22.46.30. 72/08/23.

RUN VERSION JUL 71

```

SUBROUTINE DATA
C THIS DECK HAS BEEN MODIFIED TO TERMINATE UPON AN END OF FILE NOT ENC
DIMENSION IMORD(9)
REMIND 5
WRITE (5,1000)
DO 100 I=1,100000
READ (1,1001) IMORD
IF (EOF(1)) 200,50
C
50 IF (EOF(1)) 200,50
WRITE (5,1000)
75 WRITE (5,1002) I,IMORD
WRITE (5,1001) IMORD
100 CONTINUE
200 END FILE 5
REMIND 5
RETURN
1000 FORMAT (1H1,CARD*13X*19X*2*3X*39X*4*9X*5*9X*6*9X*7*9X*8*71H
$
$
*12345678901234567890123456789012345678901234567890*
*123456789012345678901234567890*71H )
1001 FORMAT (A3,7A1C,A7)
1002 FORMAT (1H 14,4X,A3,7A10,A7)
END
DATA 10
DATA 20
DATA 30
DATA 40
DATA 50
DATA 60
DATA 70
FTN
RUN
DATA 90
DATA 100
DATA 110
DATA 120
DATA 130
DATA 140
DATA 150
DATA 160
DATA 170
DATA 180
DATA 190
DATA 200
DATA 210
DATA 220

```

SUBPROGRAM LENGTH  
000135

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

50 - 00022 75 - 00033 200 - 00054 1000 - 00071  
1001 - 00110 1002 - 00117

EXTERNALS AND TAGS

REMAIN. - 00100 OUTPTC. - 500300 IFENDF. - 500400  
ENDFIL. - 500500 END. - 500600

BLOCK NAMES AND LENGTHS

VARIABLE ASSIGNMENTS

1 - 000136 10000 - 000123

START OF CONSTANTS

000062

START OF TEMPORARIES

000122

START OF INDIRECTS

000123

SPACE REQUIRED TO COMPILE

035430

SUBJECT: SUBROUTINE PLACIN

PURPOSE: SUBROUTINE PLACIN reads a tabular array. A count of points is provided for independent variables.

METHOD: If the number of fields input, NF, is equal to zero, then data is read until the maximum allowable number of cards has been read or until a 1 is input in column 72. A field by field count is made on the last card image so that the total number of non-blank fields is returned in NF. If NF is positive, then NF values are read. All arrays are formatted ten field-seven digit.

USAGE: CALL PLACIN (A(1),NF,NCARD)

A - array to be filled

NF - number of fields to read or if zero on input, the number of fields read.

NCARD - the maximum number of cards to be read if array is full.

SUBPROGRAM: KOUNT

SUBROUTINE PLACIN(A,NF,NCARD)

COMMON/TAPNO/IN,IOUT

COMMON/CARD/CARD(4)

COMMON/IPTAB/IPTAB

DIMENSION A(1)

DATA IPTAB/1/

IF (NF) 13,20,10

C READ DEPENDENT ARRAY - COUNT PROVIDED

10 IK=0

NCARDS=(NF-1)/10+1

GO TO 40

C READ INDEPENDENT ARRAY - COUNT NO. INPUT FIELDS

20 IK=1

NCARDS=NCARD

30 LO=1

LM=10

DO 50 I=1,NCARDS

READ (IN,2) (A(I),I=LO,LM), II,IJ

IF (IPTAB.NE.0) WRITE(IOUT,3) (A(I),I=LO,LM), II,IJ

IF (IK) 35,40,35

35 IF (NCARDS.EQ.1) GO TO 60

IF (II) +J,60,40

40 LO=LO+10

50 LM=LM+10

IF (IK.EQ.0) GO TO 70

WRITE(IOUT,4) NCARDS

IPTAB=1

LM=LM-10

60 NF=L4-10+COUNT(A(LO),10)

70 RETURN

1 FORMAT (3A10)

2 FORMAT (10F7.0,12,A8)

3 FORMAT (1X,10F12.5,12,A8)

4 FORMAT ('\*\*\*\*\* THE MAXIMUM NUMBER OF DATA CARDS, 12,768, FOR THE

24771164CHECK TO SEE IF MISSING 1 IN COL 72 HAS CAUSED INPUT ERROR

5. PROGRAM WILL CONTINUE TO READ INPUTS, BUT CARD SEQUENCE 77X20HMA

4Y NUM BE IN ERROR.//)

END

000124

SUBPROGRAM LENGTH  
000206

FUNCTION ASSIGNMENTS

| STATEMENT ASSIGNMENTS |          |    |          |
|-----------------------|----------|----|----------|
| 1                     | - 000127 | 2  | - 000131 |
| 10                    | - 000007 | 20 | - 000015 |
| 40                    | - 000073 | 60 | - 000112 |
|                       |          | 3  | - 000134 |
|                       |          | 30 | - 000017 |
|                       |          | 70 | - 000123 |
|                       |          | 4  | - 000137 |
|                       |          | 35 | - 000070 |

EXTERNALS AND TAGS  
INPUTC.- S00103 OUTPUTC.- S00200 KOUNT - S00300 END. - S00400

BLOCK NAMES AND LENGTHS  
TAPE NO - 000002 CARD - 000010 IPTAB - 000001

VARIABLE ASSIGNMENTS  
CARU - 00010002 I - 000203 IO - 000205 II - 000204  
IK - 000177 IN - 00000001 IOU - 00001001 IPTAB - 000000003  
LM - 000202 LO - 000201 NCARDS - 000200

START OF CONSTANTS  
000125

START OF TEMPORARIES  
000174

START OF INDIRECTS  
000177

SPACE REQUIRED TO COMPILE  
035730

**SUBJECT:** SUBROUTINE TABL1

**PURPOSE:** SUBROUTINE TABL1 inputs tables of the form  $F = f(x)$ , table format 1.

**METHOD:** SUBROUTINE PLACIN is called to read and count the independent array, then recalled to read the dependent array.

**USAGE:** CALL TABL1(T(1), MAX, N)

T - Table to be read

MAX - Maximum number of points in X array.

Output - N - Actual number of input points in X array.

**STORAGE:** The table T is stored as follows:

|         |                                                                                                       |  |  |  |  |
|---------|-------------------------------------------------------------------------------------------------------|--|--|--|--|
| Address | T <sub>(1)</sub> (T <sub>(2)</sub> ..... T <sub>(Max)</sub> T <sub>(Max+1)</sub> T <sub>(2 Max)</sub> |  |  |  |  |
| Content | X <sub>(1)</sub> X <sub>(N)</sub> F <sub>(1)</sub> ... F <sub>(N)</sub>                               |  |  |  |  |

N MAX

T can be specified in the calling program by either:

DIMENSION T (2MAX) or COMMON/T/ TX(MAX),TY(MAX)

**SUBPROGRAMS:** PLACIN

RUN VERSION JUL 71 22.46.30. 72/08/23.

```

000036 SUBROUTINE TABL1(M,MAX,N)
000036 DIMENSION T(1)
000036 N=0
000036 NCARD=(MAX-1)/10+1
000012 CALL PLACIN(T(1),N,NCARD)
000015 CALL PLACIN(T(MAX+1),N,NCARD)
000022 RETURN
000023 END
    
```

SUBPROGRAM LENGTH  
00026

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

EXTERNALS AND TAGS  
PLACIN - S00100 END. - S00200

BLOCK NAMES AND LENGTHS

VARIABLE ASSIGNMENTS  
NGARD - 000025

START OF CONSTANTS  
000024

START OF TEMPORARIES  
000024

START OF INDIRECTS  
000025

SPACE REQUIRED TO COMPILE  
035230

**SUBJECT:** SUBROUTINE TABL2

**PURPOSE:** SUBROUTINE TABL2 inputs tables of the form  $F = f(X,Y)$  square matrix, table format 2Q.

**METHOD:** SUBROUTINE PLACIN is called to read and count the Y array, then again to read and count the X array. Then for each input Y point PLACIN is called to read NX points of the dependent array.

**USAGE:** CALL TABLE2 (T, MAXX, MAXY, NX, NY)

T - - Table to be read

MAXX - Maximum number of points in X array

MAXY - Maximum number of points in Y array

Output NX - Actual number of X array points input

Output NY - Actual number of Y array points input.

**STORAGE:** The table T is stored as follows:

|         |                                                                                              |
|---------|----------------------------------------------------------------------------------------------|
| Address | $T_{(1)} - - - T_{(MAXX)} \quad T_{(MAXX+1)} - - T_{(MAXX+MAXY)}$                            |
| Content | $X_{(1)} - - X_{(NX)} \quad Y_{(1)} - - Y_{(NY)}$                                            |
| Address | $T_{(MAXX+MAXY+1)} - - T_{(MAXX+MAXY+NX)} - T_{(12MAXX+MAXY+1)}$                             |
| Content | $F_{(1,1)} - - - F_{(NX,1)} - - - F_{(1,2)}$                                                 |
| Address | $T_{((NY+1) MAXX+MAXY+1)} \quad T_{((NY+1) MAXX+MAXY+NX)} - -$<br>$T_{((MAXY+1) MAXX+MAXY)}$ |
| Content | $F_{(1,NY)} - - - - - F_{(NX,NY)}$                                                           |

T can be specified in the calling program by either:

DIMENSION T(MAXX+MAXY+(MAXX)(MAXY)) or  
COMMON/T/TX(MAXX),TY(MAXY),TF(MAXX,MAXY)

SUBPROGRAM:

PLACIN

RUN VERSION JUL 71 22.46.30. 72/10/23.

SUBROUTINE TABL2(I,MAXX,MAXY,NX,NY)

DIMENSION T(1)

000010

NY=0

000010

NCARD=(MAXY-1)/13+1

000010

CALL PLACINT(MAXX+1,NY,NCARD)

000014

NX=0

000017

NCARD=(MAXX-1)/13+1

000023

CALL PLACINT(1,NX,NCARD)

000027

ID=MAXX+MAXY+1

000031

DO 10 I=1,NY

000036

CALL PLACINT(ID,NX,NCARD)

000040

10 ID=ID+MAXX

000043

RETURN

000052

END

SUBPROGRAM LENGTH  
000066

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

EXTERNALS AND TAGS  
PLACIN - S00100 END. - S00200

BLOCK NAMES AND LENGTHS

VARIABLE ASSIGNMENTS  
I - 000057 IO - 000056 NCARD - 000055

START OF CONSTANTS  
000053

START OF TEMPORARIES  
000053

START OF INDIRECTS  
000055

SPACE REQUIRED TO COMPILE  
035436

**SUBJECT:** SUBROUTINE TABL3

**PURPOSE:** SUBROUTINE TABLE3 inputs tables of the form  $F = f(X,Y,Z)$ , table format 3.

**METHOD:** SUBROUTINE PLACIN is called to read and count the Z array, the Y array and the X array in turn. Then is recalled to read a lependent array corresponding to the X values for the first Y and Z; then for the second Y, etc. This is repeated for each Z value in turn.

**USAGE:** CALL TABL3 (T, MAXX, MAXY, MAXZ, NX, NY, NZ)

T - - Table to be read

MAXX - Maximum number of points in X array

MAXY - Maximum number of points in Y array

MAXZ - Maximum number of points in Z array

Output NX - Actual number of X array points input

Output NY - Actual number of Y array points input

Output NZ - Actual number of Z array points input

**STORAGE:** The table T is stored as follows:

|         |                                                         |          |            |               |
|---------|---------------------------------------------------------|----------|------------|---------------|
| Address | T (1)                                                   | T (MAXX) | T (MAXX+1) | T (MAXX+MAXY) |
| Content | X (1)                                                   | X (NX)   | Y (1)      | Y (NY)        |
| Address | T (MAXX+MAXY+1) T (MAXX+MAXY+MAXZ) T (MAXX+MAXY+MAXZ+1) |          |            |               |
| Content | Z (1)                                                   | Z (NZ)   | F (1,1,1)  |               |
| Address | T (MAXX+MAXY+MAXZ+NX) - - T (2MAXX+MAXY+MAXZ+1)         |          |            |               |
| Content | F (NX,1,1)                                              |          | F (2,1,1)  |               |

$NX \leq MAXX$     $NY \leq MAXY$ ,    $NZ \leq MAXZ$

T can be specified in the calling program by either:

DIMENSION T(MAXX+MAXY+MAXZ+(MAXX) (MAXY) (MAXZ))

or COMMON/T/TX(MAXX),TY(MAXY),TZ(MAXZ),  
TF(MAXX,MAXY,MAXZ)

Note: dependent array stored in natural  
FORTRAN order.

SUBPROGRAM: PLACIN

## SUBROUTINE TABL3(I,MAXX,MAXY,MAXZ,NX,NY,NZ)

```
00012 DIMENSION Y(1)
00013 IZ=MAXX+MAXY+1
00014 ITAB=IZ+MAXZ
00015 NZ=3
00016 NCARD=(MAXZ-1)/10+1
00017 CALL PLACINT(IZ),NZ,NCARD)
00018 MAXY=MAXX+MAXY
00019 NY=3
00020 NCARD=(MAXY-1)/10+1
00021 CALL PLACINT(MAXX+1),NY,NCARD)
00022 NX=3
00023 NCARD=(MAXX-1)/10+1
00024 CALL PLACINT(1),NX,NCARD)
00025 DO 20 I=1,NZ
00026 IO=(I-1)*MAXY+ITAB
00027 DO 10 K=1,NY
00028 CALL PLACINT(IO),NX,NCARD)
00029 IO=IO+MAXX
00030 10 CONTINUE
00031 20 RETURN
00032 END
```

SUBPROGRAM LENGTH  
000125

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

EXTERNALS AND TAGS  
PLACIN - S00180 END. - S00200

BLOCK NAMES AND LENGTHS

VARIABLE ASSIGNMENTS  
I - 000122 ID - 000123 IYAB - 000117 IZ - 000116  
K - 000124 MAXI - 000121 NCARD - 000120 NZ - 000000

START OF CONSTANTS  
000113

START OF TEMPORARIES  
000113

START OF INDIRECTS  
000113

SPACE REQUIRED TO COMPILE  
035530

**SUBJECT:** SUBROUTINE TABL22

**PURPOSE:** SUBROUTINE TABL22 inputs tables of the form  $F = f(X,Y)$  skewed matrix, table format 2K.

**METHOD:** SUBROUTINE PLACIN is called to read and count the Y array. Then for each Y value in turn, PLACIN reads and counts and X array and the corresponding F values. The various X arrays need not have the same number of input points.

**USAGE:** CALL TABL22 (T,MAXY,MAXX,NY,NX)

T - - Table to be read

MAXY - Maximum of points in Y array

MAXX - Maximum of points in X array

Output NY - Actual number of Y array points input

Output NX - Array with actual numbers of X array points input

**STORAGE:** T(1) T(MAXY) T(MAXY+1) T(MAXY+MAXX)  
Y(1) Y(NY) X(1,1) X(NX(1),1)  
T (MAXY+MAXX+1) - - T (MAXY+(MAXY)(MAXX),1) - -  
X(1,2) X(NX(NY),NY)  
T(MAXY+(MAXX)(MAXY)+1 - - T(MAXY+MAXY(2MAXX))  
F(1,1) F(NX(NY),NY)

T and NX are specified in the calling program by either:

DIMENSION T(MAXY+MAXY(2MAXX)), NX(MAXY)

or COMMON/T/TY(MAXY), TX(MAXX,MAXY), TF(MAXX,MAXY)

Note: X and Y have been reversed in the actual coding of this routine, but to be consistent with the write-ups for the other TABL routines, the outer loop variable is called Y in this write-up.

**SUBPROGRAM:** PLACIN

```

SUBROUTINE TABL22(I,MAXX,MAXY,NX,NY)
  DIMENSION Y(1),NY(1)
  NX=0
  NCARD=(MAXX-1)/10+1
  CALL PLACINT(1),NX,NCARD)
  NCARD=(MAXY-1)/10+1
  K=MAXX+1
  IK=MAXX+MAXX*MAXY+1
  DO 100 I=1,NX
    NY(I)=0
    CALL PLACINT(K),NY(I),NCARD)
    CALL PLACINT(IK),NY(I),NCARD)
    K=K+MAXY
    IK=IK+MAXY
  100 CONTINUE
  RETURN
END
*DECK COUNT

```

SUBPROGRAM LENGTH  
000077

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

EXTERNALS AND TABS  
PLACIN - SC010C END. - S0020C

BLOCK NAMES AND LENGTHS

VARIABLE ASSIGNMENTS  
I - JC0076 IK - 000075 K - 000074 NCARD - 000073

START OF CONSTANTS  
000067

START OF TEMPORARIES  
000067

START OF INDIRECTS  
000071

SPACE REQUIRED TO COMPILE  
035430

01.04.29. 7270.711

01.04.29. 7270.711

PROGRAM DSCRIB(INPUT,OUTPUT,TAPES=INPUT,IAPE=OUTPUT)

```
C
C
C * PURPOSE - CALCULATES SCRUBBING DRAG
C
C * SUBPROGRAMS REQUIRED - DATA3,DKAGAFI,SC3OUT
C * RESTRICTIONS/LIMITATIONS - MAXIMUM 1000 CASES
C * NOT RUN CALCULATED.
C * AUTHOR T.J. HARRIS
C
C BCS ORG. G-2543 *
```

LOGICAL FIRST

ANET NOT USED THIS TEST

MAX=0.0  
INITIALIZE  
MAX=0  
K=0  
END=0.0

INPUT HEADER AND BASE GEOMETRY  
R=0.0,100, TITLE,BCSN  
R=0.0,100, AMAFI,AFAN,HBT,XLAFT,XLCS,HD,RD,APJAFI,10(1)  
CALL SUBJUT(1)

INPUT RESULTS DATA  
10 READ(5,30) V1,V2,P0,P10,P20,P0,T125,10(2)  
IF (V1.EQ.0.0) GO TO 1000  
MAX=4.0E+1  
WRITE INPUT CARD IMAGES  
CALL SUBJUT(2)  
GO TO 1000

CALL SUBJUT(2)  
GO TO 1000

STORE RESULTS IN OUTPUT ARRAY

KL=KL+1  
KL=KL+1, KL=JUTAFI  
KL=KL+1, KL=JUTAFI  
KL=KL+1, KL=JUTAFI  
KL=KL+1, KL=JUTAFI  
GO TO 10

WRITE OUTPUT ARRAY  
1000 CALL SUBJUT(3)

003114 C  
 003114 100 FORMAT(A16,10X,F5.0,15X)  
 003114 200 FORMAT(5F7.0,16X,AD)  
 003114 300 FORMAT(5F7.0,30X,AD)  
 003114 END

SUBROUTINE S300I(NCALL)

C \* PURPOSE - OUTPUT SCRUBBING DRAG INPUT DECK AND \*  
C \* RESULTANT CALCULATIONS-P50 LINES/PAGE. \*

C \* ARG DEF. \*

C \* NCALL CALL FLAG, WHERE:

C 1=FIRST CALL-PRINT HEADER INFO.

C 2=PRINT INPUT CARD IMAGES

C 3=PRINT CALCULATIONS

C \* AUTHOR T.D.MARRIS BSC ORG. 6-2943 \*

000003 COMMON /PRINTING/ D1(2) ,P8 ,D2(2) ,P25P8 ,D3(12) ,T125 LAST 19  
1 ,D4(16) ,VJS2 ,J5(4) ,RHOS2 ,D6(4) ,REYSEC ,D7(43) ,OSCRBS ,LAST 90  
2 ,D8(9) ,D9(14) ,D10(24) ,XLCS ,D11(5) ,XLAFT ,D12(21) ,AWAFT LAST 154

000003 3 ,D12(5) ,XAWFT ,D13(4) ,D14(1) ,P26P8 ,D15(3) ,D16(1) ,VJS1 LAST 7  
COMMON /XCA-2 / D14(1) ,D17(1) ,V8

000003 COMMON /AWBIENI/ P10 ,D17(1) ,V8 LAST 3

000003 COMMON /VACELL / D18(3) ,APJAFI ,D19(1) ,IFAN ,M8T ,D20(2) LAST 9

000003 1 ,M8 ,D21(1) ,ROD LAST 12  
COMMON /SCOUT / TIT-E(5) ,RODATE(2) ,XLINE(4,1000) ,BCSN-MAX, ID(2) ,FIRST

000003 INTEGER PSN

000003 LOGICAL FIRST

C INITIALIZE LINE AND PAGE COUNT

000003 IF (NCALL.EQ.1) GO TO 20

000003 LCN=0

000003 PSN=0

000003 CALL DATE(RDATE(1),RODATE(2))

000012 10 WRITE(6,200)RODATE,TITLE,BCSN

000012 C

000024 WRITE(6,300) AWAFT,M8T,XLAFT,XLCS,M8,ROD,APJAFI, ID(1)

000032 GO TO 200

000054 20 IF (NCALL.EQ.3) GO TO 30

000054 LCN=LCN+1

000057 IF (LCN.EQ.50)WRITE(6,400)

000057 C

000056 WRITE(6,700) V0,P0,P10,P26P8,T125, ID(2)

000112 GO TO 200

000112 C

000112 C

000112 30 IF (.NOT.FIRST) GO TO 35

000114 BGCN=BCSN

000115 IF (BGCN.EQ.0.0185CN=1.0

000117 C

000117 C

000121 35 DO 100 K=1,MAX

000123 IF (FIRST) GO TO 40

```

000124 C IF (LC.LE.50) 50 TO 60
000127 C INCREMENT PAGE NO.-RESET LINE COUNTER
000131 40 PG=PGM+1
000132 LC=0
000133 FIRST=F.A.S.E.
000133 C NEW PAGE PRINT HEADINGS
000133 50 WRITE(6,909) TITLE,RODATE,PGN
000135 WRITE(6,900)
000135 C JUMP TO ONE DATA LINE
000135 60 WRITE(6,1100)CSM2,(XLINE(1,K1),J=1,4)
000136 LC=LC+1
000170 CSNO=CSNO+1.0
000172 100 CONTINUE
000175 400 FORMAT(11,1,*,INPUT DECK-CONT.*)
000175 500 FORMAT(11,1,20X,*,SCRUBBING DRAG INPUT CARD DECK*,1X,2A10,
1//1H,5A10,10X,E3.0)
000175 500 FORMAT(11M,*,F10.4,10X,A0)
000175 700 FORMAT(11,1,*,F10.4,20X,A0)
000175 300 FORMAT(11,1,20X,*,SCRUBBING DRAG RESULTS,//10X,5A10,20X,*,RUN DATE*,
11X,2A10,10X,*,PAGE NO. *,14)
000175 C
000175 301 FORM=11M,*,CASE NO.,15X,*,DATA1*,12X,*,DISCARDS*,12X,*,VMT *,14X,
1*,VJ52 *)
000175 1003 FORMAT(11M,*,F8.0,4=20.4)
000175 2000 RETURN
000176 END

```

00.04.20.72/06/11.

VERSION JUL 71

SUBROUTINE DRAGAFI

\*\*\*\*\*

\* PURPOSE - CALCULATES SCRAMBLING DRAG (AFTERBODY) \*

\* REFERENCE ITEM 116 A. RAHAY/N. PREWITT

EXTERNAL I/O  
DIMENSION Y(4)

COMMON /PRINTING/ D1(2) ,P0 ,D2(2) ,P25P0 ,D3(12) ,I125 LAST 19  
1 ,D4(16) ,VJ52 ,D5(4) ,RM0SEC ,D6(4) ,REYSEC ,D7(43) ,USCRBS LAST 90  
2 ,D8(9) ,D9(24) ,XLC5 ,D10(6) ,XLAFT ,D11(21) ,AWAFT LAST 154  
3 ,D12(10) ,XAME1 ,D13(4) ,D14(1) ,P25P0 ,D15(3) ,D16(1) ,VJ51 LAST 7  
COMMON /ACALS/ D14(1) ,P25P0 ,D17(1) ,V0 LAST 3  
COMMON /ADJENT/ PTU ,D17(1) ,V0  
COMMON /ADJENT/ F1(16) ,X1(16) ,H ,Z ,LANE  
COMMON /ADJENT/ D18(3) ,APJAFI ,D19(1) ,AFAN ,HBT ,D20(2) LAST 4  
COMMON /ADJENT/ D18(3) ,APJAFI ,D19(1) ,AFAN ,HBT ,D20(2) LAST 12  
1 ,HU ,D21(1) ,ROD

COMMON /DRAGCF / XMACH(10) ,V2AT(10) ,D30TB(10)  
1 ,CDIM(4,4,10) ,R2TB(10) ,A2TB(10)  
2 ,CDOT(4,2,10) ,H2TB(10) ,P2TB(10)  
3 ,RODTB(13) ,GDAFT(3,3,10)

COMMON /JET203 / PEPATB(15) ,BCON11 ,BCON12(16)  
1 ,ZKCON1(15) ,ZKCON2(16)

DATA CVJ,SMIG/12013.6,0.2457143/  
DATA TO,TO.01/ ,RJFAFT/0.06/

XME2 = SRT(5.\*(P26P0)\*\*GMIG-1.1)

VJ52 = SRT(CVJ\*TT25\*(1.-(1./P26P0)\*\*SMIG))

STFAN = TT25/(1.+2.\*XME2\*\*2)

RM0SEC = 20/STFAN\*0.0839

ZMU = 9.2523E-7\*STFAN\*\*1.2/(STFAN+216.1/3)\*0SEC

REYSEC = VJ52/ZMU\*SORT(MBT\*\*2+XLAFT\*\*2)

Y(1) = 3C)NT1

Y(2) = TB.U1(P26P0,PEPATB,BCON12,2,16)

Y(3) = TB.U1(P26P0,PEPATB,ZKCON1,1,16)

Y(4) = TB.U1(P26P0,PEPATB,ZKCON2,2,16)

RAT19 = (PTU/P0-1.)/0.49471

B = KAT19\*(Y(2)-Y(1))+Y(1)

ZK = KAT19\*(Y(4)-Y(3))+Y(3)

K2 = MFAN/ZK\*(1./B)

```
000110 0X00U = AMFT/XLAFTHOSEC*ZNU**0.2
000110 C0AP = (1.0+0.16*(4E2**2)**(-0.6)
000120 TE4P = 0.135*3RMJNU*VJS2**1.6*(C0MPARUFAT)
000130 WIFE = XLAFI-XC
000140 IF (WIFE) 19,10,12

000140 11 JRG2 = J.
000141 DRG1 = TE4P*KLAFI**0.3
000140 GO TO 20

000140 12 E = (VJS2-VJ)/XC**3
000150 FGVJ = K/VJS2**0.25
000151 SUCP = J.
000152 ARG1 = J.
000153 X1(1) = KC
000154 FX1(1) = XG/J**0.2
000157 WIFF = JIFF/15.

000171 00 1+ I=2,15
000172 STEP = STEP+1.
000174 X1(I) = K+JIFF*STEP
000200 LAKE=1

000201 CALL LEEFND(4JX,X1(I-1),X1(I),IOL,ARG2,IERR)

000205 ARG1 = ARG1+ARG2
000207 1+ FX1(I) = (ARG1+XGVJ)**0.2
000216 LAKE=2

000217 CALL LEEFND(4U1,X2,XLAFI,IOL,ARG1,IERR)

000223 DRG2 = J.125334*8RMONU*ARG1
000228 URG1 = TE4P*12**0.8
000232 15 SAVE=XC-XC25
000234 15 IF (XC-XC25) 18,21,20

000237 18 V3T = VJ+E*KC25**3
000240 GO TO 22
000244 20 V3T = VJS2
000250 IF (Q.WE.0.0) GO TO 25
000251 22 U = 0.5*(4OSEC*V3T**2

000254 25 CU = 18.0J*(4J,P25P0,ROD,MUT0,PFP0,RODT0,C0AFT,1,1,1,3,3,10,3,3,10)
C
000254 20 WRITE(6,33) X2,SAVE,E,B
000301 WRITE(6,100) J,CU,UBTAFI,XANET

000325 IF (CU+1.0) CU = 0.
000327 UBTAFI = 20*Q*APJAFI
000332 USGR35 = JRG1+DRG2
000334 IF (UAMT.E.0.0) RETURN
```

RUN V-351CN JUL 71

00.04.20.72/06/10.

PAGE 001

300345  
300340

USCJUS = JSCR3S\*NAMEI/ANAFT  
UJIAFT = J.

300340  
300340  
300340  
300341

93 FORMAT(14 , \* XC=\*,F10.4,\*XC-XLCS=\*,F10.4,\* E=\*,F10.4,\* B=\*,F10.4)  
130 FJ33HI(14 , \* J.CD.DHIAFI,NAMEI =\*,F20.4,18X,\*C/D ONLY

R.10CN

END JNKAFT

00.04.28.72/26/10.

SUBROUTINE AJK (XK, EN)

000005 COMMON /IVTGR / FX1(16),X1(16) ,B ,E ,LANE ,LAST ,I  
000015 CDPHON /A48IENT/ P10 ,017(1) ,V0  
000025 GO TO(10,20) ,LANE  
000035 10 FX=1.7/(V0+2\*X\*X\*\*8)\*\*.25  
000045 RETURN  
000055 20 FX=(V0+2\*X\*X\*\*3)\*\*1.75/TOLU1(XK,X1,FX1,1,16)  
000065 RETURN  
000075 END



RUN VERSION JUL 71 00.04.20. 72/36/13.

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| 000002 | DATA (CONT1), I=101,200 /                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     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|        | \$ 0415, 1550, 3100, 4550, 0200, 0230, 2000, 3900, 0000, 0020,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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|        | \$ 0145, 1770, 0000, 0020, 0030, 0210, 0000, 0000, 0000, 0000,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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|        | \$ 0400, 1550, 2350, 4820, 0130, 1520, 1900, 3800, 0010, 0020,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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|        | \$ 0130, 1720, 0000, 0020, 0030, 0130, 0000, 0000, 0030, 0030,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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|        | \$ 0330, 1460, 2800, 4600, 0100, 1500, 1800, 3790, 0030, 0020,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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|        | \$ 0120, 1570, 0000, 0020, 0030, 0160, 0000, 0000, 0030, 0000,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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|        | \$ 0365, 1360, 2700, 4540, 0150, 3430, 1750, 3700, 0030, 0020,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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|        | \$ 0110, 1520, 0000, 0020, 0030, 0140, 0000, 0000, 0030, 0000,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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|        | \$ 0320, 1260, 2530, 4400, 0145, 0480, 1630, 0010, 0020,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | BLKOA 51 |
|        | \$ 0100, 1560, 3000, 0020, 0030, 0120, 0000, 0000, 0000, 0000,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | BLKOA 52 |
| 000002 | DATA HUI3/8.03, 8.15, 8.0.21 / 2EPH/1.5, 2.2, 8.2.8 /                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         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|        | \$ ROTR/2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0 /                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  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| 000002 | DATA COAFI /                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  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|        | \$ 0135, 0195, 0195, 0300, 0625, 0630, 0420, 0990, 1100,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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|        | \$ 0135, 0145, 0153, 0220, 0375, 0370, 0230, 0570, 0630,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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|        | \$ 0235, 0110, 0422, 0145, 0215, 0240, 0170, 0310, 0330,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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|        | \$ 0070, 0082, 0130, 0090, 0120, 0155, 0095, 0155, 0225,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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|        | \$ 0052, 0050, 0082, 0053, 0035, 0100, 0054, 0072, 0184,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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|        | \$ 0000, 0050, 0070, 0040, 0030, 0070, 0040, 0050, 0043,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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|        | \$ 0052, 0045, 0063, 0032, 0045, 0063, 0032, 0045, 0063,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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|        | \$ 0050, 0145, 0053, 0030, 0045, 0059, 0038, 0045, 0059,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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|        | \$ 0030, 0145, 0055, 0030, 0045, 0055, 0030, 0045, 0055,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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|        | \$ 0030, 0045, 0055, 0030, 0045, 0055, 0030, 0045, 0055,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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| 000002 | DATA PEPA13 /                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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|        | \$ 1.4 1.5 1.6 2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.4 3.6 3.8 4.0 4.2 4.4 4.6 4.8 5.0 5.2 5.4 5.6 5.8 6.0 6.2 6.4 6.6 6.8 7.0 7.2 7.4 7.6 7.8 8.0 8.2 8.4 8.6 8.8 9.0 9.2 9.4 9.6 9.8 10.0 10.2 10.4 10.6 10.8 11.0 11.2 11.4 11.6 11.8 12.0 12.2 12.4 12.6 12.8 13.0 13.2 13.4 13.6 13.8 14.0 14.2 14.4 14.6 14.8 15.0 15.2 15.4 15.6 15.8 16.0 16.2 16.4 16.6 16.8 17.0 17.2 17.4 17.6 17.8 18.0 18.2 18.4 18.6 18.8 19.0 19.2 19.4 19.6 19.8 20.0 20.2 20.4 20.6 20.8 21.0 21.2 21.4 21.6 21.8 22.0 22.2 22.4 22.6 22.8 23.0 23.2 23.4 23.6 23.8 24.0 24.2 24.4 24.6 24.8 25.0 25.2 25.4 25.6 25.8 26.0 26.2 26.4 26.6 26.8 27.0 27.2 27.4 27.6 27.8 28.0 28.2 28.4 28.6 28.8 29.0 29.2 29.4 29.6 29.8 30.0 30.2 30.4 30.6 30.8 31.0 31.2 31.4 31.6 31.8 32.0 32.2 32.4 32.6 32.8 33.0 33.2 33.4 33.6 33.8 34.0 34.2 34.4 34.6 34.8 35.0 35.2 35.4 35.6 35.8 36.0 36.2 36.4 36.6 36.8 37.0 37.2 37.4 37.6 37.8 38.0 38.2 38.4 38.6 38.8 39.0 39.2 39.4 39.6 39.8 40.0 40.2 40.4 40.6 40.8 41.0 41.2 41.4 41.6 41.8 42.0 42.2 42.4 42.6 42.8 43.0 43.2 43.4 43.6 43.8 44.0 44.2 44.4 44.6 44.8 45.0 45.2 45.4 45.6 45.8 46.0 46.2 46.4 46.6 46.8 47.0 47.2 47.4 47.6 47.8 48.0 48.2 48.4 48.6 48.8 49.0 49.2 49.4 49.6 49.8 50.0 50.2 50.4 50.6 50.8 51.0 51.2 51.4 51.6 51.8 52.0 52.2 52.4 52.6 52.8 53.0 53.2 53.4 53.6 53.8 54.0 54.2 54.4 54.6 54.8 55.0 55.2 55.4 55.6 55.8 56.0 56.2 56.4 56.6 56.8 57.0 57.2 57.4 57.6 57.8 58.0 58.2 58.4 58.6 58.8 59.0 59.2 59.4 59.6 59.8 60.0 60.2 60.4 60.6 60.8 61.0 61.2 61.4 61.6 61.8 62.0 62.2 62.4 62.6 62.8 63.0 63.2 63.4 63.6 63.8 64.0 64.2 64.4 64.6 64.8 65.0 65.2 65.4 65.6 65.8 66.0 66.2 66.4 66.6 66.8 67.0 67.2 67.4 67.6 67.8 68.0 68.2 68.4 68.6 68.8 69.0 69.2 69.4 69.6 69.8 70.0 70.2 70.4 70.6 70.8 71.0 71.2 71.4 71.6 71.8 72.0 72.2 72.4 72.6 72.8 73.0 73.2 73.4 73.6 73.8 74.0 74.2 74.4 74.6 74.8 75.0 75.2 75.4 75.6 75.8 76.0 76.2 76.4 76.6 76.8 77.0 77.2 77.4 77.6 77.8 78.0 78.2 78.4 78.6 78.8 79.0 79.2 79.4 79.6 79.8 80.0 80.2 80.4 80.6 80.8 81.0 81.2 81.4 81.6 81.8 82.0 82.2 82.4 82.6 82.8 83.0 83.2 83.4 83.6 83.8 84.0 84.2 84.4 84.6 84.8 85.0 85.2 85.4 85.6 85.8 86.0 86.2 86.4 86.6 86.8 87.0 87.2 87.4 87.6 87.8 88.0 88.2 88.4 88.6 88.8 89.0 89.2 89.4 89.6 89.8 90.0 90.2 90.4 90.6 90.8 91.0 91.2 91.4 91.6 91.8 92.0 92.2 92.4 92.6 92.8 93.0 93.2 93.4 93.6 93.8 94.0 94.2 94.4 94.6 94.8 95.0 95.2 95.4 95.6 95.8 96.0 96.2 96.4 96.6 96.8 97.0 97.2 97.4 97.6 97.8 98.0 98.2 98.4 98.6 98.8 99.0 99.2 99.4 99.6 99.8 100.0 100.2 100.4 100.6 100.8 101.0 101.2 101.4 101.6 101.8 102.0 102.2 102.4 102.6 102.8 103.0 103.2 103.4 103.6 103.8 104.0 104.2 104.4 104.6 104.8 105.0 105.2 105.4 105.6 105.8 106.0 106.2 106.4 106.6 106.8 107.0 107.2 107.4 107.6 107.8 108.0 108.2 108.4 108.6 108.8 109.0 109.2 109.4 109.6 109.8 110.0 110.2 110.4 110.6 110.8 111.0 111.2 111.4 111.6 111.8 112.0 112.2 112.4 112.6 112.8 113.0 113.2 113.4 113.6 113.8 114.0 114.2 114.4 114.6 114.8 115.0 115.2 115.4 115.6 115.8 116.0 116.2 116.4 116.6 116.8 117.0 117.2 117.4 117.6 117.8 118.0 118.2 118.4 118.6 118.8 119.0 119.2 119.4 119.6 119.8 120.0 120.2 120.4 120.6 120.8 121.0 121.2 121.4 121.6 121.8 122.0 122.2 122.4 122.6 122.8 123.0 123.2 123.4 123.6 123.8 124.0 124.2 124.4 124.6 124.8 125.0 125.2 125.4 125.6 125.8 126.0 126.2 126.4 126.6 126.8 127.0 127.2 127.4 127.6 127.8 128.0 128.2 128.4 128.6 128.8 129.0 129.2 129.4 129.6 129.8 130.0 130.2 130.4 130.6 130.8 131.0 131.2 131.4 131.6 131.8 132.0 132.2 132.4 132.6 132.8 133.0 133.2 133.4 133.6 133.8 134.0 134.2 134.4 134.6 134.8 135.0 135.2 135.4 135.6 135.8 136.0 136.2 136.4 136.6 136.8 137.0 137.2 137.4 137.6 137.8 138.0 138.2 138.4 138.6 138.8 139.0 139.2 139.4 139.6 139.8 140.0 140.2 140.4 140.6 140.8 141.0 141.2 141.4 141.6 141.8 142.0 142.2 142.4 142.6 142.8 143.0 143.2 143.4 143.6 143.8 144.0 144.2 144.4 144.6 144.8 145.0 145.2 145.4 145.6 145.8 146.0 146.2 146.4 146.6 146.8 147.0 147.2 147.4 147.6 147.8 148.0 148.2 148.4 148.6 148.8 149.0 149.2 149.4 149.6 149.8 150.0 150.2 150.4 150.6 150.8 151.0 151.2 151.4 151.6 151.8 152.0 152.2 152.4 152.6 152.8 153.0 153.2 153.4 153.6 153.8 154.0 154.2 154.4 154.6 154.8 155.0 155.2 155.4 155.6 155.8 156.0 156.2 156.4 156.6 156.8 157.0 157.2 157.4 157.6 157.8 158.0 158.2 158.4 158.6 158.8 159.0 159.2 159.4 159.6 159.8 160.0 160.2 160.4 160.6 160.8 161.0 161.2 161.4 161.6 161.8 162.0 162.2 162.4 162.6 162.8 163.0 163.2 163.4 163.6 163.8 164.0 164.2 164.4 164.6 164.8 165.0 165.2 165.4 165.6 165.8 166.0 166.2 166.4 166.6 166.8 167.0 167.2 167.4 167.6 167.8 168.0 168.2 168.4 168.6 168.8 169.0 169.2 169.4 169.6 169.8 170.0 170.2 170.4 170.6 170.8 171.0 171.2 171.4 171.6 171.8 172.0 172.2 172.4 172.6 172.8 173.0 173.2 173.4 173.6 173.8 174.0 174.2 174.4 174.6 174.8 175.0 175.2 175.4 175.6 175.8 176.0 176.2 176.4 176.6 176.8 177.0 177.2 177.4 177.6 177.8 178.0 178.2 178.4 178.6 178.8 179.0 179.2 179.4 179.6 179.8 180.0 180.2 180.4 180.6 180.8 181.0 181.2 181.4 181.6 181.8 182.0 182.2 182.4 182.6 182.8 183.0 183.2 183.4 183.6 183.8 184.0 184.2 184.4 184.6 184.8 185.0 185.2 185.4 185.6 185.8 186.0 186.2 186.4 186.6 186.8 187.0 187.2 187.4 187.6 187.8 188.0 188.2 188.4 188.6 188.8 189.0 189.2 189.4 189.6 189.8 190.0 190.2 190.4 190.6 190.8 191.0 191.2 191.4 191.6 191.8 192.0 192.2 192.4 192.6 192.8 193.0 193.2 193.4 193.6 193.8 194.0 194.2 194.4 194.6 194.8 195.0 195.2 195.4 195.6 195.8 196.0 196.2 196.4 196.6 196.8 197.0 197.2 197.4 197.6 197.8 198.0 198.2 198.4 198.6 198.8 199.0 199.2 199.4 199.6 199.8 200.0 200.2 200.4 200.6 200.8 201.0 201.2 201.4 201.6 201.8 202.0 202.2 202.4 202.6 202.8 203.0 203.2 203.4 203.6 203.8 204.0 204.2 204.4 204.6 204.8 205.0 205.2 205.4 205.6 205.8 206.0 206.2 206.4 206.6 206.8 207.0 207.2 207.4 207.6 207.8 208.0 208.2 208.4 208.6 208.8 209.0 209.2 209.4 209.6 209.8 210.0 210.2 210.4 210.6 210.8 211.0 211.2 211.4 211.6 211.8 212.0 212.2 212.4 212.6 212.8 213.0 213.2 213.4 213.6 213.8 214.0 214.2 214.4 214.6 214.8 215.0 215.2 215.4 215.6 215.8 216.0 216.2 216.4 216.6 216.8 217.0 217.2 217.4 217.6 217.8 218.0 218.2 218.4 218.6 218.8 219.0 219.2 219.4 219.6 219.8 220.0 220.2 220.4 220.6 220.8 221.0 221.2 221.4 221.6 221.8 222.0 222.2 222.4 222.6 222.8 223.0 223.2 223.4 223.6 223.8 224.0 224.2 224.4 224.6 224.8 225.0 225.2 225.4 225.6 225.8 226.0 226.2 226.4 226.6 226.8 227.0 227.2 227.4 227.6 227.8 228.0 228.2 228.4 228.6 228.8 229.0 229.2 229.4 229.6 229.8 230.0 230.2 230.4 230.6 230.8 231.0 231.2 231.4 231.6 231.8 232.0 232.2 232.4 232.6 232.8 233.0 233.2 233.4 233.6 233.8 234.0 234.2 234.4 234.6 234.8 235.0 235.2 235.4 235.6 235.8 236.0 236.2 236.4 236.6 236.8 237.0 237.2 237.4 237.6 237.8 238.0 238.2 238.4 238.6 238.8 239.0 239.2 239.4 239.6 239.8 240.0 240.2 240.4 240.6 240.8 241.0 241.2 241.4 241.6 241.8 242.0 242.2 242.4 242.6 242.8 243.0 243.2 243.4 243.6 243.8 244.0 244.2 244.4 244.6 244.8 245.0 245.2 245.4 245.6 245.8 246.0 246.2 246.4 246.6 246.8 247.0 247.2 247.4 247.6 247.8 248.0 248.2 248.4 248.6 248.8 249.0 249.2 249.4 249.6 249.8 250.0 250.2 250.4 250.6 250.8 251.0 251.2 251.4 251.6 251.8 252.0 252.2 252.4 252.6 252.8 253.0 253.2 253.4 253.6 253.8 254.0 254.2 254.4 254.6 254.8 255.0 255.2 255.4 255.6 255.8 256.0 256.2 256.4 256.6 256.8 257.0 257.2 257.4 257.6 257.8 258.0 258.2 258.4 258.6 258.8 259.0 259.2 259.4 259.6 259.8 260.0 260.2 260.4 260.6 260.8 261.0 261.2 261.4 261.6 261.8 262.0 262.2 262.4 262.6 262.8 263.0 263.2 263.4 263.6 263.8 264.0 264.2 264.4 264.6 264.8 265.0 265.2 265.4 265.6 265.8 266.0 266.2 266.4 266.6 266.8 267.0 267.2 267.4 267.6 267.8 268.0 268.2 268.4 268.6 268.8 269.0 269.2 269.4 269.6 269.8 270.0 270.2 270.4 270.6 270.8 271.0 271.2 271.4 271.6 271.8 272.0 272.2 272.4 272.6 272.8 273.0 273.2 273.4 273.6 273.8 274.0 274.2 274.4 274.6 274.8 275.0 275.2 275.4 275.6 275.8 276.0 276.2 276.4 276.6 276.8 277.0 277.2 277.4 277.6 277.8 278.0 278.2 278.4 278.6 278.8 279.0 279.2 279.4 279.6 279.8 280.0 280.2 280.4 280.6 280.8 281.0 281.2 281.4 281.6 281.8 282.0 282.2 282.4 282.6 282.8 283.0 283.2 283.4 283.6 283.8 284.0 284.2 284.4 284.6 284.8 285.0 285.2 285.4 285.6 285.8 286.0 286.2 286.4 286.6 286.8 287.0 287.2 287.4 287.6 287.8 288.0 288.2 288.4 288.6 288.8 289.0 289.2 289.4 289.6 289.8 290.0 290.2 290.4 290.6 290.8 291.0 291.2 291.4 291.6 291.8 292.0 292.2 292.4 292.6 292.8 293.0 293.2 293.4 293.6 293.8 294.0 294.2 294.4 294.6 294.8 295.0 295.2 295.4 295.6 295.8 296.0 296.2 296.4 296.6 296.8 297.0 297.2 297.4 297.6 297.8 298.0 298.2 298.4 298.6 298.8 299.0 299.2 299.4 299.6 299.8 300.0 300.2 300.4 300.6 300.8 301.0 301.2 301.4 301.6 301.8 302.0 302.2 302.4 302.6 302.8 303.0 303.2 303.4 303.6 303.8 304.0 304.2 304.4 304.6 304.8 305.0 305.2 305.4 305.6 305.8 306.0 306.2 306.4 306.6 306.8 307.0 307.2 307.4 307.6 307.8 308.0 308.2 308.4 308.6 308.8 309.0 309.2 309.4 309.6 309.8 310.0 310.2 310.4 310.6 310.8 311.0 311.2 311.4 311.6 311.8 312.0 312.2 312.4 312.6 312.8 313.0 313.2 313.4 313.6 313.8 314.0 314.2 314.4 314.6 314.8 315.0 315.2 315.4 315.6 315.8 316.0 316.2 316.4 316.6 316.8 317.0 317.2 317.4 317.6 317.8 318.0 318.2 318.4 318.6 318.8 319.0 319.2 319.4 319.6 319.8 320.0 320.2 320.4 320.6 320.8 321.0 321.2 321.4 321.6 321.8 322.0 322.2 322.4 322.6 322.8 323.0 323.2 323.4 323.6 323.8 324.0 324.2 324.4 324.6 324.8 325.0 325.2 325.4 325.6 325.8 326.0 326.2 326.4 326.6 326.8 327.0 327.2 327.4 327.6 327.8 328.0 328.2 328.4 328.6 328.8 329.0 329.2 329.4 329.6 329.8 330.0 330.2 330.4 330.6 330.8 331.0 331.2 331.4 331.6 331.8 332.0 332.2 332.4 332.6 332.8 333.0 333.2 333.4 333.6 333.8 334.0 334.2 334.4 334.6 334.8 335.0 335.2 335.4 335.6 335.8 336.0 336.2 336.4 336.6 336.8 337.0 337.2 337.4 337.6 337.8 338.0 338.2 338.4 338.6 338.8 339.0 339.2 339.4 339.6 339.8 340.0 340.2 340.4 340.6 340.8 341.0 341.2 341.4 341.6 341.8 342.0 342.2 342.4 342.6 342.8 343.0 343.2 343.4 343.6 343.8 344.0 344.2 344.4 344.6 344.8 345.0 345.2 345.4 345.6 345.8 346.0 346.2 346.4 346.6 346.8 347.0 347.2 347.4 347.6 347.8 348.0 348.2 348.4 348.6 348.8 349.0 349.2 349.4 349.6 349.8 350.0 350.2 350.4 350.6 350.8 351.0 351.2 351.4 351.6 351.8 352.0 352.2 352.4 352.6 352.8 353.0 353.2 353.4 353.6 353.8 354.0 354.2 354.4 354.6 354.8 355.0 355.2 355.4 355.6 355.8 356.0 356.2 356.4 356.6 356.8 357.0 357.2 357.4 357.6 357.8 358.0 358.2 358.4 358.6 358.8 359.0 359.2 359.4 359.6 359.8 360.0 360.2 360.4 360.6 360.8 361.0 361.2 361.4 361.6 361.8 362.0 362.2 362.4 362.6 362.8 363.0 363.2 |          |

### SECTION III

#### DESCRIPTION OF FUNCTIONS AND LISTINGS

**SUBJECT:** FUNCTION AREA

**PURPOSE:** FUNCTION AREA computes flow area

**METHOD:** 
$$\text{AREA} = \frac{R W T}{P V C_D} = \text{sq. ft.}$$

**USAGE:**  $A = \text{AREA} (W, T, P, V, C_D)$

W Inlet mass flow lb/sec

T Nozzle throat static temperature  
degrees R

P Nozzle throat static pressure lb/ft<sup>2</sup>

V Nozzle throat velocity ft/sec

C<sub>D</sub> Discharge coefficient = 1.0

RUN VERSION JUL 71 22.46.38. 72/08/23.

F J N C T I O N A R E A ( M , T , P , V , C D )

800010 AREA=53.342\*W\*7/(P\*V\*CD)

800014 R E T U R N

800014 E N D

RUN VERSION JUL 71

22.46.30. 72/08/23.

PAGE 002

SUBPROGRAM LENGTH  
000021

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

EXTERNALS AND TABS  
END. - 50810C

BLOCK NAMES AND LENGTHS

VARIABLE ASSIGNMENTS  
AREA - 03002C

START OF CONSTANTS  
000015

START OF TEMPORARIES  
000016

START OF INDIRECTS  
00002C

SPACE REQUIRED TO COMPILE  
03523C

SUBJECT: Thermodynamic function set;  $H_{\phi FT}$ ,  $T_{\phi FH}$ ,  $PR_{\phi FH}$ ,  $C_{\phi FH}$ , and  $C_{\phi FHS}$ .

PURPOSE: The thermodynamic function set produces data from Keenan and Kaye Gas Tables to the program.

METHOD: A polynomial fit of the tabular data is used. The appropriate coefficients are determined by the checking the range of the input variables.

USAGE:  $H = H_{\phi FT}(T, F_{\phi A})$   
 $T = T_{\phi FH}(H, F_{\phi A})$   
 $PR = PR_{\phi FH}(H, F_{\phi A})$   
 $H = H_{\phi FPR}(PR, F_{\phi A})$   
 $C = C_{\phi FH}(HT, F_{\phi A})$   
 $C = C_{\phi FHS}(HS, F_{\phi A})$

H Enthalpy BTU/lb                      T temperature degrees R

$F_{\phi A}$  fuel/air ratio                      PR relative pressure

C sonic velocity ft/sec      HT total enthalpy BTU/lb

HS static enthalpy BTU/lb

The fuel is assumed to be a hydrocarbon of composition,  $C_N H_{2N}$ .

```

C      FUNCTION MOFT(Y, FOA)
C      AUTHOR      S. C. RAYL      JANUARY, 1971
C      SUBROUTINE CALCULATES ENTHALPY AS A FUNCTION OF TEMPERATURE AND
C      FUEL/AIR RATIO. FUEL IS A HYDROCARBON OF COMPOSITION C(N)H(2N)
C      INPUTS
C      Y      = TEMPERATURE, DEG. R.
C      FOA    = FUEL/AIR RATIO
C      OTHER QUANTITIES
C      ER     = EQUIVALENCE RATIO (FUEL/AIR RATIO DIVIDED BY
C      STOICHIOMETRIC FUEL/AIR RATIO)
C      OUTPUTS
C      MOFT   = ENTHALPY, BTU/LBH.
C
C      DIMENSION A(12), B(12), C(5)
C      DATA (A(I), I=1,12) /
C      A      -6.752111, 242.6325, -6.752111, 1.337725,
C      B      6.73397, -2.351273, 25.2052667, 100.6058,
C      C      43.76364, -8.394387, 1.053822, -.0524913 /
C      DATA (B(I), I=1,12) /
C      D      1.605584, -7.261979, 20.96417, -12.58440,
C      E      2.512776, 0., -2.015578, 7.772516,
C      F      8.243529, -.0119861, -.000119473, 0. /
C      DATA (C(I), I=1,5) /
C      G      .7354312, -.1061944, -.7570786, .1192376,
C      H      -.00495369 /
C      I = 1
C      IF (Y .GT. 1440.) I=7
C      TX = .CG1 * Y
C      MOFT = A(I) + TX*(A(I+1) + TX*(A(I+2) + TX*(A(I+3) + TX*(A(I+4)
C      + TX*(A(I+5))))))
C      IF (FOA .EQ. 0.) RETURN
C      XB = B(I) + TX*(B(I+1) + TX*(B(I+2) + TX*(B(I+3) + TX*(B(I+4) + TX*(B(I+5))))))
C      XC = C(I) + TX*(C(I+1) + TX*(C(I+2) + TX*(C(I+3) + TX*(C(I+4) + TX*(C(I+5))))))
C      C2 = 14.75315 * FOA
C      MOFT = MOFT + ER * (XB + ER * XC)
C      RETURN
C      END

```

SUBPROGRAM LENGTH  
001126

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

EXTERNALS AND TAGS  
END. - 500100

BLOCK NAMES AND LENGTHS

| VARIABLE ASSIGNMENTS |   |        |    |   |        |
|----------------------|---|--------|----|---|--------|
| A                    | - | 000364 | B  | - | 000100 |
| MOFT                 | - | 000363 | I  | - | 000121 |
| MC                   | - | 000124 |    |   |        |
|                      |   |        | C  | - | 000114 |
|                      |   |        | TX | - | 000122 |
|                      |   |        | ER | - | 000125 |
|                      |   |        | X0 | - | 000123 |

START OF CONSTANTS  
000037

START OF TEMPORARIES  
000062

START OF INDIRECTS  
000063

SPACE REQUIRED TO COMPILE  
000066

```

      FUNCTION TOFM(H, FOA)
      C
      C AUTHOR          S. G. RAYL          JANUARY, 1971
      C
      C SUBROUTINE CALCULATES TEMPERATURE AS A FUNCTION OF ENTHALPY AND
      C FUEL/AIR RATIO. FUEL IS A HYDROCARBON OF COMPOSITION C(M)H(2M)
      C
      C INPUTS
      C M      = ENTHALPY, BTU/LBM.
      C FOA    = FUEL/AIR RATIO
      C
      C OTHER QUANTITIES
      C ER      = EQUIVALENCE RATIO (FUEL/AIR RATIO DIVIDED BY
      C          STOICHIOMETRIC FUEL/AIR RATIO)
      C
      C OUTPUTS
      C TOFM    = TEMPERATURE, DEG. R.
      C
      C DIMENSION A(12), H(12), C(12)
      C DATA (A(I), I=1,12) /
      C 0 5.2356, 4041.695, 1473.279, -6846.514,
      C 8 6176.345, -1245.349, -51.598, 4883.317,
      C 2 -2193.152, 1834.790, -853.332, 166.2833 /
      C
      C DATA (H(I), I=1,12) /
      C 0 -6.4550, 132.0967, -2270.842, 4793.166,
      C 8 -3019.591, 6., -226.8651,
      C 2 -263.4827, 72.07638, -4.734135, 0. /
      C
      C DATA (C(I), I=1,12) /
      C 0 .66707, -25.76324, 342.9483, -710.3386,
      C 8 .277.1753, 6., 2.851454, -5052.354,
      C 2 .45.33835, -50.47864, 9.416551, 0. /
      C
      C I = 1
      C IF (M .GT. 433.458) I=7
      C H = .C(1) * H
      C TOFM = A(I) + H*(A(I+1) + H*(A(I+2) + H*(A(I+3) + H*(A(I+4)
      C J = H*(A(I+5)))
      C IF (FOA .EQ. 0.) RETURN
      C XM = B(I) + H*(B(I+1) + H*(B(I+2) + H*(B(I+3) + H*(B(I+4)))
      C XC = C(I) + H*(C(I+1) + H*(C(I+2) + H*(C(I+3) + H*(C(I+4)))
      C ER = 1.7015 * FOA
      C TOFM = TOFM + ER*(XM + ER * XC)
      C RETURN
      C END
  
```

SUBPROGRAM LENGTH  
000134

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

EXTERNALS AND TAGS  
END. - S00100

BLOCK NAMES AND LENGTHS

| VARIABLE ASSIGNMENTS |   |        |      |   |        |
|----------------------|---|--------|------|---|--------|
| A                    | - | 000063 | B    | - | 000077 |
| MA                   | - | 000130 | I    | - | 000127 |
| XC                   | - | 000132 |      |   |        |
|                      |   |        | C    | - | 000113 |
|                      |   |        | TOFH | - | 000062 |
|                      |   |        | ER   | - | 000133 |
|                      |   |        | XB   | - | 000131 |

START OF CONSTANTS  
000056

START OF TEMPORARIES  
000061

START OF INDIRECTS  
000062

SPACE REQUIRED TO COMPILE  
035630

FUNCTION PROFM(H,FOA)

C AUTHOR S. C. RAYL JANUARY, 1971

C SUBROUTINE CALCULATES RELATIVE PRESSURE AS A FUNCTION OF ENTHALPY  
C AND FUEL/AIR RATIO. FUEL IS A HYDROCARBON OF COMPOSITION C(N)H(2N)

C INPUTS  
C H = ENTHALPY, BTU/LbM  
C FOA = FUEL/AIR RATIO

C OTHER QUANTITIES  
C ER = EQUIVALENCE RATIO (FUEL/AIR RATIO DIVIDED BY  
C STOICHIOMETRIC FUEL/AIR RATIO)

C OUTPUTS  
C RELATIVE PRESSURE (DIMENSIONLESS)

C DIMENSION A(14),J(14),C(14)  
C DATA(A1), I=1,14//  
A -.035869328, 1.8093139, -39.88328, 693.827519,  
B 1271.71594, 139.873914, 318.438817, 11.1827252,  
C -.95.653550, 315.653723, 16.566633, 1881331732,  
D 182.538424, 36.178329/  
C DATA(B1), I=1,14//  
E -.127564584, 26.343109, -343.703710,  
F 868.624288, -316.554050, 586.974753, -13.1470397,  
G 114.649099, -416.382627, 655.932098, -639.272328,  
H 1147.663904, -93.574557/  
C DATA(C1), I=1,14//  
I .0012308336, .034872705, -2.427593, 51.427321,  
J -212.709122, 196.971110, -47.809155, -2.7649713,  
K 21.651354, -62.621283, 112.113531, -146.323364,  
L -24.432159, 113.212657/  
C I = 1

C IF (4 .GT. 433.408) I=8  
C -X = .C(1) + H  
C PROF4 = A(I) + MX\*(A(I+1) + -X\*(A(I+2) + MX\*(A(I+3) + MX\*(A(I+4)  
C M + MX\*(A(I+5) + MX\*(A(I+6))))))  
C IF (FOA .EQ. 0.) RETURN  
C XB = B(I) + MX\*(B(I+1) + MX\*(B(I+2) + MX\*(B(I+3) + MX\*(B(I+4)  
C M + MX\*(B(I+5) + MX\*(B(I+6))))))  
C XC = C(I) + MX\*(C(I+1) + MX\*(C(I+2) + MX\*(C(I+3) + MX\*(C(I+4)  
C O + MX\*(C(I+5) + MX\*(C(I+6))))))  
C ER = 14.70015 + FOA  
C PROF4 = PROFM + ER \* (XB + ER + XC)

C RETURN  
C END

SUBPROGRAM LENGTH  
000151

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

EXTERNALS AND TAGS  
END. - 000100

BLOCK NAMES AND LENGTHS

VARIABLE ASSIGNMENTS

|    |   |        |   |   |        |       |   |        |    |   |        |
|----|---|--------|---|---|--------|-------|---|--------|----|---|--------|
| A  | - | 000072 | B | - | 000110 | C     | - | 000126 | ER | - | 000150 |
| HA | - | 000145 | I | - | 000144 | PROFH | - | 000071 | XB | - | 000146 |
| XC | - | 000147 |   |   |        |       |   |        |    |   |        |

START OF CONSTANTS

000005

START OF TEMPORARIES

000076

START OF INDIRECTS

000071

SPACE REQUIRED TO COMPILE

355736

| FUNCTION MOFPR,PR,FOA)      |                                                                                                                                       |                     |                      |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------------|
| C                           | AUTHOR                                                                                                                                | S. C. RAYL          | JANUARY, 1971        |
| C                           | SUBROUTINE CALCULATES ENTHALPY AS A FUNCTION OF RELATIVE PRESSURE AND FUEL/AIR RATIO. FUEL IS A HYDROCARBON OF COMPOSITION C(N)H(M2M) |                     |                      |
| C                           | INPUTS                                                                                                                                |                     |                      |
| C                           | PR (DIMENSIONLESS)                                                                                                                    |                     |                      |
| C                           | FOA = FUEL/AIR RATIO                                                                                                                  |                     |                      |
| C                           | OTHER QUANTITIES                                                                                                                      |                     |                      |
| C                           | ER = EQUIVALENCE RATIO (FUEL/AIR RATIO DIVIDED BY STOICHIOMETRIC FUEL/AIR RATIO)                                                      |                     |                      |
| C                           | OUTPUTS                                                                                                                               |                     |                      |
| C                           | MOFPR = ENTHALPY, BTU/LBM.                                                                                                            |                     |                      |
| DIMENSION A(35),B(35),C(35) |                                                                                                                                       |                     |                      |
| DATA (A(1),1=1,35)/         |                                                                                                                                       |                     |                      |
| A                           | 33.0895665,                                                                                                                           | 0229296.08125,      | 174424006810.17,     |
| B                           | 3942574933674.E+1,                                                                                                                    | 167844.82625,       | 1245118736.7728,     |
| C                           | 125373112.99358E+4,                                                                                                                   | 68.457196224,       | 1431962.971228,      |
| D                           | 2594290877.4428,                                                                                                                      | 504236131241.44,    | 9269.19768,          |
| E                           | 9150335.4610,                                                                                                                         | 816182158.1203,     | 128.4584235885,      |
| F                           | 33266.053835,                                                                                                                         | 63341581.85517,     | 143060393.4649,      |
| G                           | 1474.19465,                                                                                                                           | 122937.4314,        | 1337688.1442,        |
| H                           | 226.0305051173,                                                                                                                       | 73274.936524,       | 2076179.38711,       |
| I                           | 0385535.86687,                                                                                                                        | 146.4228128,        | 2388.88215,          |
| J                           | 3680.30315,                                                                                                                           | 344.5253717671,     | 19420.9836934,       |
| K                           | 37255.36617,                                                                                                                          | 4290.93414,         | 23.857493,           |
| L                           | 03.4822381,                                                                                                                           | 16.11137356         | /                    |
| DATA (B(1),1=1,35)/         |                                                                                                                                       |                     |                      |
| M                           | 3.1513220619,                                                                                                                         | 77522.98151,        | -1765401381.3742,    |
| N                           | 15071287218+9.,                                                                                                                       | -3524142866519.E+4, | 3156140032377.E+7,   |
| O                           | -426177464182.E+12,                                                                                                                   | 5.3216322373,       | 4442.46644,          |
| P                           | -12773345.57330,                                                                                                                      | 13651742492.098,    | -8005467874.970.8,   |
| Q                           | 24237366725112.E+2,                                                                                                                   | -2953236150743.E+5, | 6.9061722977,        |
| R                           | -2231.88132,                                                                                                                          | 151410.83426,       | -11443244.18617,     |
| S                           | 18133325.37.19,                                                                                                                       | -1975835508.259,    | 27501335311.36,      |
| T                           | 3.0560231754,                                                                                                                         | -1225.466378,       | 19666.3119977,       |
| U                           | -27428.64924,                                                                                                                         | 2437.21.38752,      | -11698873.15172,     |
| V                           | 2424373.37542,                                                                                                                        | -11.3321387105,     | -488.005311,         |
| W                           | 1427.33624,                                                                                                                           | -3464.46466,        | 5272.642720,         |
| X                           | -413.39556,                                                                                                                           | 1543.46441          | /                    |
| DATA (C(1),1=1,35)/         |                                                                                                                                       |                     |                      |
| Y                           | -1156147855,                                                                                                                          | -5043.33661,        | 62170753.91263,      |
| Z                           | -453313426465.92,                                                                                                                     | 17161918261022.E+2, | -25446185274924.E+5, |
| A                           | ...                                                                                                                                   | -3033133042,        | -337.366526,         |
| B                           | 1155008.765252,                                                                                                                       | -901754007.71009,   | 36533336676.42,      |
| C                           | -56317448439233.,                                                                                                                     | 0.,                 | -4758866541,         |
| D                           | 301.055573,                                                                                                                           | -13159.274046,      | 663816.87816,        |

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```

E -23371050.45027, 393717503.24254, 0., -2154.622705,
F .6847565720, 104.780430, -127377.31427, 264481.936484,
G 22002.05508, -127377.31427, 264481.936484, 81.811924,
H 3., 2.6579347543, 302.29717, -292.89036,
I -175.35589, 302.29717, /
J 117.130097, 0.

000035 I=1
000035 IF (PR .GT. 2.2440) I=4
000035 IF (PR .GT. 2.2440) I=15
000035 IF (PR .GT. 101.1636) I=22
000035 IF (PR .GT. 1200.0219) I=29
000035 PRX = C(3) + PR
000035 MOFPR = (A(I) + PRX*(A(I+1) + PRX*(A(I+2) + PRX*(A(I+3) + PRX*(A(I+4) + PRX*(A(I+5) + PRX*(A(I+6)))))) /
000035 K (1. + PRX*(A(I+4) + PRX*(A(I+5) + PRX*(A(I+6))))
000035 IF (FOA .EQ. 0.) RETURN
000035 XB = B(1) + PRX*(B(1+1) + PRX*(B(1+2) + PRX*(B(1+3) + PRX*(B(1+4) + PRX*(B(1+5) + PRX*(B(1+6))))))
000035 XC = C(1) + PRX*(C(1+1) + PRX*(C(1+2) + PRX*(C(1+3) + PRX*(C(1+4) + PRX*(C(1+5) + PRX*(C(1+6))))))
000035 M = PRX*(C(1+5) + PRX*(C(1+6)))
000035 ER = 14.76315 + FOA
000035 MOFPA = MOFPR + ER * (XB + ER * XC)
000035 RETURN
000035 END

```

SUBPROGRAM LENGTH  
00273

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

EXTERNALS AND TAGS  
END. - S0010J

BLOCK NAMES AND LENGTHS

VARIABLE ASSIGNMENTS

|       |   |        |   |   |        |     |   |        |    |   |        |
|-------|---|--------|---|---|--------|-----|---|--------|----|---|--------|
| A     | - | 000113 | B | - | 000160 | C   | - | 000223 | ER | - | 000272 |
| MO-PR | - | 000114 | I | - | 000206 | PRX | - | 000257 | X0 | - | 000270 |
| MC    | - | 000271 |   |   |        |     |   |        |    |   |        |

START OF CONSTANTS

0001J3

START OF TEMPORARIES

0001J2

START OF INDIRECTS

0001J4

SPACE REQUIRED TO COMPILE  
0005J0

| FUNCTION COFM(M, FOA)         |                                                             | S. C. RAYL                                     |                | JANUARY, 1971  |  |
|-------------------------------|-------------------------------------------------------------|------------------------------------------------|----------------|----------------|--|
| C                             | AUTHOR                                                      |                                                |                |                |  |
| C                             | FUNCTION CALCULATES CRITICAL (MACH = 1) SONIC VELOCITY AS A |                                                |                |                |  |
| C                             | FUNCTION OF TOTAL ENTHALPY AND FUEL/AIR RATIO. FUEL IS A    |                                                |                |                |  |
| C                             | HYDROCARBON OF COMPOSITION C(N)H(2M)                        |                                                |                |                |  |
| C                             |                                                             |                                                |                |                |  |
| C                             | INPUTS                                                      |                                                |                |                |  |
| C                             | M                                                           | = TOTAL ENTHALPY, BTU/LBM                      |                |                |  |
| C                             | FOA                                                         | = FUEL/AIR RATIO                               |                |                |  |
| C                             |                                                             |                                                |                |                |  |
| C                             | OTHER QUANTITIES                                            |                                                |                |                |  |
| C                             | ER                                                          | = EQUIVALENCE RATIO (FUEL/AIR RATIO DIVIDED BY |                |                |  |
| C                             | STOICHIOMETRIC FUEL/AIR RATIO)                              |                                                |                |                |  |
| C                             |                                                             |                                                |                |                |  |
| C                             | OUTPUTS                                                     |                                                |                |                |  |
| C                             | COFM                                                        | = CRITICAL SONIC VELOCITY                      |                |                |  |
| C                             |                                                             |                                                |                |                |  |
| DIMENSION A(30), B(30), C(30) |                                                             |                                                |                |                |  |
| DATA (A(I), I=1,30) /         |                                                             |                                                |                |                |  |
| A                             | 287.73365,                                                  | 8768.12549,                                    | -34774.99027,  | 122050.46815,  |  |
| B                             | -29030.34700,                                               | 223329.52375,                                  | 677.24353,     | 2627.47247,    |  |
| C                             | -868.23502,                                                 | -36713.46231,                                  | 46276.23471,   | -25109.76645,  |  |
| J                             | 331.704145,                                                 | 6382.33657,                                    | -10614.35876,  | 11816.68445,   |  |
| E                             | -852.33102,                                                 | 1316.05773,                                    | 3105.04552,    | -10972.52279,  |  |
| F                             | 3253.23785,                                                 | -41335.83319,                                  | 25630.75433,   | -6295.60766,   |  |
| G                             | 1623.16258,                                                 | -922.73017,                                    | 5705.89734,    | -6352.74300,   |  |
| M                             | 5242.37010,                                                 | -841.76647,                                    |                |                |  |
| DATA (B(I), I=1,30) /         |                                                             |                                                |                |                |  |
| I                             | -13.44793,                                                  | 271.37288,                                     | -3950.09189,   | 13597.19441,   |  |
| J                             | -18575.42276,                                               | 6312.31213,                                    | -347.90518,    | 4612.97154,    |  |
| K                             | -28154.31485,                                               | 70169.29836,                                   | -92269.74018,  | 47771.49423,   |  |
| L                             | 90.33498,                                                   | -39756.07127,                                  | 129804.13722,  | -211856.24957, |  |
| M                             | 17222.43663,                                                | -55795.54381,                                  | -8453.13297,   | 52978.95471,   |  |
| N                             | -13334.83771,                                               | 10687.42429,                                   | -104113.26372, | 25329.98315,   |  |
| O                             | 1115.77324,                                                 | -4777.37156,                                   | 7333.33232,    | -5636.29346,   |  |
| P                             | 2.0340473,                                                  | -283.22993,                                    |                |                |  |
| DATA (C(I), I=1,30) /         |                                                             |                                                |                |                |  |
| Q                             | 1.42321,                                                    | 52.25002,                                      | 642.83334,     | -2009.97789,   |  |
| R                             | 2541.03300,                                                 | 6.9,                                           | -67.63421,     | 722.53323,     |  |
| S                             | -6022.11061,                                                | 4459.49806,                                    | -2756.97349,   | 3.9,           |  |
| T                             | 7.9437,                                                     | -31.91254,                                     | 130.83947,     | -121.39847,    |  |
| U                             | 35.03442,                                                   | 6.9,                                           | -143.33757,    | 352.91171,     |  |
| V                             | -1593.33069,                                                | 1030.88603,                                    | -283.64163,    | 6.9,           |  |
| W                             | -202.73743,                                                 | 1005.11443,                                    | -2109.50434,   | 1333.00472,    |  |
| X                             | -310.52364,                                                 | 6.9,                                           |                |                |  |
| I = 1                         |                                                             |                                                |                |                |  |
| IF (4 .GT. 291.522)           | I=7                                                         |                                                |                |                |  |
| IF (4 .GT. 215.820)           | I=13                                                        |                                                |                |                |  |
| IF (4 .GT. 703.331)           | I=19                                                        |                                                |                |                |  |
| IF (4 .GT. 914.624)           | I=25                                                        |                                                |                |                |  |

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```

000025      M4 = .001 * M
000026      COFM = A(I) * MX*(A(I+1) + MX*(A(I+2) + MX*(A(I+3) + MX*(A(I+4)
          + MX*(A(I+5))))))
000027      IF (FOA.EQ. 0.) RETURN
000028      XB = B(I) + MX*(B(I+1) + MX*(B(I+2) + MX*(B(I+3) + MX*(B(I+4)
          + MX*(B(I+5))))))
000029      XJ = C(I) + MX*(C(I+1) + MX*(C(I+2) + MX*(C(I+3) + MX*(C(I+4)
          + MX*(C(I+5))))))
000030      ER = 14.75315 * FOA
000031      COFM = COF4 + ER * (XB + ER * XJ)
000032      RETURN
000033      END

```

SUBPROGRAM LENGTH  
060243

## FUNCTION ASSIGNMENTS

## STATEMENT ASSIGNMENTS

EXTERNALS AND TAGS  
END. - SC010C

## BLJCK NAMES AND LENGTHS

| VARIBLE | ASSIGNMENTS | C | COFM |
|---------|-------------|---|------|
| A       | - 000104    | - | -    |
| ER      | - 000242    | I | -    |
| XC      | - 000241    | - | -    |

## STATE OF CONSTANTS

55-74

## START OF TEMPORARIES

20163

## START OF INJURIES

CCJ 123

SPACE REQUIRED TO COMPLETE

33

RUN VERSION JUL 71 22.46.30. 72/30/23.

FUNCTION COFMS (M,FOA)

S. G. RAYL JANUARY, 1971

SUBROUTINE CALCULATES SONIC VELOCITY AS A FUNCTION OF STATIC ENTHALPY AND FUEL/AIR RATIO. FUEL IS A HYDROCARBON OF COMPOSITION C(N)H(2N)

INPUTS

H = STATIC ENTHALPY, BTU/LBM.  
FOA = FUEL/AIR RATIO

OTHER QUANTITIES

ER = EQUIVALENCE RATIO (FUEL/AIR RATIO DIVIDED BY STOICHIOMETRIC FUEL/AIR RATIO)

OUTPUTS

COFMS = SONIC VELOCITY, FT/SEC

J DIMENSION A(35),J(35),C(35)

JATA (A(I),I=1,35)/

|   |                |                |                |                 |
|---|----------------|----------------|----------------|-----------------|
| A | 203.3265,      | 10797.7053,    | -56078.635,    | 276156.237,     |
| B | -901657.263,   | 1633251.076,   | -1226974.245,  | 2726.0400,      |
| C | -32.52727,     | 269222.677,    | -1003542.394,  | 2109408.2355,   |
| D | -2325394.359,  | 1055523.027,   | 11500.9117,    | -122697.6866,   |
| E | 51633.097,     | -1613923.5455, | 2347503.419,   | -1814548.366,   |
| F | 561518.498,    | 1944.0333,     | -2412.4025,    | 10330.927,      |
| G | -37.71343,     | 39654.481,     | -21644.153,    | 4824.6501,      |
| H | -102408.284,   | 1034497.502,   | -2414549.5854, | 3305968.2671,   |
| I | -2122384.7391, | 702759.3932,   | -12125.4652,   |                 |
| J | 0.372277,      | -498.4250,     | 7412.7167,     | -90431.6578,    |
| K | 96488.6757,    | -1273900.521,  | 1247375.8983,  | -8554.803795,   |
| L | 1.77612639,    | -1050419.1291, | 4223695.5963,  | -8526354.2777,  |
| M | 490341.0317,   | -4443037.5202, | 11026.5075,    | -111568.6151,   |
| N | 47335.5561,    | -97267.1173,   | 1117173.3339,  | -64185.3436,    |
| O | 159048.4568,   | 4296.7742,     | -33083.0419,   | 100431.8669,    |
| P | -159341.3343,  | 144294.4551,   | -85473.2535,   | 12539.6235,     |
| Q | 516039.3101,   | -4500516.3665, | 18731807.740,  | -13357663.8456, |
| R | 436433.7488,   | -3498414.3017, | 563102.1273,   |                 |

JATA (C(I),I=1,35)/

|   |                |               |                |                |
|---|----------------|---------------|----------------|----------------|
| S | 2.12339,       | -44.251071,   | 231.5120,      | 6436.1547,     |
| T | -96835.3453,   | 170459.3312,  | -194082.4619,  | 5217.8311,     |
| U | -90357.3478,   | 048765.3630,  | -240838.2281,  | 525334.60605,  |
| V | -546535.5584,  | 2767783.3485, | -30371.4661,   | 343020.2405,   |
| W | 1575805.1554,  | 3340352.6101, | -257451.7324,  | 3815969.8088,  |
| X | -1143453.8603, | -46745053,    | 35039.2138,    | -133777.7592,  |
| Y | 176784.4270,   | -104215.3519, | 79911.5355,    | -16096.9183,   |
| Z | -712915.17432, | 406761.3184,  | -9372293.3747, | 11677315.0170, |
| 1 | -0173211.0205, | 3046901.8723, | -472627.5643,  |                |

I=1

IF (4.0F. 276.035) I=8

IF (M.5F. 443.712) I=15

000005

000005

000011

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```

000015 IF (M .GT. 517.209) I=22
000021 IF (M .GT. 960.222) I=29
000025 HX = .001 * M
000026 COFMS = A(I) + HX*(A(I+1) + HX*(A(I+2) + HX*(A(I+3) + HX*(A(I+4)
      1 + HX*(A(I+5) + HX*(A(I+6))))))
000031 IF (FOA .EQ. 0.) RETURN
000044 XB = B(I) + HX*(B(I+1) + HX*(B(I+2) + HX*(B(I+3) + HX*(B(I+4)
      1 + HX*(B(I+5) + HX*(B(I+6))))))
000057 XC = C(I) + HX*(C(I+1) + HX*(C(I+2) + HX*(C(I+3) + HX*(C(I+4)
      1 + HX*(C(I+5) + HX*(C(I+6))))))
000071 ER = 14.76015 * FOA
000072 COFMS = 33FMS + ER * IX6 + ER * XC)
000100 RETURN
000130 END
000130 *DECK DATA

```

SUBPROGRAM LENGTH  
000267

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

EXTERNALS AND TAGS  
ENJ. - S00100

BLOCK NAMES AND LENGTHS

VARIABLE ASSIGNMENTS

|    |   |        |    |   |        |   |   |        |       |   |        |
|----|---|--------|----|---|--------|---|---|--------|-------|---|--------|
| A  | - | 000111 | B  | - | 000154 | C | - | 000217 | COFMS | - | 000110 |
| ER | - | 000260 | HX | - | 000263 | I | - | 000262 | XB    | - | 000264 |
| XC | - | 000265 |    |   |        |   |   |        |       |   |        |

START OF CONSTANTS

000101

START OF TEMPORARIES

000107

START OF INDIRECTS

000110

SPACE REQUIRED TO COMPLETE

035500

SUBJECT: FUNCTION KOUNT

PURPOSE: FUNCTION KOUNT counts the number of input points on a ten field seven digit input card.

METHOD: Starting with the right most field a test is made for a blank field. Upon finding a non-blank field that field number is returned as the input count.

USAGE: K = KOUNT (CARD, NFI)

CARD - Array of input points

NFI - Maximum fields defined on card  
- 10

FUNCTION KOUNT ( CARD,NFI)

C KOUNT DETERMINES THE NUMBER OF NON-BLANK INPUT FIELDS ON A DATA  
C CARD. THE CARDS ARE PACKED SO THE FIRST BLANK FIELD TERMINATES  
C THE INPUT. SEVEN DIGIT FORMAT IS ASSUMED.

000035 JIMENSION CARD(1)

000036 NF=NFI

000037 K=NFI

000038 DO 1, I=1,NF

000039 IF (CARD(I).NE.0.0) GO TO 20

000040 IF (SIGN(1.0,CARD(I)).GT.0.0) GO TO 20

000041 IF (SIGN(1.0,CARD(I)).GT.0.0) GO TO 20

000042 KTM FIELD IS BLANK - CHECK (K-1)TH FIELD

000043 13 K=K-1

000044 C KTM FIELD NON-BLANK - K DATA FIELDS INPUT

000045 23 KOUNT=K

000046 RETURN

000047 END

SUBPROGRAM LENGTH  
000034

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS  
20 - 000023

EXTERNALS AND TAGS  
END. - 500100

BLOCK NAMES AND LENGTHS

VARIABLE ASSIGNMENTS  
I - 000033 K - 000032 COUNT - 000030 NF - 000031

START OF CONSTANTS  
000026

START OF TEMPORARIES  
000027

START OF INDIRECTS  
000030

SPACE REQUIRED TO COMPLETE  
035230

SUBJECT: FUNCTION DEMAND

PURPOSE: FUNCTION DEMAND computes engine demand,  $A_O/A_C$ , as a function of recovery factor.

METHOD: 
$$\text{DEMAND} = \frac{\text{Area RFW}_C}{A_C} + \frac{\text{Area RFW}_S}{A_C} + \frac{A_{O_{BY}}}{A_C}$$

where  $A_{O_{BY}}$  is from Table 7  
$$\frac{A_{O_{BY}}}{A_C}$$

USAGE:  $A_{OAC} = \text{DEMAND}(\text{RF})$

RF is recovery factor

Area = AREAF (Mach)

$W_C$  = Engine airflow

$W_S$  = Secondary airflow

$A_C$  = Capture area

SUBPROGRAMS: TABU2



RUN VERSION JUL 71 22.46.30. 72/04/25.

SUBPROGRAM LENGTH  
060032

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

EXTERNALS AND TAGS  
TABU2 - SC0103 END. - SC0200

BLOCK NAMES AND LENGTHS  
AC - 000005 AREAVL - 000001 MC - 000002  
TAB7 - 000172 GAMMA - 000001

VARIABLE ASSIGNMENTS

AC - 00000001 AREA - 00000002 A0BYAC - 000002001 A0EAC - 000001001  
COM - 000031 DEMAND - 000030 NTX7 - 000170005 NTY7 - 000171005  
TAB7A - 00000005 TAB7V - 000012005 TAB7Z - 000020005 MCENG - 000000004  
MCSEC - 000001004 ANZERO - 000000003

START OF CONSTANTS

000026

START OF TEMPORARIES

000027

START OF INDIRECTS

000030

SPACE REQUIRED TO COMPILE

035330

NUM VERSION JUL 71 22.46.30. 72/38/23.

```

000003 FUNCTION AREA(XMACH)
000003 COMMON/GAMMA/GAMMA
000003 DATA C70.013858/
000003 AREA=C*(1.+((GAMMA-1.)*.5)*XMACH**2)**((GAMMA+1.)/(2.* (GAMMA-1.)
      3)) / (XMACH*SQR(XMACH))
000124 RETURN
000024 END
  
```

SUBPROGRAM LENGTH  
000036

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

EXTERNALS AND TAGS  
SORT - S30100 RBAREX.- S40200 END. - S00300

BLOCK NAMES AND LENGTHS  
GAMA - 000021

VARIABLE ASSIGNMENTS  
MEAF - 000034 C - 000035 GAMA - 00003601

START OF CONSTANTS  
000025

START OF TEMPORARIES  
000036

START OF INDIRECTS  
000034

SPACE REQUIRED TO COMPLETE  
000036

RUW VERSION JUL 71 22.46.44. 72/88/23.

```

000336      FUNCTION AEINST(AE0,GAMMAP,P700)
000337      GM1=GAMMAP-1.0
000338      GP1=GAMMAP+1.0
000339      dVP7=1.3/P700
000340      G1=SQRT((2.0/GM1)*((.5*GP1)**((GP1/GM1)))
000341      C2=SUKT(1.0-dVP7**((GM1/GAMMAP)))
000342      AEINST=AE0/(G1*C2*DYF7**((1.0/GAMMAP)))
000343      RETURN
000344      END

```

RUN VERSION JUL 71 22.40.44. 72/30/23.

SUBPROGRAM LENGTH  
000074

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS

EXTERNALS AND TAGS  
SQRT - S00100 RWAREX.- S00200 END. - S00300

BLOCK NAMES AND LENGTHS

VARIABLE ASSIGNMENTS  
AEXMST - 000360 BPP7 - 000071 C1 - 000072 C2 - 000073  
GM1 - 000367 GP1 - 000070

START OF CONSTANTS  
000053

START OF TEMPORARIES  
000056

START OF INDIRECTS  
000066

SPACE REQUIRED TO COMPLETE  
035330

SECTION IV

CROSS-LISTING FOR PROGRAM TEM-333

| ENGNO | MACNO | 122 | ONREF | 21 | INS    | 3 |
|-------|-------|-----|-------|----|--------|---|
| GAM1A | G     | 1   | 2     | 1  | TAPENO | 2 |
| IBAD  | IOATA | 1   | QJTS  | 45 | TITLE  | 8 |
| PCODE | DATE  | 2   | CARD  | 4  | KIRAN  | 1 |
| 1EWN  |       | 1   |       |    |        |   |

| ENGNO | MACNO | 122 | ONREF | 21 | INS    | 3 |
|-------|-------|-----|-------|----|--------|---|
| GAM1A | G     | 1   | 2     | 1  | TAPENO | 2 |
| IBAD  | IOATA | 1   | QJTS  | 45 | TITLE  | 8 |
| PCODE | DATE  | 2   | CARD  | 4  | KIRAN  | 1 |
| 1EWN  |       | 1   |       |    |        |   |

| ENGNO | MACNO | 122 | ONREF | 21 | INS    | 3 |
|-------|-------|-----|-------|----|--------|---|
| GAM1A | G     | 1   | 2     | 1  | TAPENO | 2 |
| IBAD  | IOATA | 1   | QJTS  | 45 | TITLE  | 8 |
| PCODE | DATE  | 2   | CARD  | 4  | KIRAN  | 1 |
| 1EWN  |       | 1   |       |    |        |   |

| ENGNO | MACNO | 122 | ONREF | 21 | INS    | 3 |
|-------|-------|-----|-------|----|--------|---|
| GAM1A | G     | 1   | 2     | 1  | TAPENO | 2 |
| IBAD  | IOATA | 1   | QJTS  | 45 | TITLE  | 8 |
| PCODE | DATE  | 2   | CARD  | 4  | KIRAN  | 1 |
| 1EWN  |       | 1   |       |    |        |   |

| ENGNO | MACNO | 122 | ONREF | 21 | INS    | 3 |
|-------|-------|-----|-------|----|--------|---|
| GAM1A | G     | 1   | 2     | 1  | TAPENO | 2 |
| IBAD  | IOATA | 1   | QJTS  | 45 | TITLE  | 8 |
| PCODE | DATE  | 2   | CARD  | 4  | KIRAN  | 1 |
| 1EWN  |       | 1   |       |    |        |   |

| ENGNO | MACNO | 122 | ONREF | 21 | INS    | 3 |
|-------|-------|-----|-------|----|--------|---|
| GAM1A | G     | 1   | 2     | 1  | TAPENO | 2 |
| IBAD  | IOATA | 1   | QJTS  | 45 | TITLE  | 8 |
| PCODE | DATE  | 2   | CARD  | 4  | KIRAN  | 1 |
| 1EWN  |       | 1   |       |    |        |   |

| ENGNO | MACNO | 122 | ONREF | 21 | INS    | 3 |
|-------|-------|-----|-------|----|--------|---|
| GAM1A | G     | 1   | 2     | 1  | TAPENO | 2 |
| IBAD  | IOATA | 1   | QJTS  | 45 | TITLE  | 8 |
| PCODE | DATE  | 2   | CARD  | 4  | KIRAN  | 1 |
| 1EWN  |       | 1   |       |    |        |   |

| ENGNO | MACNO | 122 | ONREF | 21 | INS    | 3 |
|-------|-------|-----|-------|----|--------|---|
| GAM1A | G     | 1   | 2     | 1  | TAPENO | 2 |
| IBAD  | IOATA | 1   | QJTS  | 45 | TITLE  | 8 |
| PCODE | DATE  | 2   | CARD  | 4  | KIRAN  | 1 |
| 1EWN  |       | 1   |       |    |        |   |

| ENGNO | MACNO | 122 | ONREF | 21 | INS    | 3 |
|-------|-------|-----|-------|----|--------|---|
| GAM1A | G     | 1   | 2     | 1  | TAPENO | 2 |
| IBAD  | IOATA | 1   | QJTS  | 45 | TITLE  | 8 |
| PCODE | DATE  | 2   | CARD  | 4  | KIRAN  | 1 |
| 1EWN  |       | 1   |       |    |        |   |

| ENGNO | MACNO | 122 | ONREF | 21 | INS    | 3 |
|-------|-------|-----|-------|----|--------|---|
| GAM1A | G     | 1   | 2     | 1  | TAPENO | 2 |
| IBAD  | IOATA | 1   | QJTS  | 45 | TITLE  | 8 |
| PCODE | DATE  | 2   | CARD  | 4  | KIRAN  | 1 |
| 1EWN  |       | 1   |       |    |        |   |

| ENGNO | MACNO | 122 | ONREF | 21 | INS    | 3 |
|-------|-------|-----|-------|----|--------|---|
| GAM1A | G     | 1   | 2     | 1  | TAPENO | 2 |
| IBAD  | IOATA | 1   | QJTS  | 45 | TITLE  | 8 |
| PCODE | DATE  | 2   | CARD  | 4  | KIRAN  | 1 |
| 1EWN  |       | 1   |       |    |        |   |

| ENGNO | MACNO | 122 | ONREF | 21 | INS    | 3 |
|-------|-------|-----|-------|----|--------|---|
| GAM1A | G     | 1   | 2     | 1  | TAPENO | 2 |
| IBAD  | IOATA | 1   | QJTS  | 45 | TITLE  | 8 |
| PCODE | DATE  | 2   | CARD  | 4  | KIRAN  | 1 |
| 1EWN  |       | 1   |       |    |        |   |

| ENGNO | MACNO | 122 | ONREF | 21 | INS    | 3 |
|-------|-------|-----|-------|----|--------|---|
| GAM1A | G     | 1   | 2     | 1  | TAPENO | 2 |
| IBAD  | IOATA | 1   | QJTS  | 45 | TITLE  | 8 |
| PCODE | DATE  | 2   | CARD  | 4  | KIRAN  | 1 |
| 1EWN  |       | 1   |       |    |        |   |

|--|



| CDU IN | 5 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
|--------|---|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| CDU IN | 5 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| CDU IN | 5 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| CDU IN | 5 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| CDU IN | 5 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
|        |   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |

PROGRAM TEM333

COMMON

REFERENCED SUBPROGRAMS

| 1  | A      | LENGTH | 4    | 5 REFERENCES | ORG              | DRAGAB          | COCONV           | SUBBT            | SUPBT  |
|----|--------|--------|------|--------------|------------------|-----------------|------------------|------------------|--------|
| 2  | ABURAG | LENGTH | 3    | 6 REFERENCES | DRAGAB<br>PLUGMH | DBTTB<br>DINTFR | DBASER<br>DBOATR | COCONV           | PLUGMH |
| 3  | ABINP  | LENGTH | 41   | 9 REFERENCES | DRAGAB<br>PLUGMH | DBTTB<br>DINTFR | DBASER<br>DBOATR | COCONV<br>CABTAB | PLUGMH |
| 4  | ABTAB1 | LENGTH | 122  | 2 REFERENCES | DBTTB            | ABINPT          |                  |                  |        |
| 5  | ABTAB2 | LENGTH | 122  | 3 REFERENCES | PLUGMH           | PLUGMH          | ABINPT           |                  |        |
| 6  | ABTAB3 | LENGTH | 21   | 3 REFERENCES | PLUGMH           | PLUGMH          | ABINPT           |                  |        |
| 7  | ABTAB4 | LENGTH | 21   | 2 REFERENCES | DBASER           | ABINPT          |                  |                  |        |
| 8  | ABTAB5 | LENGTH | 122  | 2 REFERENCES | DINTFR           | ABINPT          |                  |                  |        |
| 9  | ABTAB6 | LENGTH | 1033 | 2 REFERENCES | ABINPT           | CABTAB          |                  |                  |        |
| 10 | AC     | LENGTH | 5    | 6 REFERENCES | TABIN<br>DEMAND  | INLDRAG         | SIZINL           | AIRBYP           | AIRSPL |
| 11 | AMAX   | LENGTH | 1    | 0 REFERENCES | DRAGAB<br>CABTAB | DBTTB           | COCONV           | PLUGMH           | PLUGMH |
| 12 | AREAVL | LENGTH | 1    | 4 REFERENCES | INLDRAG          | AIRBYP          | AIRSPL           | DEMAND           |        |
| 13 | AREAL0 | LENGTH | 2    | 4 REFERENCES | ABINPT           | CABTAB          | SUBBT            | SUPBT            |        |
| 14 | AJAC   | LENGTH | 1    | 3 REFERENCES | INLDRAG          | AIRBYP          | AIRSPL           |                  |        |
| 15 | CARD   | LENGTH | 3    | 2 REFERENCES | TEM333           | PLACIN          |                  |                  |        |
| 16 | DATE   | LENGTH | 2    | 2 REFERENCES | TEM333           | OUTGO           |                  |                  |        |
| 17 | INDEX  | LENGTH | 21   | 2 REFERENCES | TEM333           | COMPUTE         |                  |                  |        |

# PROGRAM TEM333

## REFERENCED SUBPROGRAMS

| COMMON | ORGB   | LENGTH | 4+6 | 3 REFERENCES | ORG              | SUBBT   | SUPBT | PLUGM   | PLUGM | DINTF |
|--------|--------|--------|-----|--------------|------------------|---------|-------|---------|-------|-------|
| 19     | USPACE | LENGTH | 1   | 4 REFERENCES | COCONV           |         |       |         |       |       |
| 20     | ENGNO  | LENGTH | 3   | 2 REFERENCES | TEM333           | COMPUTE |       |         |       |       |
| 21     | ENRICH | LENGTH | 620 | 2 REFERENCES | TABIN            | AIRBYP  |       |         |       |       |
| 22     | ERNES  | LENGTH | 5   | 1 REFERENCES | GTHRST           |         |       |         |       |       |
| 23     | G      | LENGTH | 1   | 2 REFERENCES | TEM333           | COMPUTE |       |         |       |       |
| 24     | GAMMA  | LENGTH | 1   | 6 REFERENCES | TEM333<br>DEMAND | INLRAG  | AREAF | AIRBYP  |       | AIRSP |
| 25     | IGAD   | LENGTH | 1   | 1 REFERENCES | TEM333           |         |       |         |       |       |
| 26     | IOATA  | LENGTH | 1   | 1 REFERENCES | TEM333           |         |       |         |       |       |
| 27     | IGESN  | LENGTH | 3   | 2 REFERENCES | TABIN            | SIZINL  |       |         |       |       |
| 28     | INS    | LENGTH | 3   | 5 REFERENCES | TEM333           | COMPUTE | OUTGO | WARNING |       | STORE |
| 29     | IATAB  | LENGTH | 1   | 1 REFERENCES | PLADIN           |         |       |         |       |       |
| 30     | IWARN  | LENGTH | 1   | 2 REFERENCES | OUTGO            | WARNING |       |         |       |       |
| 31     | KTRAN  | LENGTH | 1   | 1 REFERENCES | TEM333           |         |       |         |       |       |
| 32     | MACHNS | LENGTH | 24  | 2 REFERENCES | TEM333           | COMPUTE |       |         |       |       |
| 33     | MEMH   | LENGTH | 1   | 2 REFERENCES | TEM333           | OUTGO   |       |         |       |       |
| 34     | NOZARR | LENGTH | 40  | 2 REFERENCES | COMPUTE          | ABINPT  |       |         |       |       |

| COMMON |        |            | PROGRAM TEM333 |         | REFERENCED SUBPROGRAMS |         |        |  |
|--------|--------|------------|----------------|---------|------------------------|---------|--------|--|
| 35     | OUTIN  | LENGTH 10  | 2 REFERENCES   | COMPUTE | INLDRAG                |         |        |  |
| 36     | OUTS   | LENGTH 42  | 4 REFERENCES   | TEM333  | COMPUTE                | WARNING | STORE  |  |
| 37     | PCODE  | LENGTH 1   | 2 REFERENCES   | TEM333  | OUTGO                  |         |        |  |
| 38     | PT     | LENGTH 1   | 3 REFERENCES   | INLDRAG | AIRBYP                 | AIRSPL  |        |  |
| 39     | PT2PT0 | LENGTH 1   | 3 REFERENCES   | INLDRAG | AIRBYP                 | AIRSPL  |        |  |
| 40     | P0PA   | LENGTH 1   | 2 REFERENCES   | ABINPT  | CABTAB                 |         |        |  |
| 41     | R      | LENGTH 1   | 1 REFERENCES   | TEM333  |                        |         |        |  |
| 42     | RESULT | LENGTH 36  | 2 REFERENCES   | OUTGO   | STORE                  |         |        |  |
| 43     | TAB1   | LENGTH 21  | 3 REFERENCES   | TABIN   | INLDRAG                | SIZINL  |        |  |
| 44     | TAB2A1 | LENGTH 221 | 2 REFERENCES   | TABIN   | AIRBYP                 |         |        |  |
| 45     | TAB2A  | LENGTH 21  | 4 REFERENCES   | TABIN   | INLDRAG                | SIZINL  | AIRSPL |  |
| 46     | TAB2C  | LENGTH 21  | 3 REFERENCES   | TABIN   | SIZINL                 | AIRSPL  |        |  |
| 47     | TAB2U  | LENGTH 21  | 3 REFERENCES   | TABIN   | AIRBYP                 | AIRSPL  |        |  |
| 48     | TAB2E  | LENGTH 21  | 3 REFERENCES   | TABIN   | AIRBYP                 | AIRSPL  |        |  |
| 49     | TAB3   | LENGTH 122 | 2 REFERENCES   | TABIN   | INLDRAG                |         |        |  |
| 50     | TAB4   | LENGTH 122 | 2 REFERENCES   | TABIN   | INLDRAG                |         |        |  |
| 51     | TAB5   | LENGTH 122 | 2 REFERENCES   | TABIN   | INLDRAG                |         |        |  |

PROGRAM TEN333  
REFERENCED SUBPROGRAMS

COMMON

|    |        |        |     |              |         |         |        |
|----|--------|--------|-----|--------------|---------|---------|--------|
| 52 | TAB6A  | LENGTH | 122 | 2 REFERENCES | TABIN   | AIRJVP  |        |
| 53 | TAB6B  | LENGTH | 21  | 2 REFERENCES | TABIN   | AIRSP   |        |
| 54 | TAB7   | LENGTH | 122 | 3 REFERENCES | TABIN   | AIRJVP  | DEMAND |
| 55 | TAPEN  | LENGTH | 2   | 2 REFERENCES | TEN333  | PLACIN  |        |
| 56 | TITLE  | LENGTH | 8   | 2 REFERENCES | TEN333  | OUTGO   |        |
| 57 | MC     | LENGTH | 2   | 4 REFERENCES | INLDRAG | AIRJVP  | AIRSP  |
| 58 | KNACH  | LENGTH | 1   | 3 REFERENCES | INLDRAG | AIRJVP  | AIRSP  |
| 59 | ARMCHS | LENGTH | 1   | 2 REFERENCES | TABIN   | INLDRAG |        |
| 60 | XPACW9 | LENGTH | 20  | 2 REFERENCES | ADINPT  | CABTAB  |        |
| 61 | KNMIN  | LENGTH | 1   | 2 REFERENCES | TABIN   | INLDRAG |        |
| 62 | XPZERO | LENGTH | 1   | 4 REFERENCES | INLDRAG | AIRJVP  | AIRSP  |
|    |        |        |     |              |         |         | DEMAND |

**SECTION V**

**INLET MAP PROGRAM**

11.19.18. 72/06/23.

**Moore Business Forms, Inc., c/o**

RUN VERSION JUL 71

11.19.13. 72/06/29.

```

000124      200 WC=WC+DELAC
000130      NT2A=-N2A
000132      IF (XNZERO-XMACHS) 205,220,220
000134      205 IF (XNZERO,JE,XMIN) GO TO 210
000137      WCACOL=ASTER
000140      RFOL=ASTER
000141      COOL=ASTER
000142      WCACBZ=ASTER
000143      RFBZ=ASTER
000144      CDBZ=ASTER
000145      GO TO 233
000145      210 AJACOL=TBLU1(XMZERO,TAB2EX,TAB2EY,1,NT2E)
000152      RFOL=TBLU1(AJACOL,TAB2AX,TAB2AY,1,NT2A)
000156      WCACOL=AJACOL/(AREA*RFOL)
000160      WC=WCACOL*AC
000162      CALL INLDIAG(XMACH,P,WC ,C.O,DIAG,RFOL)
000166      COOL=CO
000170      ENCODE(10,931,RFOL) RFOL
000177      ENCODE(10,932,WCACOL) WCACOL
000207      ENCODE(10,931,COOL) COOL
000217      WCACBZ=TBLU1(XMZERO,TAB2OX,TAB2OY,1,NT2O)
000224      IF (WCACBZ,LE,C.O) GO TO 215
000225      RFBZ=TBLU1(AJACBZ,TAB2AX,TAB2AY,1,NT2A)
000232      WCACBZ=AJACBZ/(AREA*RFBZ)
000234      II=0
000235      590 WC=WCACBZ*AC
000237      CALL INLDIAG(XMACH,P,WC ,C.O,DIAG,RFBZ)
000243      F=AC-AC-ACBZ
000245      IF (ABS(F).LT,C.O,3335) GO TO 650
000250      IF (II.GT,15) GO TO 640
000254      IF (II.LE,0) GO TO 610
000254      XX=C.5*WCACBZ
000256      GO TO 620
000257      610 IF (F.EQ,FSAVE) GO TO 640
000261      XX=WCACBZ-(WCACBZ-FAVEN)*F/(F-FSAVE)
000267      IF (XX.LT,C.5) XX=C.5
000272      620 II=II+1
000274      FAVEN=WCACBZ
000275      FSAVE=F
000277      WCACBZ=XX
000300      GO TO 590
000310      640 WCACBZ=-C.O
000312      RFBZ=-C.O
000313      CDBZ=-C.O
000315      590 CONTINUE
000315      CDBZ=CO
000317      ENCODE(10,931,RFBZ) RFBZ
000316      ENCODE(10,932,WCACBZ) WCACBZ
000326      ENCODE(10,931,CDBZ) CDBZ
000336      GO TO 233
000337      215 WCACBZ=ZERO
000341      RFBZ=ASTER
000342      CDBZ=ASTER

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RUN VERSION JUL 71

11.19.10. 72/38/23.

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003343      GO TO 230
003343      220 ACACOL=T1-ULI(AMZERO,TAB2CX,TAB2CY,1,NT20)
003350      RFCL= TBLU1(AMZERO,TAB2CX,TAB2CY,1,NT20)
003354      WCACOL=(1.32*ACACOL)/(AREA*RFCL)
003357      WC=WCACOL*AC
003361      CALL INDRAG(XMACH,P,WC      ,3.0,DRAG,RFCL)
003365      CDCL=CD
003367      ENCODE(13,931,RFCL) RFCL
003376      ENCODE(13,932,WCACOL) WCACOL
000406      ENCODE(13,931,COOL) COOL
000416      RF82=ASTER
000420      WCAC82=ASTER
000421      CO82=ASTER
000422      230 OUT1(J)=XMACH
003424      OUT2(J)=WCACOL
000426      OUT3(J)=RFCL
000427      OUT6(J)=WCAC82
003431      OUT7(J)=RF82
003432      OUT9(J)=COOL
000434      OUT9(J)=CO82
003435      IF((J.LT.13).AND.(I.LT.NTMACH)) GO TO 330
      C      OUTPUT RECOVERY MAP
000445      LABEL(1)=13MINLET RECO
003446      LABEL(2)=13M/ERY MAP
003450      WRITE(6,933) LABEL,TITLE,XMACHS,AC
003463      WRITE(6,934) (OUT1(L),L=1,J)
003476      WRITE(6,935) (OUT2(L),L=1,J)
000511      WRITE(6,936) (OUT3(L),L=1,J)
003524      WRITE(6,937) (OUT6(L),L=1,J)
003537      WRITE(6,938) (OUT7(L),L=1,J)
000532      WRITE(6,939) (PLABLE,L=1,J)
000564      DO 240 K=1,NWC
003566      WRITE(6,913) OUT4(K),(OUT5(L,K),L=1,J)
000604      240 CONTINUE
      C      OUTPUT DRAG MAP
003637      LABEL(1)=13MINLET DRAG
000610      LABEL(2)=13M MAP
000612      WRITE(6,933) LABEL,TITLE,XMACHS,AC
003625      WRITE(6,934) (OUT1(L),L=1,J)
003640      WRITE(6,935) (OUT2(L),L=1,J)
003653      WRITE(6,911) (OUT3(L),L=1,J)
003666      WRITE(6,937) (OUT6(L),L=1,J)
003711      WRITE(6,912) (OUT9(L),L=1,J)
000714      WRITE(6,933) (PLABLE,L=1,J)
003726      DO 250 K=1,NWC
003730      WRITE(6,913) OUT4(K),(OUT13(L,K),L=1,J)
003746      250 CONTINUE
000751      J=C
003752      300 CONTINUE
003755      STOP
003757      600 FORMAT(14I,20X,9413)
003757      801 FORMAT(9X,MACH NUMBER ARRAY)
003757      802 FORMAT(9X,CORRECTED AIRFLOW POINTS* 12X 7HINITIAL,12X 5HDELTA, 12X

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RUN VERSION JUL 71

11.19.16. 72/08/23.

A3HFINAL /25X,3F17.1 )

000757 813 FORMAT(10F7.0)

000757 900 FORMAT(5A10)

000757 901 FORMAT(F13.4)

000757 902 FORMAT(F13.2)

000757 913 FORMAT(14I,4X,8A10,5X,10HSTART HACH,F5.3,3X,12HCAPTURE AREA,F7.3)

000757 904 FORMAT(3H: 12CH NO,12X,10F10.3)

000757 903 FORMAT(17H: DISTORTION LIMIT, /3X, 10H(WJC/AC) DL,7X,10A10)

000757 906 FORMAT(3X,11H(PT2/PT3) DL,6X,10A10)

000757 907 FORMAT(11H BUZZ LIMIT /3X,10H(WJC/AC) BL,7X,10A10)

000757 908 FORMAT(3X,11H(PT2/PT3) BL,6X,10A10)

000757 909 FORMAT(1H,5X,6H(WJC/AC,8X,10A10)

000757 910 FORMAT(1X,F11.2,8X,10F10.4)

000757 911 FORMAT(5X,6H(CD) DL,9X,10A10)

000757 912 FORMAT(5X,6H(CD) DL,9X,10A10)

000757 END

(SAMPLE OUTPUT)

TEST RUN OF INLET MAP PROGRAM

|                          |        |         |         |         |         |         |        |        |          |
|--------------------------|--------|---------|---------|---------|---------|---------|--------|--------|----------|
| MACH NUMBER ARRAY        | .75000 | 1.00000 | 1.25000 | 1.50000 | 1.75100 | 2.00002 | .25000 | .50000 | -0.00000 |
| CORRECTED AIRFLOW POINTS |        |         |         |         |         |         |        |        |          |
|                          |        | INITIAL |         | DELTA   |         | FINAL   |        |        |          |
|                          |        | 60.0    |         | 10.0    |         | 300.0   |        |        |          |





INLET RECOVERY MAP TEST RUN OF INLET MAP PROGRAM START MACH 3.030 CAPTURE AREA 5.910

| MACH NO                                       | .500    | .750           | 1.000          | 1.250          | 1.500          | 1.750          | 2.000          | .250    | .500    |
|-----------------------------------------------|---------|----------------|----------------|----------------|----------------|----------------|----------------|---------|---------|
| DIST CRITIC LIMIT<br>(WCC/AC)DL<br>(PI2/PI)DL | ----    | 41.35<br>.9255 | 39.31<br>.9591 | 39.32<br>.9491 | 39.44<br>.9245 | 37.62<br>.8481 | 35.50<br>.7736 | ----    | ----    |
| 8022 LIMIT<br>(WCC/AC)DL<br>(PI2/PI)DL        | ----    | 0.00<br>----   | 0.00<br>----   | 0.00<br>----   | 15.30<br>.9014 | 29.37<br>.9781 | 29.21<br>.7920 | ----    | ----    |
| WCC/AC                                        | PI2/PI0 | PI2/PI0        | PI2/PI0        | PI2/PI0        | PI2/PI0        | PI2/PI0        | PI2/PI0        | PI2/PI0 | PI2/PI0 |
| 13.15                                         | .9470   | 1.0273         | 1.0123         | .9872          | .8923          | .8469          | .7920          | .8935   | .9470   |
| 11.64                                         | .9470   | 1.0151         | 1.0033         | .9837          | .8931          | .8495          | .7920          | .8935   | .9470   |
| 13.54                                         | .9470   | 1.0030         | 1.0066         | .9841          | .8975          | .8522          | .7920          | .8935   | .9470   |
| 15.23                                         | .9470   | 1.0038         | 1.0039         | .9826          | .8911          | .8549          | .7920          | .8935   | .9470   |
| 16.92                                         | .9470   | .9987          | 1.0012         | .9810          | .8947          | .8576          | .7920          | .8935   | .9470   |
| 19.61                                         | .9470   | .9986          | .9986          | .9735          | .8984          | .8603          | .7920          | .8935   | .9470   |
| 23.31                                         | .9470   | .9944          | .9959          | .9730          | .8912          | .8631          | .7920          | .8935   | .9470   |
| 22.03                                         | .9470   | .9923          | .9933          | .9754          | .8918          | .8659          | .7920          | .8935   | .9470   |
| 23.69                                         | .9470   | .9902          | .9937          | .9749          | .8916          | .8686          | .7920          | .8935   | .9470   |
| 25.39                                         | .9470   | .9881          | .9831          | .9734          | .8933          | .8714          | .7920          | .8935   | .9470   |
| 27.07                                         | .9470   | .9861          | .9855          | .9719          | .8927          | .8743          | .7920          | .8935   | .9470   |
| 29.77                                         | .9470   | .9840          | .9829          | .9704          | .8910          | .8771          | .7920          | .8935   | .9470   |
| 31.46                                         | .9470   | .9819          | .9803          | .9659          | .8949          | .8799          | .7920          | .8935   | .9470   |
| 33.15                                         | .9470   | .9798          | .9778          | .9674          | .8933          | .8799          | .7920          | .8935   | .9470   |
| 35.84                                         | .9470   | .9768          | .9752          | .9659          | .8927          | .8786          | .7920          | .8935   | .9470   |
| 38.53                                         | .9470   | .9734          | .9726          | .9642          | .8903          | .8726          | .7739          | .8935   | .9470   |
| 41.23                                         | .9470   | .9694          | .9691          | .9609          | .8943          | .8571          | .7472          | .8935   | .9470   |
| 43.92                                         | .9470   | .9621          | .9623          | .9528          | .8916          | .8298          | .7147          | .8935   | .9470   |
| 46.61                                         | .9470   | .9591          | .9432          | .9279          | .8871          | .7953          | .6849          | .8935   | .9470   |
| 49.30                                         | .9470   | .9556          | .9035          | .8941          | .8515          | .7634          | .6575          | .8935   | .9470   |
| 52.00                                         | .9470   | .8738          | .8745          | .8597          | .7341          | .6322          | .5935          | .8935   | .9470   |
| 54.69                                         | .9470   | .8385          | .8421          | .8278          | .7845          | .7059          | .6038          | .8935   | .9470   |
| 57.38                                         | .9470   | .8036          | .8120          | .7953          | .7653          | .6816          | .5871          | .8935   | .9470   |
| 60.07                                         | .9470   | .7837          | .7843          | .7707          | .7341          | .6581          | .5663          | .8935   | .9470   |
| 62.76                                         | .9470   | .7547          | .7579          | .7431          | .7053          | .6362          | .5479          | .8935   | .9470   |

# INLET DRAG MAP

## TEST RUN OF INLET MAP PROGRAM

### START MACH 3.000 CAPTURE AREA 9.910

| MACH NO                        | .500   | .750   | 1.000 | 1.250 | 1.500 | 1.750 | 2.000 | .250   | .500   |
|--------------------------------|--------|--------|-------|-------|-------|-------|-------|--------|--------|
| DISTORTION LIMIT<br>(MDC/AC)DL | ----   | 41.35  | 39.31 | 39.32 | 38.44 | 37.82 | 35.58 | ----   | ----   |
| (C)DL                          | ----   | -.0023 | .0458 | .0449 | .0142 | .3353 | .5231 | ----   | ----   |
| BUZZ LIMIT<br>(MDC/AC)DL       | ----   | 0.00   | 0.00  | 0.00  | 15.30 | 29.37 | 29.21 | ----   | ----   |
| (C)DL                          | ----   | ----   | ----  | ----  | .5272 | .1878 | .1773 | ----   | ----   |
| MDC/AC                         | CD     | CD     | CD    | CJ    | CJ    | CD    | CD    | CD     | CD     |
| 13.15                          | 0.0300 | .1963  | .3734 | .5246 | .5432 | .7649 | .8890 | 0.0000 | 0.0000 |
| 13.24                          | 0.0300 | .1808  | .3529 | .4958 | .6059 | .7157 | .8257 | 0.0000 | 0.0000 |
| 13.54                          | 0.0300 | .1649  | .3325 | .4671 | .5634 | .6663 | .7624 | 0.0000 | 0.0000 |
| 15.23                          | 0.0200 | .1469  | .3123 | .4365 | .5326 | .6167 | .6991 | 0.0000 | 0.0000 |
| 16.92                          | 0.0200 | .1331  | .2921 | .4039 | .4925 | .5667 | .6328 | 0.0000 | 0.0000 |
| 19.61                          | 0.0300 | .1173  | .2721 | .3815 | .4541 | .5164 | .5725 | 0.0000 | 0.0000 |
| 20.31                          | 0.0000 | .1016  | .2521 | .3531 | .4133 | .4657 | .5092 | 0.0000 | 0.0000 |
| 22.30                          | 0.0300 | .0867  | .2322 | .3248 | .3732 | .4147 | .4470 | 0.0000 | 0.0000 |
| 23.69                          | 0.0300 | .0731  | .2125 | .2936 | .3338 | .3634 | .3848 | 0.0000 | 0.0000 |
| 25.34                          | 0.0300 | .0597  | .1929 | .2635 | .2971 | .3116 | .3221 | 0.0000 | 0.0000 |
| 27.37                          | 0.0000 | .0477  | .1733 | .2405 | .2536 | .2595 | .2578 | 0.0000 | 0.0000 |
| 28.77                          | 0.0000 | .0458  | .1539 | .2129 | .2158 | .2069 | .1937 | 0.0000 | 0.0000 |
| 30.46                          | 0.0300 | .0337  | .1348 | .1953 | .1716 | .1537 | .1311 | 0.0000 | 0.0000 |
| 32.35                          | 0.0300 | .0265  | .1156 | .1579 | .1316 | .1036 | .0739 | 0.0000 | 0.0000 |
| 34.54                          | 0.0000 | .0219  | .0959 | .1335 | .0911 | .0584 | .0210 | 0.0000 | 0.0000 |
| 35.93                          | 0.0300 | .0224  | .0777 | .1020 | .0549 | .0492 | .0232 | 0.0000 | 0.0000 |
| 37.23                          | 0.0000 | .0228  | .0623 | .0738 | .0331 | .0378 | .0167 | 0.0000 | 0.0000 |
| 39.92                          | 0.0000 | .0196  | .0433 | .0493 | .0134 | .0323 | .0167 | 0.0000 | 0.0000 |
| 42.61                          | 0.0100 | .0036  | .0424 | .0387 | .0212 | .0323 | .0167 | 0.0000 | 0.0000 |
| 42.32                          | 0.0300 | -.0023 | .0379 | .0359 | .0219 | .0323 | .0167 | 0.0000 | 0.0000 |
| 44.63                          | 0.0300 | -.0023 | .0379 | .0358 | .0219 | .0323 | .0167 | 0.0000 | 0.0000 |
| 45.13                          | 0.0300 | -.0023 | .0379 | .0354 | .0219 | .0323 | .0167 | 0.0000 | 0.0000 |
| 47.32                          | 0.0300 | -.0023 | .0379 | .0358 | .0219 | .0323 | .0167 | 0.0000 | 0.0000 |
| 49.17                          | 0.0200 | -.0023 | .0379 | .0368 | .0219 | .0323 | .0167 | 0.0000 | 0.0000 |
| 50.76                          | 0.0300 | -.0023 | .0379 | .0358 | .0219 | .0323 | .0167 | 0.0000 | 0.0000 |

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| 13. ABSTRACT<br>This report presents the results of a research program to develop a procedure for use in calculating propulsion system installation losses. These losses include inlet and nozzle internal losses and external drag losses for a wide variety of subsonic and supersonic aircraft configurations up to Mach 4.5. The calculation procedure, which was largely developed from existing engineering procedures and experimental data, is suitable for preliminary studies of advanced aircraft configurations. Engineering descriptions, equations, and flow charts are provided to help in adapting the calculation procedures to digital computer routines. Many of the calculation procedures have already been programmed on the CDC 6600 computer. Program listings and flow charts are provided for the calculation procedures that have been programmed. The work accomplished during the program is contained in four separate volumes. Volume I contains an engineering description of the calculation procedures. Volume II is a programmers manual containing flow charts, listings, and subroutine descriptions. Volume III contains sample calculations and sample input data. Volume IV contains bookkeeping definitions and data correlations. |                                                                                                                                    |                                                    |

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| KEY WORDS                            | LINK A |    | LINK B |    | LINK C |    |
|--------------------------------------|--------|----|--------|----|--------|----|
|                                      | ROLE   | WT | ROLE   | WT | ROLE   | WT |
| Afterbody Drag                       |        |    |        |    |        |    |
| Boattail Drag                        |        |    |        |    |        |    |
| Bookkeeping Aero-Propulsion Forces   |        |    |        |    |        |    |
| Boundary Layer Bleed Drag            |        |    |        |    |        |    |
| Bypass Drag                          |        |    |        |    |        |    |
| Inlet Performance                    |        |    |        |    |        |    |
| Inlet Shock Losses                   |        |    |        |    |        |    |
| Nozzle/Afterbody Installation Losses |        |    |        |    |        |    |
| Nozzle Interference Drag             |        |    |        |    |        |    |
| Nozzle Thrust Coefficient            |        |    |        |    |        |    |
| Propulsion Installation Losses       |        |    |        |    |        |    |
| Spillage Drag                        |        |    |        |    |        |    |
| Subsonic Diffuser Losses             |        |    |        |    |        |    |
| Supersonic Inlets                    |        |    |        |    |        |    |
| Total Pressure Recovery              |        |    |        |    |        |    |