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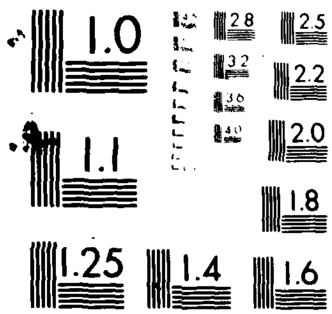

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REPORT NO. NADC-81259-60

A SHORT TAKEOFF PERFORMANCE COMPUTER PROGRAM

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A short takeoff performance computer program has been developed by NAVAIRDEVCEN to be used for performance estimation and conceptual aircraft design.

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SUMMARY

A computer program has been developed which is capable of analyzing the short takeoff of typical V/STOL aircraft configurations. This program can be used as a means for performance estimation as well as for assisting in aircraft conceptual design.

This program was written in FORTRAN for use on a CDC 6600 and uses five supporting subroutines. This report describes the analytical development and logic development for the program. In addition it includes a user description and complete listing of the program

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LIST OF SYMBOLS

a_x, a_z	Longitudinal and vertical acceleration (m/sec^2, or ft/sec^2)
a/g	Normalized longitudinal acceleration
C_D	Drag coefficient
C_L	Lift coefficient
C_M	Pitching moment coefficient
D	Drag (N or lb f)
F_G	Gross thrust (N or lb f)
F_{G_F}, F_{G_A}	Fore and aft engine gross thrust (N or lb f)
F_{GH}, F_{G_V}	Horizontal and vertical gross thrust (N or lb f)
g	Acceleration due to gravity (9.8 m/sec^2 or 32.2 ft/sec^2)
$I_{yy_{cg}}$	Lateral moment of inertia (kg-m^2 or slug-ft^2)
L	Lift (N or lb f)
My	Lateral pitching moment (N-m or ft-lb f)
m	Aircraft mass (kg or lb)
R_F, R_A	Fore and aft gear wheel reaction force (N or lb f)
RD_F, RDA	Fore and aft engine ram drag (N or lb f)
S_x, S_z	Longitudinal and vertical distance (m or ft)
T	Time (sec)
V_x, V_z	Longitudinal and vertical velocity (m/sec or ft/sec)
WOD	Wind over deck
W_F	Fuel flow (kg/hr or lb/hr)
W	Aircraft weight (m*g)
α	Angle of attack (deg)
α_{MG}	Angular acceleration about main gear wheel (deg/sec^2)
γ	Flight path angle (deg)

LIST OF SYMBOLS

Δ	Increment
δ_e	Control surface deflection angle (deg)
θ_j	Jet nozzle inclination angle (deg)
θ_p	Pitch Angle (deg)
μ	Coefficient of friction
Σ	Sum

INTRODUCTION

A methodology for predicting the short takeoff (STO) performance of Vertical or Short Takeoff and Landing (V/STOL) aircraft is essential for the preliminary design of these vehicles as the propulsion system may be sized by STO requirements. Since a wide range of VSTOL configurations may be of interest to the Navy, and each would have its own unique set of thrust and drag variations during the takeoff run, a generalized computer program offers the most feasible method of analyzing STO performance.

Several STO programs currently available in the technical community were examined for applicability. It was found that each program was developed for a specific configuration and did not provide the flexibility necessary to examine arbitrary V/STOL aircraft concepts. Since the existing programs could not be easily modified, it was necessary to develop a new program.

The resulting program can be utilized for performance estimation and for aircraft conceptual design. In the performance estimation mode, inputs are aircraft aerodynamics, propulsion data, takeoff gross weight (TOGW), and STO technique while outputs are time, distance, velocity, longitudinal acceleration, lift, drag, and horizontal and vertical gross thrust. These data can be calculated at the condition of liftoff, at some specified rate of climb (R/C), or at some specified sink distance. In the conceptual design mode, inputs are given design parameters such as takeoff distance, rate of climb at liftoff, and longitudinal acceleration (with or without one engine inoperative (OEI)), and outputs such as engine size and optimum STO technique can be determined.

DISCUSSION

Theoretical Considerations

This program utilizes an open form, time history, numerical integration. The forces included in this treatment are lift, drag, gross thrust, and friction. A force diagram is presented in Figure 1. The horizontal forces are summed and divided by the aircraft mass to yield a horizontal acceleration. This acceleration in turn is equated to the following kinematic formula:

$$a_x = \frac{\Delta V_x}{\Delta T} = \frac{1}{2} \frac{\Delta(V_x^2)}{\Delta S_x}$$

Using time increments, a change in velocity and distance can be determined. More specifically, the basic equations are:

$$DRAG = C_D*1/2\rho V^2 S + D_{ENGINE\ RELATED} + D_{STORE} + D_{OEI} + D_{INDUCED}$$

where: $D_{ENGINE\ RELATED}$ = ram drag, spillage drag, boattail drag, etc.

$$LIFT = C_L*1/2\rho V^2 S + L_{INDUCED}$$

Summing vertical gross thrust components:

$$F_{G_V} = F_{G_{F_V}} + F_{G_{A_V}}$$

$$F_{G_V} = F_{G_1}*SIN\ \beta_1 + F_{G_2}*SIN\ \beta_2$$

where: $F_{G1} = F_{G_F}$ - fore engine gross thrust loss

$F_{G2} = F_{GA}$ - aft engine gross thrust loss

$\beta_1 = \theta_{jF} + \theta_p$ + engine datum angle

$\beta_2 = \theta_{jA} + \theta_p$ + engine datum angle

Summing horizontal gross thrust components:

$$F_{G_H} = F_{G_{F_H}} + F_{G_{A_H}}$$
$$F_{G_H} = F_{G1}*COS\ \beta_1 + F_{G_2}*COS\ \beta_2$$

Balancing the vertical forces:

$$BALANCE = W - Lift - F_{G_V}$$

The change in velocity over a time increment ΔT is:

$$\Delta V_x = \Delta T*g*(F_{GH} - DRAG - \mu\ *BALANCE)/W$$

where: $\Delta V_x = V_{x2} - V_{x1}$

Finally, the distance gained over ΔT is:

$$\Delta S_x = 1/2*\Delta T*((V_{x_2}-WOD)^2 - (V_{x_1}-WOD)^2)/\Delta V_x$$

By using this technique the forces which vary as a function of time and angle can be accurately represented and, in addition, pilot technique can also be closely approximated. Also by using small time increments any procedural changes can be fitted through the input.

Increased program accuracy can be obtained by accounting for and by correcting a pitching moment inbalance. This is done through the following formula:

$$\Sigma\ My = I_{yy_{cg}}\ \alpha_{MG}$$

By making use of the supplied aircraft moment of inertia and a power-on pitching moment, an angular acceleration about the main gear can be taken into account. The moment about the vehicle center of gravity is:

$$MOMENT = C_M * 1/2\rho V^2*MAC$$

The fore gear wheel reaction force is therefore:

$$R_F = (BALANCE*\beta_3-MOMENT)/(LRF + \beta_3 + \cos\ \theta_p)$$

where: β_3 = LRA*cos θ_p+ LRA*μ*sin θ_p+ LR*μ*cos θ_p - LR*sin θ_p

See Table I for the definitions of LR, LRA, LRF and MAC.

If the supplied aerodynamic data is a function of control surface deflection, the deflection required to nullify any moments can be calculated. This is accomplished by the following algorithm:

initialize α, θ_j and δe
$C_L = f(\alpha, \delta e, \theta_j)$
$C_D = f(C_L, \delta e, \theta_j)$
$C_M = f(C_L, \delta e, \theta_j)$

$DRAG = f(C_D) + D_{ENGINE\ RELATED} + D_{STORE} + D_{OEI} + D_{INDUCED}$

$LIFT = f(C_L) + L_{INDUCED}$

$MOMENT = f(C_M)$

$F_{GV} = f(F_G, \theta_j, \theta_p)$

$BALANCE = W - Lift - F_{GV}$

R_F = f (BALANCE, MOMENT)

iterate δe until $R_F = 0$

Rates of climb or sink can be calculated if the horizontal component of velocity is considered much larger than the vertical component ($V_z < .02\ V_x$). Here the vertical acceleration is: $a_z = \frac{\Delta V_z}{\Delta T}$

and the vertical velocity is: $V_z = \frac{\Delta S_z}{\Delta T}$

Hence, climb or sink accelerations, velocities, and distances can be determined. For rate of climb velocity over the ΔT increment:

$a_z = (-BALANCE)*g/w$

$\bar{a}_z = 1/2*(a_{z2} + a_{z1})$

To determine the incremental ROC:

$\Delta ROC = \bar{a}_z * \Delta T$

For sink off the bow distance over the ΔT increment:

$a_z = BALANCE*g/w$

$\bar{a}_z = 1/2*(a_{z2} + a_{z1})$

$\Delta V_z = \bar{a}_z * \Delta T$

$$V_{z2} = V_{z1} + \Delta V_z$$

$$\overline{V}_z = 1/2 * (V_{z2} + V_{z1})$$

The incremental sink distance is:

$$\Delta SINK = \overline{V}_z * \Delta T$$

If an instantaneous ROC at liftoff is needed, the following formula is used:

$$a_x = (F_{G_H} - DRAG - \mu * BALANCE)/W$$

Assuming a small flight path angle at liftoff:

$$ROC_{instantaneous} = V \sin \gamma \approx V\gamma$$

Where $V\gamma = V * ((LIFT + F_{GV} - W)/F_{G_H})$

The main program logic, which illustrates how all the above equations are implemented, is presented in Appendix D.

Program Description

In addition to the main program, which performs the computations on the dynamic equations, there are five supporting subroutines, as described below.

TAKE 5 - In the formulation of the STO computer program a four degree-of-freedom interpolation routine was developed from an earlier three degree-of-freedom routine (reference (a)). This was done to accomodate aerodynamic inputs which are a function of four variables.

This subroutine has two modes of operation. In the first mode, table data representing aerodynamic and propulsion characteristics are input and stored. Each table is assigned a predetermined reference number. In the second mode, table data is interpolated and extrapolated by the function SPLNQ1 for use in the dynamic calculations. TAKE5 subroutine logic is presented in Appendix D.

SPLNQ1 - This function is used to interpolate or extrapolate tabular data. The interpolation is calculated using a local curve fit scheme described in reference (b). Linear extrapolations are made using each end point slope of the local curve fit.

UPDATE - This subroutine is used to reshape data arrays into a form usuable by the function SPLNQ1.

SNEST - This is an iteration subroutine used to solve one degree-of-freedom problems. A slope intercept convergence technique is employed.

ATMOS - This is a 1962 standard atmosphere table which returns properties of density, pressure, temperature, and sound velocity for an input geometric altitude.

The data required for the program consists of a series of single-value, fixed inputs and multiple-valued tabular inputs. The form of the computer data deck necessary to make a run is presented in Figure 2.

The tabular data includes:

- Gross thrust as a function of Mach number and engine speedup time.

- Fuel flow as a function of Mach number and engine speedup time.

- Drag coefficient as a function of lift coefficient, control surface deflection, jet nozzle inclination, and velocity.

- Lift coefficient as a function of angle of attack, control surface deflection, jet nozzle inclination, and velocity.

- Induced lift increment as a function of jet inclination angle

- Induced drag increment as a function of jet inclination angle

- Pitching moment coefficient as a function of lift coefficient, control surface deflection, jet nozzle inclination, and velocity.

- Aircraft moment of inertia as a function of aircraft mass.

- Distance from aircraft center of gravity to main gear wheel as a function of aircraft mass.

- Gross thrust loss relative to zero nozzle deflection gross thrust as a function of jet nozzle angle.

- Throttle dependent, ram, and external store drag as a function of Mach number.

These tabular inputs are graphically illustrated in Appendix A.

The fixed inputs consist of aircraft size and mass data, ambient conditions, initial thrust vector angles and control surface deflections, rotation rates for the nozzles and specification for events that may occur during the takeoff run (e.g. loss of an engine). Table I contains a fixed input variable list.

Program Options

Available to the user are two main options which concern the type of STO vehicle that can be approximated. First, is a Harrier type vehicle which maintains moment balance by a reaction control system, rotates its jet nozzles, and pitches up at a given rate and at a predetermined airspeed. Second, is a vehicle which maintains moment balance by a control surface deflection and has a fixed jet nozzle angle.

For vehicles using control surfaces to maintain moment balance on the ground, the program will search for the start of auto rotation (stick free pitch up) and either give information on the rotation of the aircraft about the aft wheel or attempt to correct this rotation by the deflection of a control surface. Pertinent tabular inputs for this vehicle type include:

$$C_M = f(C_L, \delta_e, \theta_j, V_x)$$

$$I_{yyCG} = f(m)$$

Distance from CG to aft wheel = f(m)

Fixed inputs concerned with this type of vehicle are LR, LRA, LRF, DELTAE, VSTARR, MAC, SEGMENT, IYYCG, XCG, YCG, DELMAX and ALPHMIN. Examination of the above data, by considering the descriptions made in Table I and Appendix A, will clearly illustrate the options available for this type of vehicle.

If a Harrier type vehicle is to be considered, the previously mentioned input can be ignored.

By viewing the form of the remaining tabular and fixed input, in Table I and Appendix A, it is seen that a wide variety of pilot techniques can be approximated. This is because any continuous or discontinuous tabular aerodynamic or propulsion function can be fitted. In addition, a large variety of fixed input switches are available for duplication of aircraft rotation and thrust deflection at any prescribed airspeed.

The following comments offer some additional options that can be implemented for a Harrier type vehicle.

1. If a series of data cases are to be run, put the additional aircraft weights or velocities in ascending order. Set RUN not equal to zero for interpolated weight or set RUN and PSINT not equal to zero for interpolated pitch speed.

2. Apply variables RS, ALPHARR, ALPHAAR, ALPHA, PHI2, PHI2AR, and PS for desired rotation method. For the fore engine nozzle variation apply RSF, PHI1, PHI1AR, PHI1RR accordingly.

3. Set NOEDRAG not equal to zero and NOSTORE not equal to zero if engine related drags and store drags exist in reference table 33 (nos. 1 and 2) (see Appendix A). Set NODOEI not equal to zero if engine out drag exists in reference table 33 (no. 3).

4. For OEI at brake release, read in NEF = NEA = 0.5 or any appropriate scale down, or put in single engine tabular data inputs and add failed engine drag in store drag (reference table 33 (no. 2)). For OEI at liftoff, set EFAILA not equal to zero and OEILOSF to an appropriate front engine scale down value and add failed engine drag as additional drag (reference table 33 (no. 3)). Set OEITAB not equal to zero for OEI at liftoff when thrust, fuel flow, and drags (engine related and external store) for one engine out are supplied in tabular form (reference table 10, 11, and 33 (nos. 3 and 4)). Put in RAM for a constant ram drag scale down during OEI.

5. For dynamic R/C constraint, put in ROC limit. Set PHONY not equal to zero when instantaneous R/C is desired (fore and aft nozzle angles and aircraft pitch angle are set to maximum values for instantaneous R/C calculation). Set SINKD to bow height for sink calculations. (If PS, RS, and RSF have not been reached at SINKD, these variables will be set to the airspeed at SINKD). NOTE: rate of climb and sink estimates assume that the horizontal velocity is much greater than the vertical velocity.

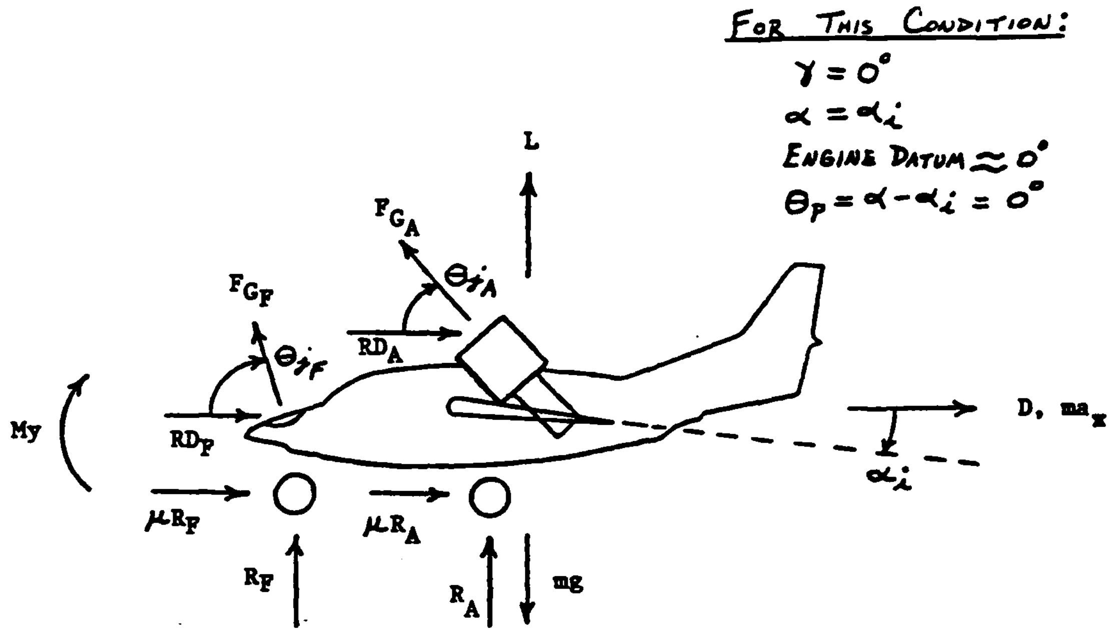
ACKNOWLEDGEMENTS

A mention of appreciation is given by the author to Michael Caddy who developed the supporting subroutines and to John Cyrus for his technical concepts.

REFERENCES

(a) Caddy, M. J., "TREAD/TLOOK - Multipurpose Computer Routine for Interpolation and Extrapolation of Tabular Data," NAVAIRDEVCEN Report No. NADC-76366-30, 11 January 1977

(b) Akima, Hiroshi, "Interpolation and Smooth Curve Fitting Based on Local Procedures," Institute for Telecommunication Sciences, 1 March 1972



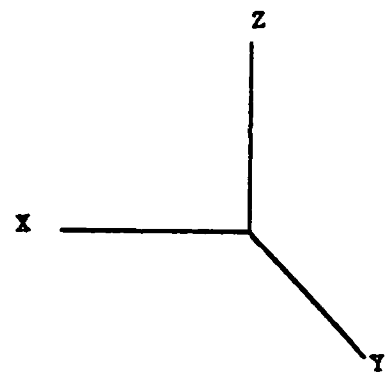


FIGURE 1. Force Diagram (Ground Run)

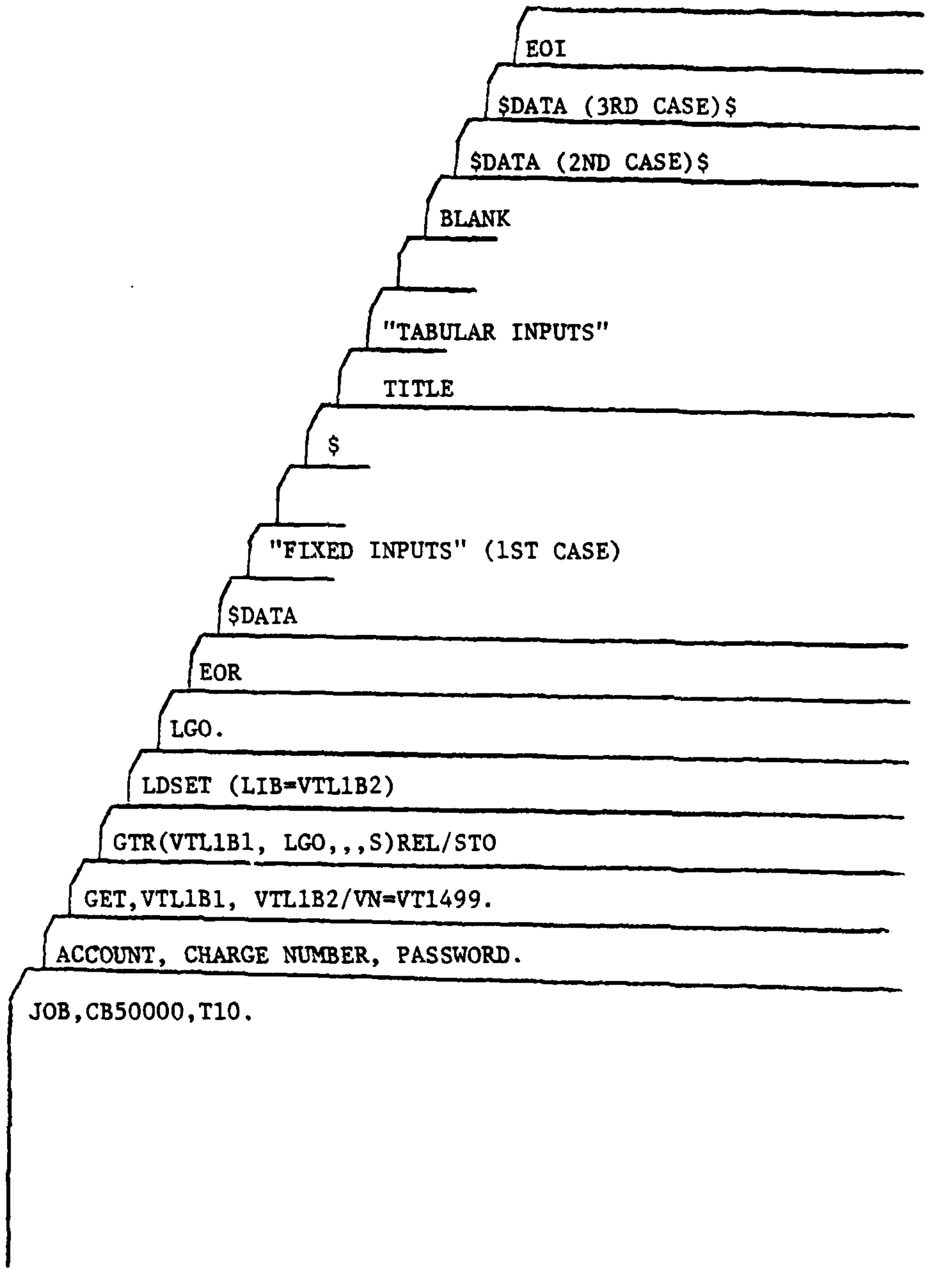


FIGURE 2. Data Input Deck Structure

TABLE I

FIXED INPUT VARIABLE LIST

Variable Name	Description	Units	Default Value
ALPHA	Initial angle of attack (for C_L-α curve)	deg.	-----
ALPHAAR	Pitch angle after rotation	deg.	0.0
ALPHARR	Pitch up rotation rate	deg/sec	0.0
ALPHMIN	Maximum angle of attack before auto rotation control attempted	deg	0.0
ALT	Field altitude	m. or ft.	0.0
ANGFRL	Initial fuselage reference line angle (for engine reference)	deg	0.0
DELMAX	Maximum control surface deflection angle (maximum δ_e)	deg	-----
DELTAE	Initial control surface deflection angle	deg	0.0
DISTMAX	Abort run if this takeoff distance is exceeded	m. or ft.	10^6
DT	Time integration increment	sec.	.05
EDATUM	Engine datum (with respect to fuselage reference line)	deg	0.0
EFAILA	If ≠ zero, failure of one engine assumed at liftoff	-----	0.0
E1	If ≠ zero, two thrust vectors are present	-----	0.0
FLDTEMP	Field ambient temperature	°C or °F	59.
IPRINT	If ≠ zero, a time history of parameters will be printed	-----	0
IYYCG	Constant aircraft moment of inertia	kg-m^2 or slug-ft^2	-----
LR	Vertical distance from center of gravity (CG) to ground	m. or ft.	-----
LRA	Horizontaol distance from CG to aft wheel	m. or ft.	-----
LRF	Horizontal distance from CG to fore wheel	m. or ft.	-----
MAC	Mean aerodynamic chord	m. or ft.	-----
METRIC	If ≠ zero, metric units present	-----	0
MU	Wheel friction coefficient	-----	.02
NEA	Number of lift cruise engines	-----	1.
NEF	Number of lift engines	-----	1.
NODOEI	If ≠ zero, tabular engine out drag present	-----	0
NOEDRAG	If ≠ zero, tabular throttle dependent drag present (includes ram drag)	-----	0
NOSTORE	If ≠ zero, tabular external store drag data present	-----	0
NPRINT	If ≠ zero, tabular input will be printed	-----	0
OEILOSF	Lift engine scale down when OEI occurs	-----	.0
OEITAB	If ≠ zero, OEI at liftoff assumed with tabular OEI data present	-----	0.
PHI1	Initial lift engine jet nozzle angle (with respect to engine datum)	deg	0.0
PHI1AR	Lift engine nozzle angle after rotation	deg	0.0

TABLE I
(Continued)

FIXED INPUT VARIABLE LIST

Variable Name	Description	Units	Default Value
PHI1RR	Lift engine nozzle rotation rate	deg/sec	0.0
PHI2	Initial lift cruise engine jet nozzle angle (with respect to engine datum)	deg	0.0
PHI2AR	Lift cruise engine nozzle angle after rotation	deg	0.0
PHI2RR	Lift cruise nozzle rotation rate	deg/sec	0.0
PHONY	If ≠ zero, instantaneous R/C is calculated	-----	0.0
PS	Pitch up aircraft speed	m/sec or ft/sec	0.0
PSINT	If ≠ zero, and RUN ≠ zero, will give interpolated pitch up speed	-----	0.0
RAM	Ram drag scale factor for OEI; if default value selected, tabular OEI ram drag is used	-----	1.
RDSCALE	Tabular ram drag scale factor	-----	1.
REVTIME	Engine speed up time	sec	0.0
ROC	If ≠ zero, dynamic liftoff characteristics at this R/C will be given	m/sec or ft/sec	0.0
RS	Airspeed which initiation of lift cruise engine nozzle rotation occurs	m/sec or ft/sec	0.0
RSF	Airspeed which initiation of lift engine nozzle rotation occurs	m/sec or ft/sec	0.0
RUN	IF ≠ zero, STO distance to determine interpolated TOGW	m or ft	0.0
S	Wing area	m^2 of ft^2	-----
SEGMENT	If default value used, no pitching moment estimation is entered in calculations; if = 1, auto rotation included in estimates; and if = 2, elevator correction to auto rotation applied	-----	0
SINKD	If ≠ zero, this is bow distance for sink calculations	m or ft	0.0
VSTARR	Maximum velocity before which a constant linear extrapolation of aerodynamic tabular data occurs	m/sec or ft/sec	0.0
W	Aircraft mass	kg or lb	-----
WOD	Wind over deck (+ for headwind, - for tailwind)	m/sec or ft/sec	0.0
XCG	Constant horizontal distance from CG to main gear wheel (presumes no tabular CG locations inputting)	m or ft	-----
YCG	Constant vertical distance from CG to main gear wheel (supposes no tabular CG locations inputted)	m or ft	-----

APPENDIX A

TABULAR INPUTS

A list of the tabular data inputs is presented in graphical form. An example of this data in numerical form can be found in Appendix B and reference (a).

Table Reference No. 13

$C_D = f(C_L, \delta_e, \theta_j, V_x)$

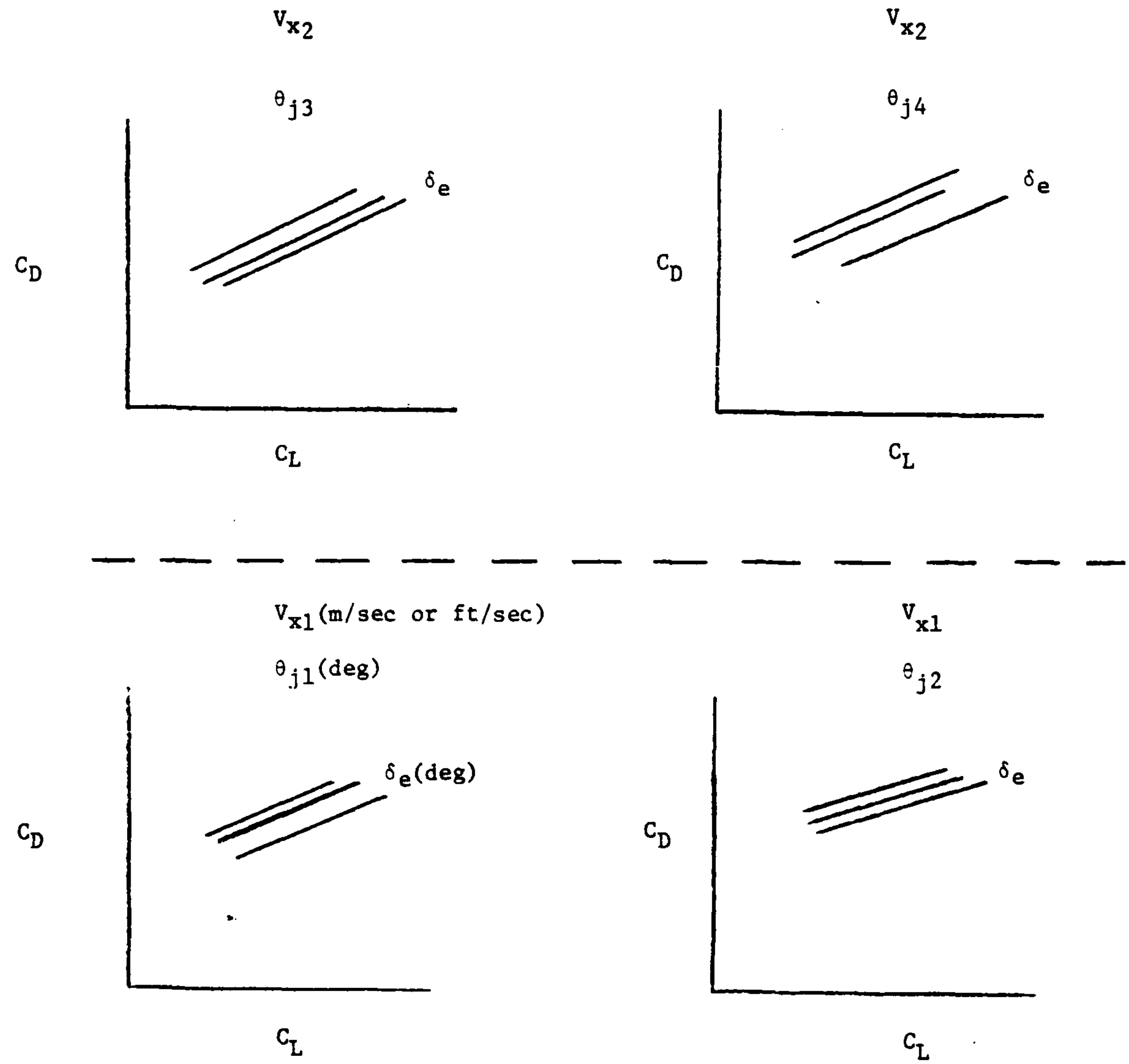


FIGURE A1. Drag Coefficient Tabular Input

Table Reference No. 14

$C_L = f(\alpha, \delta_e, \theta_j, Vx)$

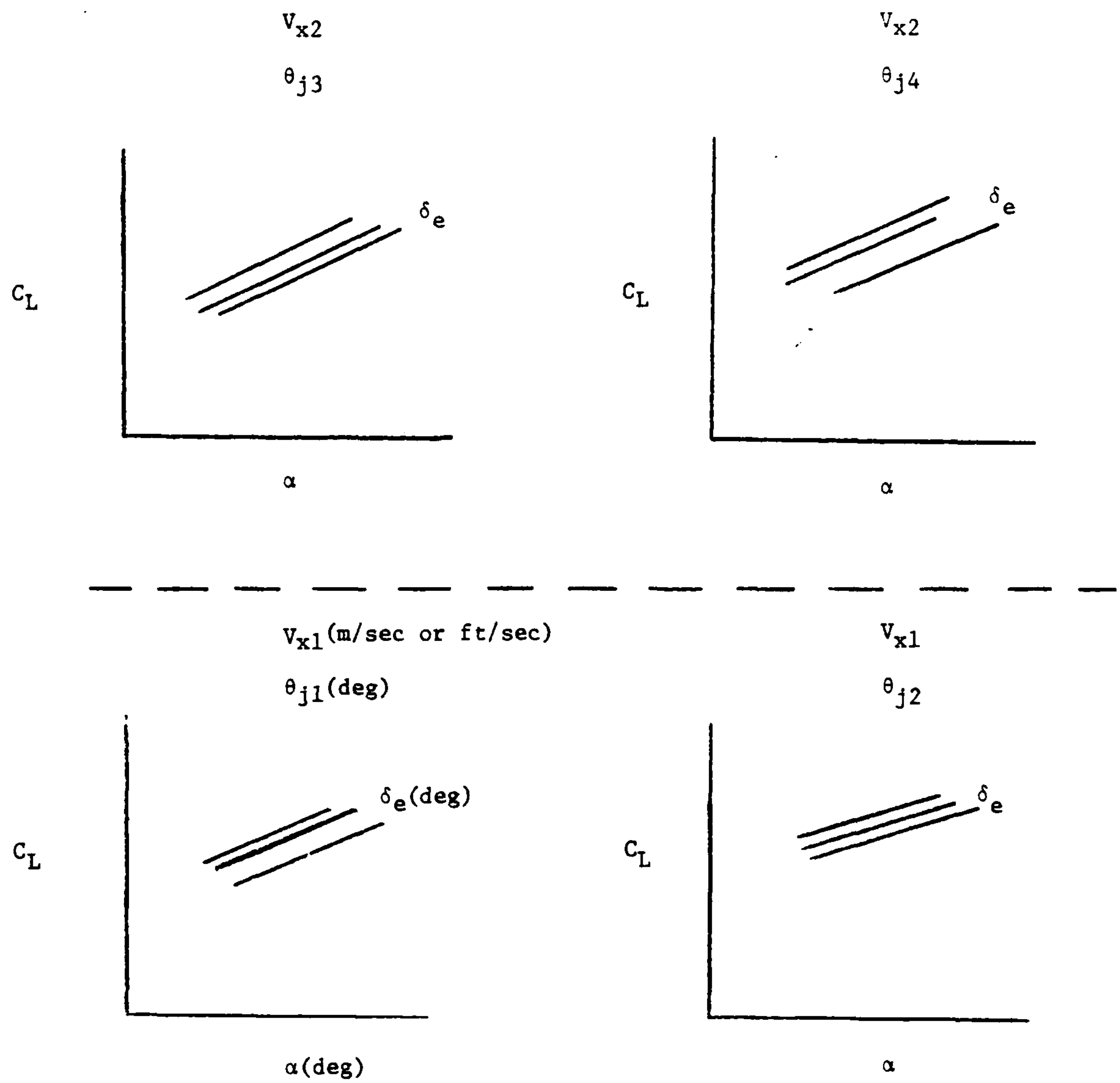


FIGURE A2. Lift Coefficient Tabular Input

Table Reference No. 10

F_G=f(MACH, Engine Type, REVTIME)

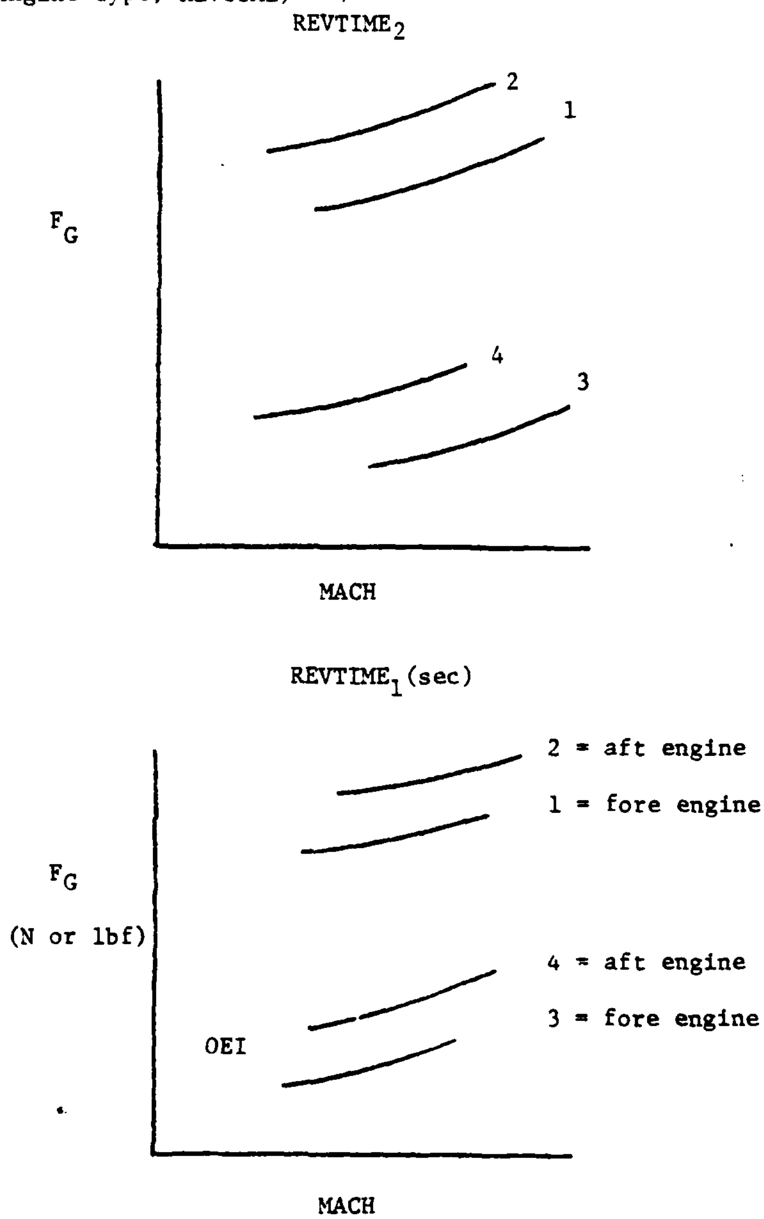


FIGURE A3. Gross Thrust Tabular Input

Table Reference No. 11
$W_F = f$(MACH, Engine Type, REVTIME)

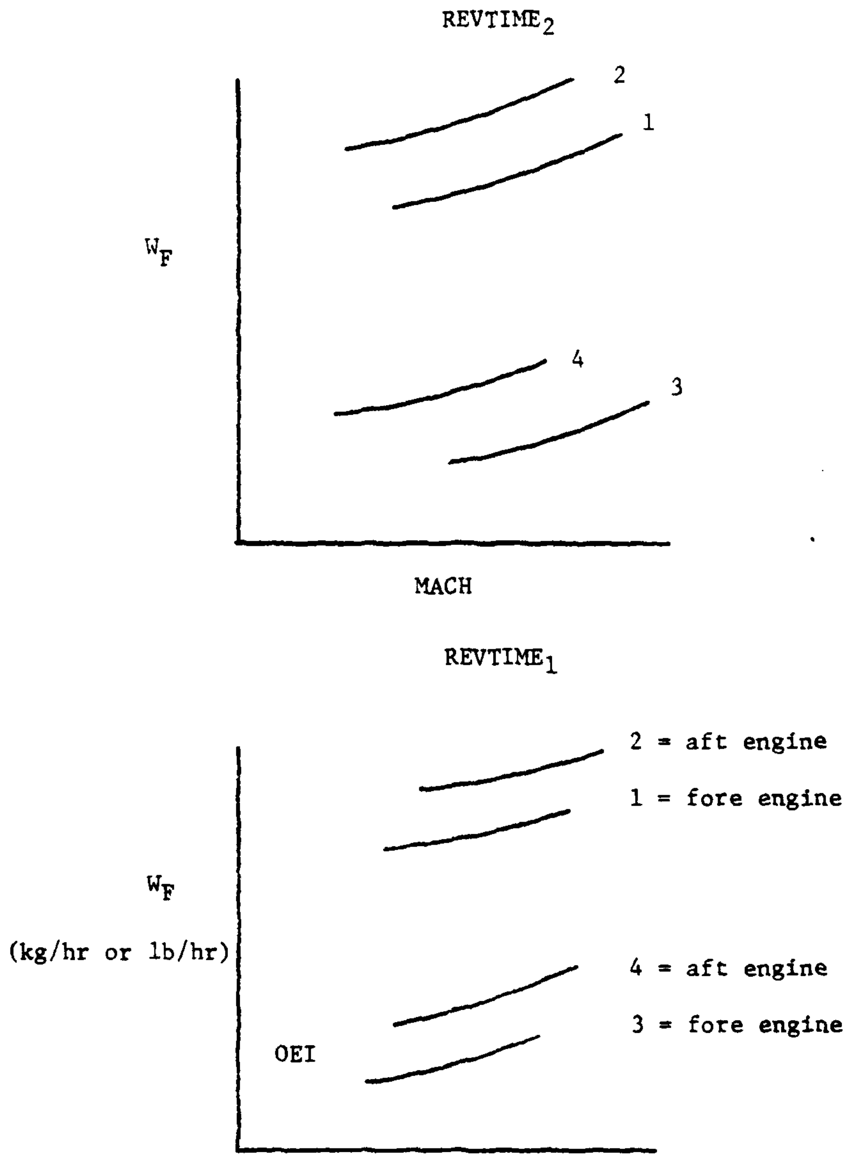


FIGURE A4. Fuel Flow Tabular Input

Table Reference No. 17
$C_M = f(C_L, \delta_e, \theta_j, V_x)$

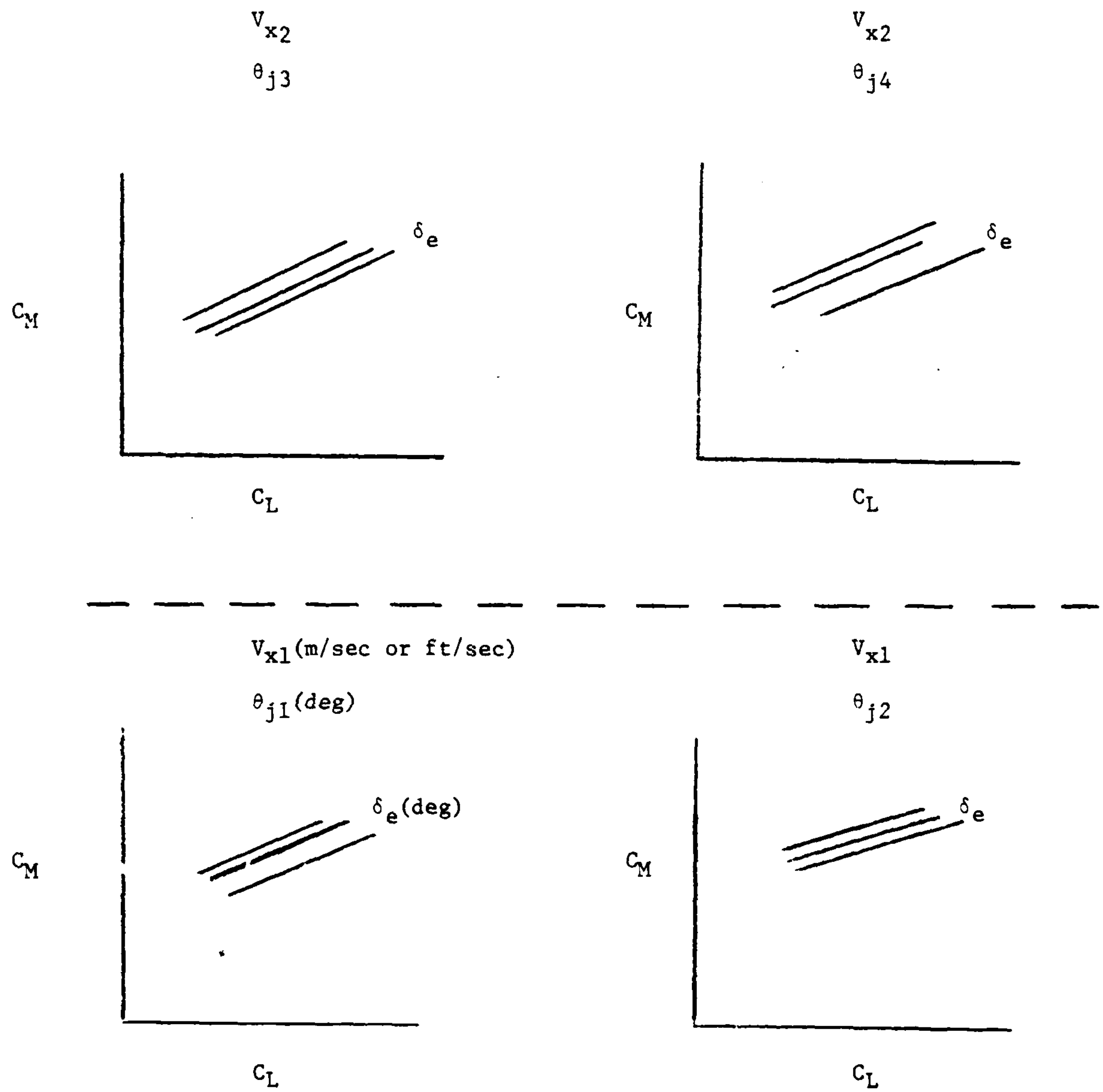


FIGURE A5. Moment Coefficient Tabular Input

Table Reference No. 30
$I_{yy_{CG}} = f(m)$

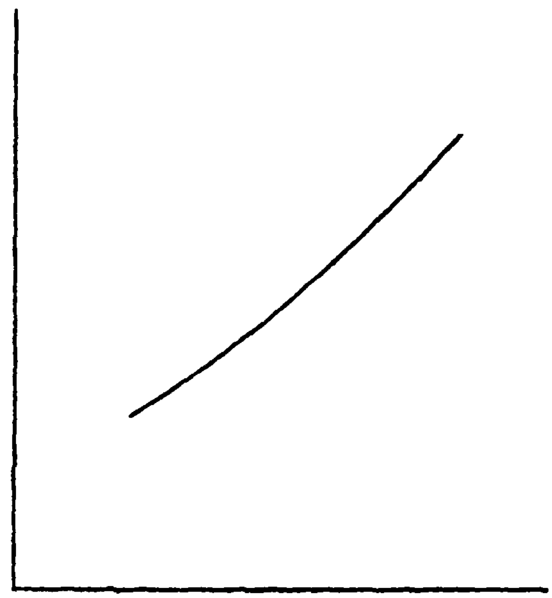


FIGURE A6. Moment of Inertia Tabular Input

Table Reference No. 15

$\frac{\Delta L}{F_G}, \frac{\Delta D}{F_G} = f(\theta_j)$

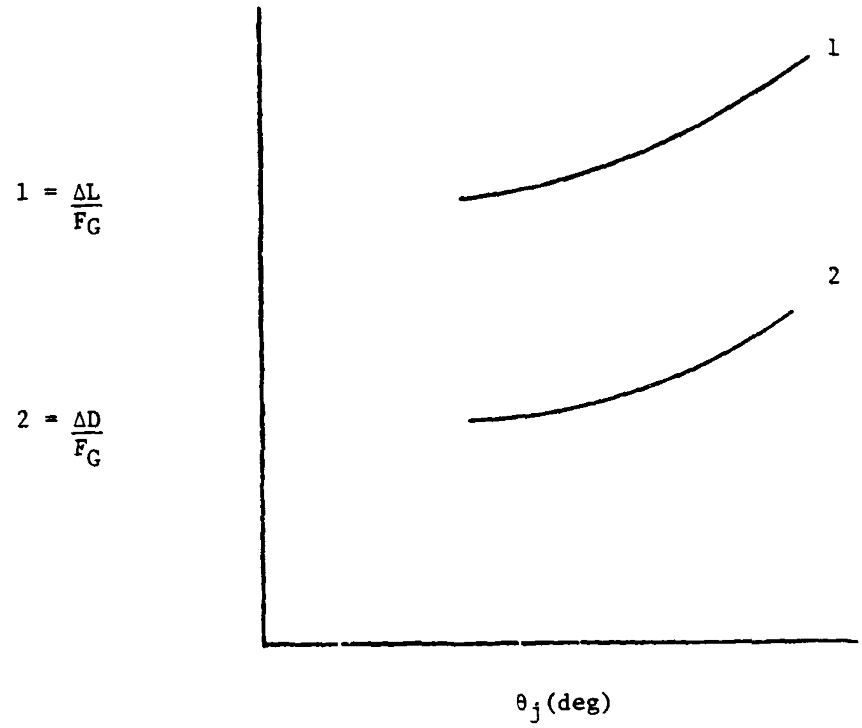


FIGURE A7. Induced Lift and Drag Tabular Input

Table Reference No. 33
D = f(MACH, Drag Type)

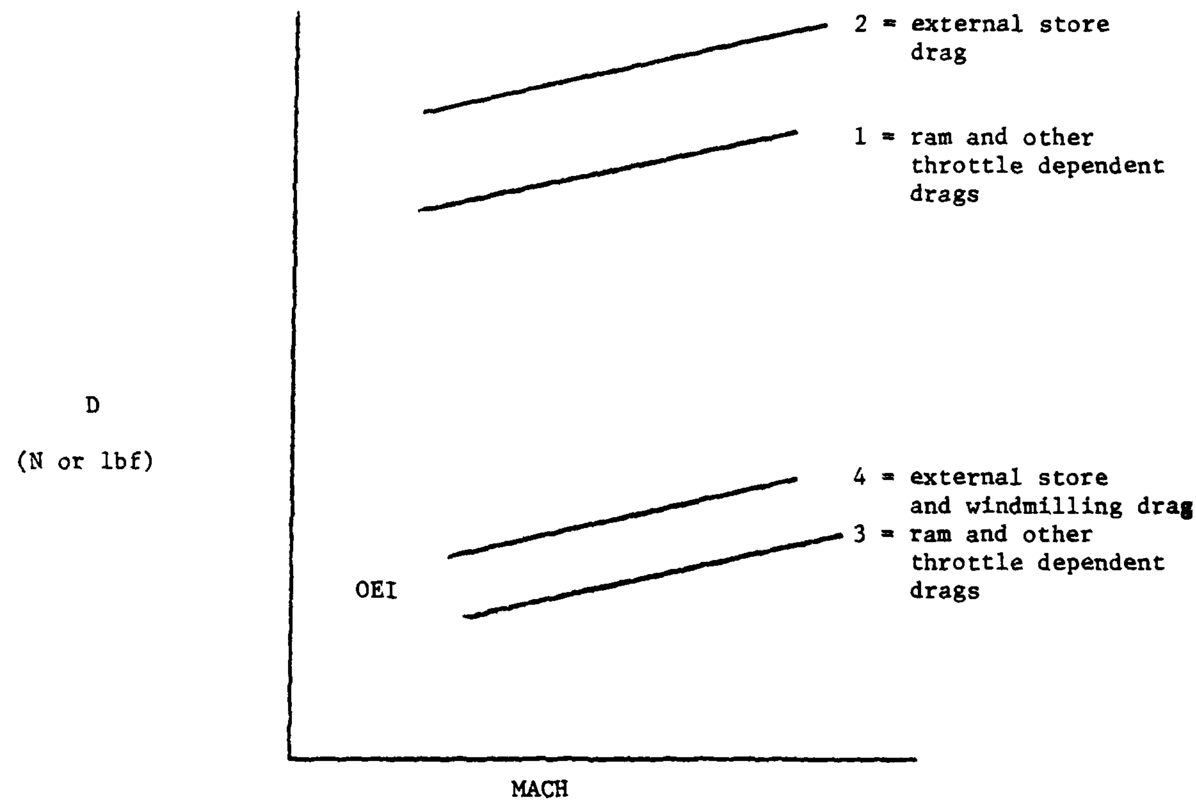


FIGURE A8. External Store and Ram Drag Tabular Input

Reference Table No. 31
X_{CG}, Y_{CG} = f(m)

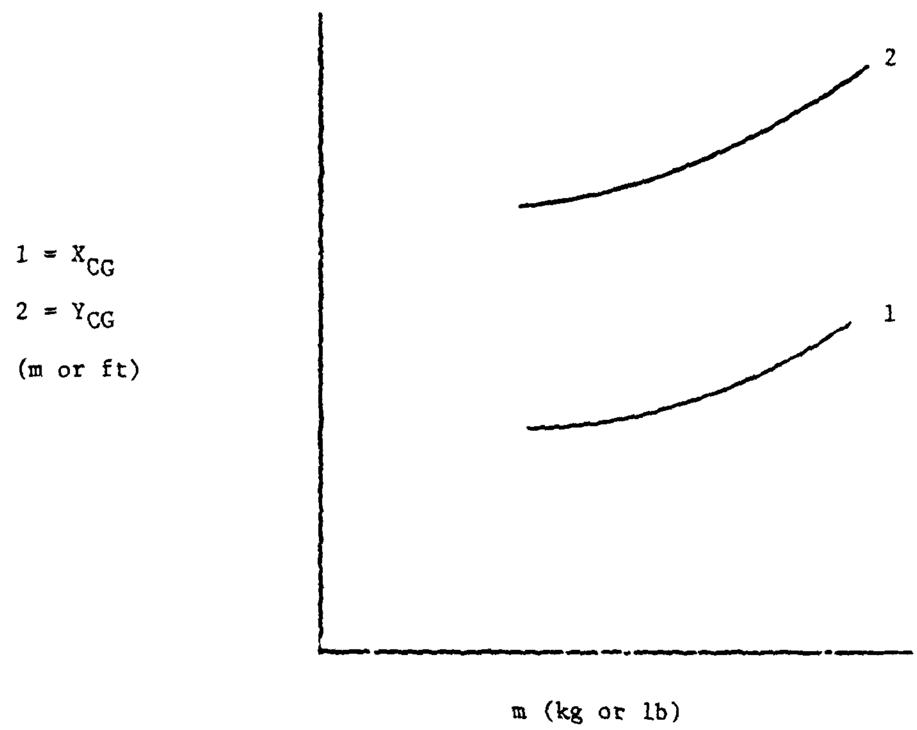


FIGURE A9. Center of Gravity Location Tabular Input

Reference Table No. 12

$F_{GLoss}/F_{G\,(No\ nozzle\ deflection)} = f(\theta_j,$ ENGINE TYPE)

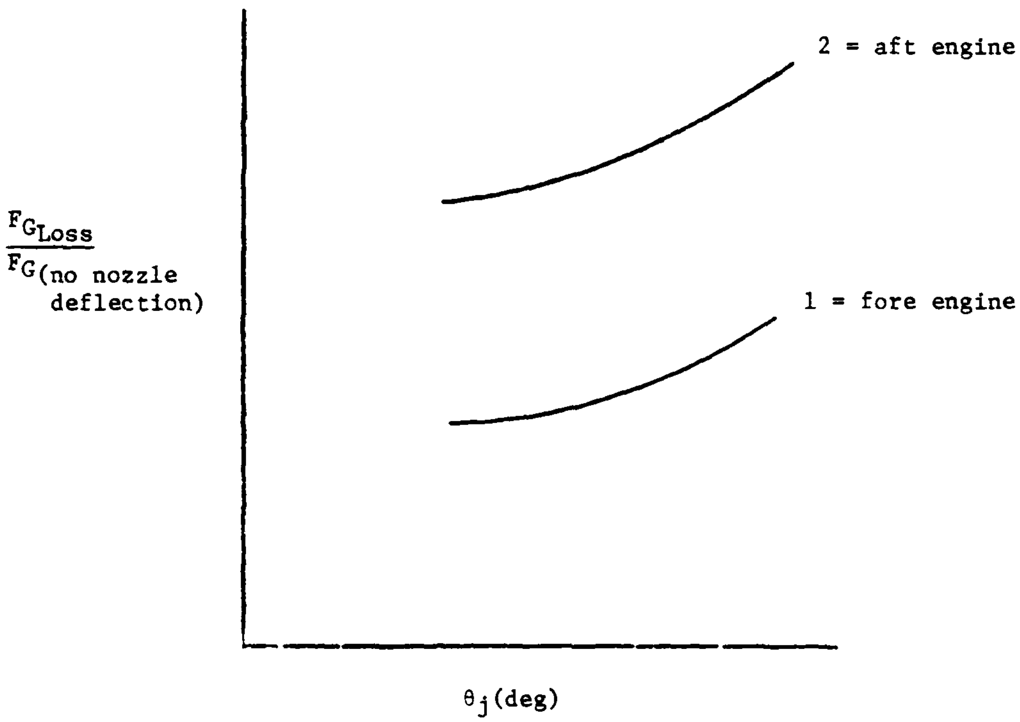


FIGURE A10. Gross Thrust Loss Tabular Input

APPENDIX B

EXAMPLE CASE

An example card deck and printout is presented. The required programs, supporting subroutines, and control cards to execute this program with any charge number under the NAVAIRDEVCEN KRONOS 2.1 operating system is illustrated. An explanation of the sample case is also presented.

Example Case

Card Deck

An example card deck listing, similar in form to the arrangement illustrated in Figure 2, is presented. As shown, three cases are to be run and they require less than 50,000 octal central memory core and ten octal seconds central processor unit time.

For the first case an aircraft, with a wing area of 430 square feet, is initially resting on the ground with a wing angle of attack and fuselage reference line at negative five degrees from the horizontal. The lift engine nozzle angle is set at 45 degrees while the cruise engine nozzle angle is set at five degrees. Both nozzle angles are with respect to the fuselage reference line (or to the engine datum line for the cruise engines). On examining the initial case's fixed inputs, at an airspeed of 66 ft/sec the vehicle will rotate its lift engine nozzles to 75 degrees at a rate of 15 degrees/sec and it will rotate its cruise engine nozzles to 54 degrees also at 15 deg/sec. At an airspeed of 80 ft/sec the aircraft will pitch up to 13 degrees at 5.9 deg/sec. This vehicle weighs 40,000 lbs. Additional fixed inputs state that the vehicle has a tabular ram drag input (NOEDRAG), two thrust vectors are present (E1), and the analysis is for a 90°F day (FLDTEMP). The default value of METRIC causes English units to be used. If the deck run exceeds 750 feet the case runs will be terminated. The variables RUN and PSINT are used, in combination, to interpolate or extrapolate the case values of PS. This is to determine the appropriate value of this variable for a deck run of 400 feet. The variable SINKD specifies the carrier bow length and signals for sink calculations to be done for this case. The IPRINT parameter indicates that a time history of pertinent parameters for this specific case will be printed.

Example tabular data includes C_L versus α, drag polars, engine thrusts, ram drag, and induced aerodynamics. The table numbers used for each table are predetermined as outlined in Appendix A. Notice that omitted input, such as fuel flow data, is assumed to be zero by the program.

The second and third fixed input cases switch off the sink calculations and the time history printout and change the lift and cruise nozzle rotation initiation airspeeds. These additional cases also change the airspeed in which the vehicle begins pitching up. Note that a maximum of one card is permitted for each additional case. For the additional cases a value for ROC causes dynamic rate of climb calculations to be made.

```
TEST,C950009,T10.
ACCOUNT,CHARGE NUMBER,PASSWORD.
GET,VTLIB1,VTLIB2/UN=VT1499.
GTR(VTLIB1,LGO,,,SIFEL/STO
LDSET(LIB=VTLIB2)
LGO.
END OF RECORD
 $DATA ALPHA=-5.5*430,PHI2=5,PHI2AR=54,PHI2RR=15,ALPHARR=5.9,ALPHAAR=13,
 ANPFRL=-5,NOEDRAG=1,E1=1,FLDTEMP=90,PHI1=45,DISTMAX=750,PHI1AR=75,
 PHI1RR=15,RS=66,PS=80,RSF=66,W=40000,IPRINT=1,PSINT=1,HUN=400,
 SINKR=200,NPRINT=1,
 $
                EXAMPLE CASE
   14      EXAMPLE CL VS. ALPHA TABLE
VEL    1    0.
PHI2   3    0.          50.         40.
DLTE   1    0.
ALPH   9    -8.         -4.         0.          4.          8.          12.         16.
            20.
CL     9    -.48        -.175       .175        .45         .78         1.04        1.375
            1.49
DLTE   1    0.
CL     8    -.13        .15         .42         .69         .96         1.2         1.45
            1.57
DLTE   1    0.
CL     8    .34         .59         .86         1.11        1.34        1.47        1.56
            1.55
EOT
   13        EXAMPLE DRAG POLARS (POWER OFF) TABLE
DUMM   1    0.
PHI2   1    0.
DLTE   1    0.
CL     6    -.4         0.          .4          .8          1.2         1.4
CD     6    .34159      .02938      .03742      .06533      .17463      .22905
EOT
   10       EXAMPLE ENGINE THRUST TABLE
DUMM   1    0.
TIME   1    0.
SET    4    1.          2.          3.          4.
MACH   5    0.          .05         .1          .15         .2
FG     5    13755.      14044.      14332.      14875.      15417.
FG     5    29437.      29988.      30538.      31606.      32673.
FG     5    10994.      11330.      11565.      12342.      13018.
FG     5    23734.      24346.      24958.      25161.      27363.
EOT
   33       EXAMPLE RAM DRAG TABLE
DUMM   1    0.
TIME   1    0.
SET    2    1.          3.
MACH   5    0.          .05         .1          .15         .2
RAMC   5    0.          3936.       9123.       12240.      16621.
RAMD   5    0.          3862.       7931.       12023.      16486.
EOT
   15      EXAMPLE INDUCED AERODYNAMICS TABLE
DUMM   1    0.
Y      1    0.
SET    2    1.          2.
PHI2   3    0.          50.         100.
DFL    3    .02         .12         .214
PHI2   3    27.3        44.5        84.7
CFL    3    -.058       -.031       .042
EOT
```

```
BLANK CARD
 $DATA SINKD=0,ROC=1.67,PS=90,RS=76,RSF=76,IPRINT=0$
 $DATA SINKD=0,ROC=1.67,PS=100,RS=84,RSF=84,IPRINT=0$
NOTE: MAXIMUM OF ONE CARD FOR EACH ADDITIONAL CASE.
END OF INFORMATION
```

Printout

The computer printout of the previously mentioned card deck is now presented. On the second page of the printout a loader map illustrating all the supporting subroutines and their individual core requirements is presented. On the bottom of this page the fixed inputs for the first case are shown. The variable NPRINT enables the tabular input to be printed in full on the following five successive pages. This data, in turn, is followed by a summary of core requirements for each table. Next, the output data begins with a time history of the first of three sample cases. Each element is a successive point in a time variance of parameters. These parameters include:

W - Aircraft mass (kg or lb) (English units for this example)
V - Vehicle airspeed (m/sec or ft/sec)
L - Lift force (N or lbf)
DR - Drag force (N or lbf)
RF - Nose gear reaction force (N or lbf) (not used in this example)
EDRG - Engine related drags (N or lbf)
FN2 - Cruise engines gross thrust (N or lbf)
PH2I - Cruise engine nozzle angle (deg)
ALPHA - Angle of attack (deg)
T - Time (sec)
D2 - Distance (m or ft)
BALANCE - Lifting forces minus weight (N or lbf)
PH1I - Lift engine nozzle angle (deg)
FN1 - Lift engines gross thrust (N or lbf)
C_L - Lift coefficient
C_D - Drag coefficient
C_M - Pitching moment coefficient (not used this example)
A/G - Normalized longitudinal acceleration
RHO - Atmospheric density (kg/m^3 or slug/ft^3)
DELTAE - Control surface deflection angle (deg) (not used this example)

The following parameters were not printed in this listing because they were not used for this example case.

DALPHAD - Angle of attack increment caused by auto rotation (deg)
IYYCG - Lateral aircraft moment of inertia (kg-m^2 or slug-ft^2)
XCG - Horizontal distance from CG to main gear wheel (m or ft)
YCG - Vertical distance from CG to main gear wheel (m or ft)
N - Iteration number for elevator correction to counter auto rotation
RF - Nose gear reaction force during iteration (N or lbf)
DELTAE - Control surface deflection during iteration (deg)

The following parameters are printed if dynamic rate of climb calculations are made. These parameters are printed only after liftoff.

ROC - Dynamic rate of climb (m/sec or ft/sec)
ACCY - Vertical dynamic acceleration (m/sec^2 or ft/sec^2)

Finally, the following parameters (which are used for this example case) are printed after liftoff when sink calculations are made.

ASINK - Sink acceleration (m/sec^2 or ft/sec^2) (sink calculations cease when this value becomes zero)

VSINK - Sink velocity (m/sec or ft/sec)
DSINK - Sink distance (m or ft)

The time history printout concludes on the following page of output. After liftoff the appropriate sink parameters are shown. After the time history the final liftoff parameters are presented. These parameters include maximum sink height and time, distance, and airspeed at that sink height condition. Other characteristics at this condition include lift, drag, horizontal acceleration, gross thrust, and vertical gross thrust.

Since the IPRINT was switched off for the two additional cases no time history is printed. These cases were done with dynamic rate of climb calculations so instead of sink parameters the prescribed rate of climb along with the vertical height when this rate of climb is achieved is printed.

After all the cases are determined an extrapolation is made to estimate the pitchup airspeed and horizontal acceleration for a deck run of 400 feet.

KRONOS 2.1.1-107 81/03/30.
OPERATING SYSTEM
JOB ORIGIN = EI200.

```
TTTTTTTTTTTT  EEEEEEEEEEEE   SSSSSSSSSS   TTTTTTTTTTTT    AAAAAAAAAA    VV          VV  IIIIIIIIIIII
TTTTTTTTTTTT  EEEEEEEEEEEE  SSSSSSSSSSSS  TTTTTTTTTTTT  AAAAAAAAAAAA    VV          VV  IIIIIIIIIIII
     TT       EE            SS         S       TT       AA        AA    VV          VV       II
     TT       EE            SS                 TT       AA        AA     VV        VV        II
     TT       EE            SS                 TT       AA        AA     VV        VV        II
     TT       EE            SS                 TT       AA        AA     VV        VV        II
     TT       EE            SS                 TT       AA        AA      VV      VV         II
     TT       EEEEEEEE      SSSSSSSSSSS        TT       AA        AA      VV      VV         II
     TT       EEEEEEEE       SSSSSSSSSSS       TT       AAAAAAAAAAAA      VV      VV         II
     TT       EE                      SS       TT       AAAAAAAAAAAA       VV    VV          II
     TT       EE                      SS       TT       AA        AA       VV    VV          II
     TT       EE                      SS       TT       AA        AA       VV    VV          II
     TT       EE                      SS       TT       AA        AA        V    V           II
     TT       EE            S         SS       TT       AA        AA        VVVV             II
     TT       EEEEEEEEEEEE  SSSSSSSSSSSS       TT       AA        AA        VVVV        IIIIIIIIIIII
     TT       EEEEEEEEEEEE   SSSSSSSSSS        TT       AA        AA         VV         IIIIIIIIIIII
```

81/09/29. 14.54.07.

```
LOAD MAP - STO                                   CYBER LOADER 1.4-485     81/09/28. 14.54.01.     PAGE     1

FWA OF THE LOAD            111
LWA+1 OF THE LOAD        32715

TRANSFER ADDRESS -- STO              6206

PROGRAM ENTRY POINTS --       STO              6206


PROGRAM AND BLOCK ASSIGNMENTS.
```

BLOCK	ADDRESS	LENGTH	FILE	DATE	PROCSSR	VER	LEVEL	HARDWARE	COMMENTS
/PRINT/	111	1							
STO	112	11662	LGO	78/01/0	FTN	3.0	P380	6666	
/TSIZE/	11774	5671							
TAKES	17665	1353	UL-VTLIB2	77/03/0	FTN	3.0	P380	6666	
SPLN01	21240	504	UL-VTLIB2	77/10/1	FTN	3.0	P380	6666	
UPDATE	21744	135	UL-VTLIB2	75/07/1	FTN	3.0	P380	6666	
ATMOS	22101	213	UL-VTLIB2	76/10/2	FTN	3.0	P380	6666	
SNEST	22314	110	UL-VTLIB2	75/06/1	FTN	3.0	P380	6666	
SYSTEM$	22424	1035	SL-FTN3LIB	80/09/02	COMPASS	3.6	485		
ACGOER$	23461	13	SL-FTN3LIB	80/09/02	COMPASS	3.6	485		
BACKSP$	23474	334	SL-FTN3LIB	80/09/02	COMPASS	3.6	485		
IFENDF$	24030	57	SL-FTN3LIB	80/09/02	COMPASS	3.6	485		
INPUTC$	24107	131	SL-FTN3LIB	80/09/02	COMPASS	3.6	485		
INPUTN$	24240	1171	SL-FTN3LIB	80/09/02	COMPASS	3.6	485		
OUTPTC$	25431	74	SL-FTN3LIB	80/09/02	COMPASS	3.6	485		
REWINM$	25525	52	SL-FTN3LIB	80/09/02	COMPASS	3.6	485		
EXPE	25577	44	SL-FTN3LIB	80/09/02	COMPASS	3.6	485		
SINCOSE	25643	55	SL-FTN3LIB	80/09/02	COMPASS	3.6	485		
SQRTE	25720	22	SL-FTN3LIB	80/09/02	COMPASS	3.6	485		
XTOYE	25742	7	SL-FTN3LIB	80/09/02	COMPASS	3.6	485		
KODER$	25751	1422	SL-FTN3LIB	80/09/02	COMPASS	3.6	485		
KRAKER$	27373	1525	SL-FTN3LIB	80/09/02	COMPASS	3.6	485		
ALNLOGE	31120	37	SL-FTN3LIB	80/09/02	COMPASS	3.6	485		
GETBA	31157	17	SL-FTN3LIB	80/09/0					
SIO$	31176	1517	SL-FTN3LIB	80/09/0					

```
    .106 CP SECONDS          467008 CM STORAGE USED          11 TABLE MOVES


$DATA ALPHA=-5,S=430,PHI2=5,PHI2AR=54,PHI2RR=15,ALPHARR=5.9,ALPHAAR=13,
ANGFRL=-5,NOEDRAG=1,FI=1,FLOTFMP=90,PHI1=45,DISTMAX=750,PHI1AR=75,
PHI1RR=15,HS=66,PS=80,RSF=66,W=40000,IPRINT=1,PSINT=1,RUN=400,
SINAD=200,PPRINT=1,
$
```

```
14    EXAMPLE CL VS. ALPHA TABLE

VEL =   .0
PHI2=   .0          CLTE=   .0
                    ALPH    -.80000E+01  -.40000E+01  .0           .40000E+01  .80000E+01  .12000E+02  .16000E+02  .20000E+02
                    CL      -.48000E+00  -.17500E+00  .17500E+00   .45000E+00  .78000E+00  .10400E+01  .13750E+01  .14900E+01
VEL =   .0
PHI2=   .50000E+02  CLTE=   .0
                    ALPH    -.80000E+01  -.40000E+01  .0           .40000E+01  .80000E+01  .12000E+02  .16000E+02  .20000E+02
                    CL      -.13000E+00   .15000E+00  .42000E+00   .69000E+00  .96000E+00  .12000E+01  .14500E+01  .15700E+01
VEL =   .0
PHI2=   .90000E+02  CLTE=   .0
                    ALPH    -.80000E+01  -.40000E+01  .0           .40000E+01  .80000E+01  .12000E+02  .16000E+02  .20000E+02
                    CL       .34000E+00   .59000E+00  .86000E+00   .11100E+01  .13400E+01  .14700E+01  .15600E+01  .15500E+01
```

```
13      EXAMPLE DRAG POLARS (POWER OFF) TABLE


DUMM=   .0
PHI2=   .0          CLTE=   .0
                    CL     -.40000E+00   .0           .40000E+00   .80000E+00   .12000E+01   .14000E+01
                    CD      .41590E-01   .29380E-01   .37420E-01   .65330E-01   .17463E+00   .22905E+00
```

```
10      EXAMPLE ENGINE THRUST TABLE


DUMM=    .0
TIME=    .0           SET =    .10000E+01
                      MACH     .0           .50000E-01   .10000E+00   .15000E+00   .20000E+00
                      FG       .13755E+05   .14044E+05   .14332E+05   .14875E+05   .15417E+05
DUMM=    .0
TIME=    .0           SET =    .20000E+01
                      MACH     .0           .50000E-01   .10000E+00   .15000E+00   .20000E+00
                      FG       .29437E+05   .29988E+05   .30538E+05   .31606E+05   .32673E+05
DUMM=    .0
TIME=    .0           SET =    .30000E+01
                      MACH     .0           .50000E-01   .10000E+00   .15000E+00   .20000E+00
                      FG       .10994E+05   .11330E+05   .11665E+05   .12342E+05   .13018E+05
DUMM=    .0
TIME=    .0           SET =    .40000E+01
                      MACH     .0           .50000E-01   .10000E+00   .15000E+00   .20000E+00
                      FG       .23734E+05   .24346E+05   .24958E+05   .26161E+05   .27363E+05
```

```
33      EXAMPLE RAM DRAG TABLE


DUMM=     .0
TIME=     .0           SET =    .10000E+01
                       MACH     .0              .50000E-01    .10000E+00    .15000E+00    .20000E+00
                       RAMD     .0              .39860E+04    .81230E+04    .12240E+05    .16621E+05
DUMM=     .0
TIME=     .0           SET =    .30000E+01
                       MACH     .0              .50000E-01    .10000E+00    .15000E+00    .20000E+00
                       RAMD     .0              .38620E+04    .79310E+04    .12023E+05    .16486E+05
```

15 EXAMPLE INDUCED AERODYNAMICS TABLE

```
DUMM=   .0
Y   =   .0          SET =   .10000E+01
                    PHI2    .0            .50000E+02    .10000E+03
                    CEL     .20000E-01    .12000E+00    .21400E+00
DUMM=   .0
Y   =   .0          SET =   .20000E+01
                    PHI2    .20300E+02    .44500E+02    .84700E+02
                    CEL    -.58000E-01   -.31000E-01    .42000E-01
```

TABLE DATA INPUT SUMMARY 5 TABLES

TABLE NUMBER	REFERENCE NUMBER	ARRAY LOCATION
1	10.	217.
2	13.	178.
3	14.	61.
4	15.	373.
5	33.	316.

DATA STORAGE ALLOCATION 3000
DATA STORAGE NOT USED 2582

```
VSTOL TAKEOFF PERFORMANCE ESTIMATION
-----------------------------------

     EXAMPLE CASE

TOGW =           .40000E+05

INITIAL GROUND RUN PARAMETERS

$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
W,V,L,DR,RF,EDRA,FN2
PH2I,ALPHA,T,D2,BALANCE,PHII,FN1
CL,CD,CM,A/G,RHO,DELTAE
ALPHA,DALPHAD,IYYCG,XCG,YCG
N,RF,DELTAE
ROC,ACCY
ASINK,VSINK,DSINK
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
   .40000E+05      .84870E+01      .13032E+04     -.24404E+04         IIIII      .57810E+03      .29518E+05
   .50000E+01     -.50000E+01      .25000E+00      .15292E+01      .29828E+05      .45000E+02      .13798E+05
  -.23089E+00      .33947E-01           IIIII      .10483E+01      .22429E-02      .0
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
   .40000E+05      .16882E+02      .12832E+04     -.18718E+04         IIIII      .11518E+04      .29599E+05
   .50000E+01     -.50000E+01      .50000E+00      .51215E+01      .29821E+05      .45000E+02      .13840E+05
  -.23089E+00      .33947E-01           IIIII      .10369E+01      .22429E-02      .0
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
   .40000E+05      .25186E+02      .12479E+04     -.13042E+04         IIIII      .17221E+04      .29679E+05
   .50000E+01     -.50000E+01      .75000E+00      .10797E+02      .29829E+05      .45000E+02      .13882E+05
  -.23089E+00      .33947E-01           IIIII      .10255E+01      .22429E-02      .0
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
   .40000E+05      .33398E+02      .11980E+04     -.73685E+03         IIIII      .22900E+04      .29757E+05
   .50000E+01     -.50000E+01      .10000E+01      .18532E+02      .29852E+05      .45000E+02      .13923E+05
  -.23089E+00      .33947E-01           IIIII      .10141E+01      .22429E-02      .0
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
   .40000E+05      .41518E+02      .11339E+04     -.16891E+03         IIIII      .28563E+04      .29835E+05
   .50000E+01     -.50000E+01      .12500E+01      .28304E+02      .29890E+05      .45000E+02      .13964E+05
  -.23089E+00      .33947E-01           IIIII      .10026E+01      .22429E-02      .0
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
   .40000E+05      .49545E+02      .10560E+04      .40027E+03         IIIII      .34216E+04      .29912E+05
   .50000E+01     -.50000E+01      .15000E+01      .40039E+02      .29942E+05      .45000E+02      .14004E+05
  -.23089E+00      .33947E-01           IIIII      .99102E+00      .22429E-02      .0
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
   .40000E+05      .57479E+02      .96502E+03      .97133E+03         IIIII      .39869E+04      .29986E+05
   .50000E+01     -.50000E+01      .17500E+01      .53865E+02      .30008E+05      .45000E+02      .14044E+05
  -.23089E+00      .33947E-01           IIIII      .97938E+00      .22429E-02      .0
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
   .40000E+05      .65319E+02      .86111E+03      .15422E+04         IIIII      .45496E+04      .30059E+05
   .50000E+01     -.50000E+01      .20000E+01      .69603E+02      .30088E+05      .45000E+02      .14081E+05
  -.23089E+00      .33947E-01           IIIII      .96755E+00      .22429E-02      .0
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
   .40000E+05      .73008E+02      .11342E+04      .22311E+04         IIIII      .51025E+04      .30123E+05
   .87500E+01     -.50000E+01      .22500E+01      .47287E+02      .27135E+05      .48750E+02      .14115E+05
  -.21161E+00      .33105E-01           IIIII      .93703E+00      .22429E-02      .0
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
   .40000E+05      .80434E+02      .14937E+04      .24017E+04         IIIII      .56376E+04      .30183E+05
   .12500E+02     -.47050E+01      .25000E+01      .10684E+03      .23913E+05      .52500E+02      .14147E+05
  -.16863E+00      .32045E-01           IIIII      .90064E+00      .22429E-02      .0
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
   .40000E+05      .87525E+02      .22332E+04      .35441E+04         IIIII      .61487E+04      .30242E+05
   .16250E+02     -.32100E+01      .27500E+01      [illegible]      .19627E+05      .56250E+02      .14174E+05
```

```
      -.34668E-01       .24630E-01          IIIII          .65141E+00        .22429E-02        .0
****************************************************************************************************************************
       .40000E+05        .94195E+02        .31384E+04       .41654E+04           IIIII         .66297E+04        .30301E+05
       .20000E+02       -.17550E+01        .30000E+01       .15125E+03        .15293E+05       .60000E+02        .14209E+05
       .10182E+00        .29817E-01          IIIII          .79463E+00        .22429E-02       .0
****************************************************************************************************************************
       .40000E+05        .10939E+03        .41758E+04       .47722E+04           IIIII         .70759E+04        .30362E+05
       .23750E+02       -.28000E+00        .32500E+01       .17589E+03        .10990E+05       .63750E+02        .14241E+05
       .23288E+00        .32481E-01          IIIII          .73048E+00        .22429E-02       .0
****************************************************************************************************************************
       .40000E+05        .10604E+03        .53114E+04       .53659E+04           IIIII         .74830E+04        .30424E+05
       .27500E+02        .11950E+01        .35000E+01       .20199E+03        .67826E+04       .67500E+02        .14273E+05
       .35522E+00        .36059E-01          IIIII          .65930E+00        .22429E-02       .0
****************************************************************************************************************************
SINK DATA                 .54556E+01                        .13639E+00                           .34097E-02
       .40000E+05        .11111E+03        .65542E+04       .59320E+04           IIIII         .76481E+04        .30486E+05
       .31250E+02        .26700E+01        .37500E+01       .22939E+03        .26876E+04       .71250E+02        .14305E+05
       .47494E+00        .38411E-01          IIIII          .58321E+00        .22429E-02       .0
****************************************************************************************************************************
SINK DATA                 .21618E+01                        .10857E+01                           .17277E+00
        VEHICLE IS AIRBORNE
        MAXIMUM SINK DISTANCE IS          .41562E+00 FT.
        DISTANCE =             .25216E+03 FT.
        VELOCITY =             .11553E+03 FT./SEC.
        TIME =                 .40000E+01 SEC.
        END WEIGHT FOR THIS PHASE IS              .40000E+05 POUNDS MASS


        LIFTOFF CHARACTERISTICS

        HORIZONTAL ACCELERATION =           .51570E+00 GIS
        LIFT =                              .76359E+04 POUNDS FORCE
        DRAG =                              .63560E+04 POUNDS FORCE
        VERTICAL GROSS THRUST =             .32863E+05 POUNDS FORCE
        HORIZONTAL GROSS THRUST =           .26984E+05 POUNDS FORCE

 NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT

 $DATA SINKD=0,ROC=1.67,PS=90,RS=76,RSF=76,IPRINT=0$
        TOGW =          .40000E+05

        INITIAL GROUND RUN PARAMETERS

        VEHICLE IS AIRBORNE
        VEHICLE HAS A R/C OF              .16700E+01 FT./SEC.
        VERTICAL HIEGHT IS            .36921E+00 FT.
        DISTANCE =             .35474E+03 FT.
        VELOCITY =             .13093E+03 FT./SEC.
        TIME =                 .48000E+01 SEC.
        END WEIGHT FOR THIS PHASE IS              .40000E+05 POUNDS MASS


        LIFTOFF CHARACTERISTICS

        HORIZONTAL ACCELERATION =           .36399E+00 GIS
        LIFT =                              .11300E+05 POUNDS FORCE
        DRAG =                              .81952E+04 POUNDS FORCE
        VERTICAL GROSS THRUST =             .37272E+05 POUNDS FORCE
        HORIZONTAL GROSS THRUST =           .22635E+05 POUNDS FORCE

 NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT  NEXT

 $DATA SINKD=0,ROC=1.67,PS=100,RS=86,RSF=86,IPRINT=0$
        TOGW =          .40000E+05

        INITIAL GROUND RUN PARAMETERS
```

```
VEHICLE IS AIRBORNE
VEHICLE HAS A R/C OF              .16700E+01 FT./SEC.
VERTICAL HIEGHT IS              .33656E+00 FT.
DISTANCE =              .39324E+03 FT.
VELOCITY =              .13866E+03 FT./SEC.
TIME =                  .50500E+01 SEC.
END WEIGHT FOR THIS PHASE IS             .40000E+05 POUNDS MASS


LIFTOFF CHARACTERISTICS

HORIZONTAL ACCELERATION =          .36907E+00 GIS
LIFT =                             .11639E+05 POUNDS FORCE
DRAG =                             .86602E+04 POUNDS FORCE
VERTICAL GROSS THRUST =            .36941E+05 POUNDS FORCE
HORIZONTAL GROSS THRUST =          .23423E+05 POUNDS FORCE

NEXT NEXT NEXT NEXT NEXT NEXT NEXT NEXT NEXT NEXT NEXT NEXT NEXT NEXT NEXT NEXT NEXT NEXT NEXT NEXT NEXT

BY CUBIC SPLINE INTERPOLATION OF THE ABOVE DATA POINTS
            FOR A RUN OF            .40000E+03 FEET THE  PS  IS          .10320E+03 FT./SEC.
                                              AND THE HORIZONTAL ACCELERATION IS          .37630E+00 GIS
```

```
TESTAVI.    81/09/24.KRONOS 2.1.1-SYS-C25-NADC.

.51.TEST.C450000.T10.
.51.ACCOUNT.60334A..
.51. MASTER DEVICE:  A
.52.GET.VTLIB1.VTLIB2/UN=VT1499.
.57.GTR(VTLIB1.LGO...STREL/STO
.00. EDITING COMPLETE.
.00.LDSET(LIB=VTLIB2)
.00.LGO.
.04.STOP
.04.COMPUTER UNITS AT.100  P = 1.
.04.CP        1.680 SEC.         $      0.88
.04.CM       14.323 KWD.
.04.IO        1.895 SEC.         $      0.09
.04.IM       19.838 KWD.
.04.TAPES SCHEDULED 00
.04.PACKS SCHEDULED 00
.04.SERVICE CHARGE               $      2.20
.04.                               ---------
.04.SUBTOTAL                     $      3.17
```

APPENDIX C

Program Listings

A listing of the FORTRAN source code for the main STO program and a four degree-of-freedom interpolating subroutine TAKE5 is presented.

```
      CSTD***                                                           STD 0001
            PROGRAM STD (INPUT,OUTPUT,TAPE8,TAPE9=INPUT)                STD 0002
      C*****************************************************************STD 0003
      C  CREATED BY KOHLS ON APRIL 1977.                                STD 0004
      C*****************************************************************STD 0005
            DIMENSION TITLE(8),ICOPY(10),RUNDATA(33),K(4),AGDATA(33),   STD 0006
           * PHDATA(33)                                                 STD 0007
            COMMON/PRINT/NPRINT                                         STD 0008
            REAL MACH,NEF,NEA,MU,L,LW,LRA,LRF,MAC,MOMENT,LEVER,IYY,IYYCG STD 0009
            INTEGER SEGMENT                                             STD 0010
            NAMELIST/DATA/ALPHA,S,DELTAE,NEF,NEA,MU,W,LR,LRA,LRF,REVTIME,DT, STD 0011
           *IPRINT,NPRINT,VDATA,MAC,SEGMENT,IYYCG,XCG,YCG,EL,DELMAX,PHI1,  STD 0012
           *ANGFRL,FLOTEMP,ALPHMIN,PHI2,PHI2AR,PHI2RR,RS,ALPHARR,ALPHAAR,ALT, STD 0013
           * RUN,EDATUM,NDEDRAG,NOSTORE,EFAIL,DEILOSF,NODDEI,METRIC,PS,WOD, STD 0014
           *DEITAB,RSF,PHI1RR,PHI1AR,PSINT,ROC,DISTMAX,SINKO,RDSCALE,RAM,PHONYSTD 0015
            ICOUNT=0 $ RUN=RUNDATA(1)=AGDATA(1)=PHDATA(1)=0.            STD 0016
         10 NSEGMENT=NPRINT=IPRINT=NDEDRAG=NOSTORE=METRIC=NODDEI=0      STD 0017
            FLOSSA=FLOSSF=0.                                            STD 0018
            DT=.05        $      RAM=1.                                 STD 0019
            REVTIME=ANGFRL=ALPHMIN=EDRAG=OSTORE =V=T=ALT=D=EL=WF1=PHI1=PHI2= STD 0020
           *FN1=FN2=DLFG=DDFS      =VSTARR=EDATUM=EFAILA=DEI=DEILOSF=0.  STD 0021
            DDEILOF=RSF=PHI1AR=PHI1RR=PSINT=AGY=DROC=ROC=WOD=ROCH=PHONY=0. STD 0022
           *F2=RS=DELTAE=PHI2AR=PHI2RR=ALPHARR=ALPHAAR=RUN=PS=DEITAB=QQ=0. STD 0023
            FLOTEMP=59. $ MU=.02 $ NEA=NEF=1.    $ Q1=1. $ Q2=2. $ DISTMAX=1.E5STD 0024
            SINKO=ASINK=VSINK=CSINK=0.       $ RDSCALE=1.               STD 0025
            IF(ICOUNT.NE.0) GO TO 90                                    STD 0026
            IC=1                                                        STD 0027
         20 READ 30,ICOPY                                               STD 0028
         30 FORMAT(2A1,A8,7A10)                                         STD 0029
         40 FORMAT(1X,2A1,A8,7A10)                                      STD 0030
            IF(EOF(5)) 60,50                                            STD 0031
         50 IC=IC+1                                                     STD 0032
            WRITE(9,30) ICOPY                                           STD 0033
            PRINT 40,ICOPY                                              STD 0034
            IF(IC.NE.2.AND.ICOPY(2).EQ.1H$) GO TO 60                    STD 0035
            GO TO 20                                                    STD 0036
         60 DO 70 II=1,IC                                               STD 0037
         70 BACKSPACE 9                                                 STD 0038
            READ DATA                                                   STD 0039
            READ80,TITLE                                                STD 0040
            CALL TREAS(1,WD,XD,YD,ZD,FWXYZ)                             STD 0041
         80 FORMAT(8A10)                                                STD 0042
            GO TO 110                                                   STD 0043
         90 REWIND 9                                                    STD 0044
            READ(9,DATA)                                                STD 0045
            READ 30,ICOPY                                               STD 0046
            IF(EOF(9)) 750,100                                          STD 0047
        100 PRINT 40,ICOPY                                              STD 0048
            BACKSPACE 9 $ READ DATA                                     STD 0049
        110 PH2I=PHI2                                                   STD 0050
            ALPHAO=ALPHA                                                STD 0051
            PHII=PHI1                                                   STD 0052
            PHI1=(PHI1+ANGFRL)*3.14159265/180.                          STD 0053
            IF(SEGMENT.EQ.0) GO TO 120                                  STD 0054
            LEVER=LRA+MU*LR      $ DLEVER=LRA+LRF                       STD 0055
        120 V=V+WOD                                                     STD 0056
            IF(ICOUNT.EQ.0) PRINT 130,TITLE                             STD 0057
```

```
PROGRAM STD        74/74   OPT=1                    FTN 4.6+428        81/09/29. 10.19.43        PAGE    2

         130 FORMAT(1H1,//,10X,*VSTOL TAKEOFF PERFORMANCE ESTIMATION*,/,10X,35(STD 0058
            1H-),//,3A10,//)                                                  STD 0059
             ICOUNT=0                                                         STD 0060
             TOGW=W                                                           STD 0061
             PRINT 140,W                                                      STD 0062
         140 FORMAT(10X,*TOGW *,E20.5,//,10X,                                 STD 0063
            **INITIAL GROUND RUN PARAMETERS*,/)                               STD 0064
             IF(IPRINT.NE.0) PRINT 150                                        STD 0065
         150 FORMAT(10X,120(1HS),/,10X,*W,V,L,DR,RF,EDRG,FN2*,/,10X,*PHI2,ALPHASTD 0066
            ,,T,D2,BALANCE,PHI1,FN1*,/,10X,*CL,CD,CM,A/G,RHO,DELTAE*,/,10X,*ALPSTD 0067
            ,HA,DALPHAD,IYYCG,XCG,YCG*,/,10X,*N,FF,DELTAE*,/,10X,*ROC,ACCY*,/,1STD 0068
            *0X,*ASINK,VSINK,DSINK*,/,10X,120(1HS))                           STD 0069
             IF(METRIC.EQ.0) ALT=ALT*.3043                                    STD 0070
             CALL ATMOS(ALT,A1,A2,A3,A4,A5,A6,A7,A9)                          STD 0071
             IF(METRIC.NE.0) GO TO 160                                        STD 0072
             ALT=ALT*3.280839895                                              STD 0073
             A6=A6*3.280839895                                                STD 0074
             A3=A2*2.3769E-3                                                  STD 0075
             AFLOTEM=FLOTEMP+459.7                                            STD 0076
             A6=A6*SQRT(AFLOTEM/518.7)                                        STD 0077
             A3=A3*518.7/AFLOTEM                                              STD 0078
             GO TO 170                                                        STD 0079
         160 AFLOTEM=FLOTEMP+273.16                                           STD 0080
             A6=A6*SQRT(AFLOTEM/288.16)                                       STD 0081
             A3=A3*288.16/AFLOTEM                                             STD 0082
         170 EDATUM=EDATUM*3.141592654/180.                                   STD 0083
             G=32.1741                                                        STD 0084
             IF(METRIC.NE.0) G=9.8                                            STD 0085
             GOGC=1. $ IF (METRIC.NE.0) GOGC=9.8                              STD 0086
             W=W*GOGC                                                         STD 0087
             J=-1 $ WRC=0. $ COUNT=(.25/DT)+1.0E-10 $ I=COUNT $ M=I+1         STD 0088
         180 MACH=V/A6                                                        STD 0089
             J=J+1 $ IF(J.GE.M) J=1                                           STD 0090
             TOUM=T     $           IF(TOUM.GT.REVTIME)  TOUM=REVTIME         STD 0091
             PHI2=PH2I                                                        STD 0092
             IF(SEGMENT.NE.0) GO TO 210                                       STD 0093
       C******** FORE ENGINE NOZZLE VARIATION                                 STD 0094
             IF(PHI1AR.EQ.0..OR.V.LT.RSF) GO TO 190                           STD 0095
             PHI1=PHI1+PHI1RR*DT                                              STD 0096
             IF(PHI1.GT.PHI1AR) PHI1=PHI1AR                                   STD 0097
             PHI1=(PHI1+ANGFRL)*3.141592654/180.                              STD 0098
       C  FOR ANY FUTURE TABLE LOOK UPS USE PHI1                              STD 0099
       C*********************************************                         STD 0100
         190 IF(V.LT.RS) GO TO 200                                            STD 0101
                         PHI2=PHI2+PHI2RR*DT                                  STD 0102
             IF(PHI2.GT.PHI2AR) PHI2=PHI2AR                                   STD 0103
         200 IF(V.LT.PS) GO TO 210                                            STD 0104
             ALPHA=ALPHA+ALPHARR*DT                                           STD 0105
             IF(ALPHA.GT.ALPHAAR) ALPHA=ALPHAAR                               STD 0106
         210 IF(E1.NE.0.) CALL TLOO5(011,MACH,01,TOUM,0.,WF1)                 STD 0107
             CALL TLOO5(11,MACH,02,TOUM,0.,WF2)                               STD 0108
             WF1=WF1*NEF*GOGC                                                 STD 0109
             WF2=WF2*NEA*GOGC                                                 STD 0110
             IF(E1.NE.0.) CALL TLOO5(10,MACH,01,TOUM,0.,FN1)                  STD 0111
             CALL TLOO5(10,MACH,02,TOUM,0.,FN2)                               STD 0112
             CALL TLOO5(12,PHI1,1.,0.,0.,FLOSSF)                              STD 0113
             CALL TLOO5(12,PHI2,2.,0.,0.,FLOSSA)                              STD 0114
```

```
PROGRAM STD        74/74    OPT=1                        FTN 4.6+428        81/09/28. 10.18.43        PAGE     3

          FN1=(FN1-FLOSSF*FN1)*NEF                                              STD 0115
          FN2=(FN2-FLOSSA*FN2)*NEA                                              STD 0116
      C ********   INDUCED AERO                                                 STD 0117
          FGTOTAL=FN1+FN2                                                       STD 0118
          CALL TLOO5(15,PHI2,1.,0.,0.,DLFG)                                     STD 0119
          CALL TLOO5(15,PHI2,2.,0.,0.,DDFG)                                     STD 0120
          DLFG=DLFG*FGTOTAL $ DDFG=DDFG*FGTOTAL                                 STD 0121
      C $$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$                     STD 0122
          PH2I=PHI2                                                             STD 0123
          VSTARR1=V     $      IF(V.LT.VSTARR) VSTARR1=VSTARR                   STD 0124
          CALL TLOO5(14,ALPHA,DELTAE,PH2I,VSTARR1,CL)                           STD 0125
          CALL TLOO5(13,CL,DELTAE,PH2I,VSTARR1,CD)                              STD 0126
          IF(SEGMENT.NE.0) CALL TLOO5(17,CL,DELTAE,PH2I,VSTARR1,CM)             STD 0127
          PHI2=(PHI2+ANGFAL)*3.141592654/180.                                   STD 0128
          DR=.5*CD*V**2*A3*S                                                    STD 0129
          CALL TLOO5(33,MACH,D1,0.,0.,EDRAG)                                    STD 0130
          CALL TLOO5(33,MACH,D2,0.,0.,DSTORE)                                   STD 0131
          EDRAG=EDRAG*RDSCALE                                                   STD 0132
          IF(NOEDRAG.EQ.0) EDRAG=0                                              STD 0133
          IF(NOSTORE.EQ.0) DSTORE=0                                             STD 0134
          IF(DEI.NE.0..AND.NODDEI.NE.0.)CALL TLOO5(33,MACH,3.,0.,0.,DDEILOF)STD 0135
          DR=DR+EDRAG+DSTORE+DDEILOF+DDFG                                       STD 0136
          PITCH=(ALPHA-ALPHAD)*3.141592654/180.                                 STD 0137
          ANG1=PHI1+PITCH+EDATUM $ ANG2=PHI2+PITCH+EDATUM                       STD 0138
          L=.5*CL*V**2*A3*S                                                     STD 0139
          L=L+DLFG                                                              STD 0140
          FGV=FN1*SIN(ANG1)+FN2*SIN(ANG2)                                       STD 0141
          FGH=FN1*COS(ANG1)+FN2*COS(ANG2)                                       STD 0142
          BALANCE=W-L-FGV                                                       STD 0143
          DV=DT*G      *(FGH-DR-MU*BALANCE)/W                                   STD 0144
          V2=V+DV                                                               STD 0145
          IF(SEGMENT.EQ.0) GO TO 220                                            STD 0146
          MOMENT=.5*CM*V**2*A3*S*MAC                                            STD 0147
          RF=(LEVER*BALANCE-MOMENT)/DLEVER                                      STD 0148
          IF(PITCH.LE.0.) GO TO 220                                             STD 0149
          ANGMESS=LRA*COS(PITCH)+MU*LRA*SIN(PITCH)+LR*MU*COS(PITCH)-LR*SIN(PSTD 0150
         *ITCH)                                                                 STD 0151
          RF=(BALANCE*ANGMESS-MOMENT)/(LRF+ANGMESS*COS(PITCH))                  STD 0152
      220 D2=D+.5*DT*((V2-WDD)**2.-(V-WDD)**2.)/DV                              STD 0153
          IF(IPRINT.EQ.0.OR.J.NE.I) GO TO 250                                   STD 0154
          ACCX=(FGH-DR-MU*BALANCE)/W                                            STD 0155
          PRINT 230,W,V,L,DR,RF,EDRAG,FN2                                       STD 0156
          PRINT 230,PH2I ,ALPHA,T ,D2,BALANCE,PHI1,FN1                          STD 0157
          PRINT 240,CL,CD,CM,ACCX,       A3,DELTAE                              STD 0158
      230 FORMAT(5X,7(5X,E12.5))                                                STD 0159
      240 FORMAT(5X,6(5X,E12.5),/,130(1H?))                                     STD 0160
      250 IF(SEGMENT.EQ.0) GO TO 260                                            STD 0161
          IF(RF.LE.0.) GO TO 520                                                STD 0162
      260 IF(BALANCE.GT.0..OR.DEITAB.EQ.0.) GO TO 280                           STD 0163
          DD=1.        $    J=J-1                                               STD 0164
          DEITAB=0.                                                             STD 0165
          RDSCALE=RAM                                                           STD 0166
          IF(RAM.EQ.1.)D1=3.                                                    STD 0167
          IF(RAM.EQ.1.)D2=4.                                                    STD 0168
          IF(PHONY.EQ.0.) GO TO 180                                             STD 0169
          PHI1=PHI1AR $ PH2I=PHI2AR $ ALPHA=ALPHAAR                             STD 0170
          PRINT 270                                                             STD 0171
```

```
PROGRAM STD        74/74    OPT=1                                FTN 4.5+426          81/09/26. 10.15.43          PAGE      4

      270 FORMAT(10X,*INSTANTANEOUS ROTATION AT OEI*)                   STD 0172
          PHONY=-.13 $ GO TO 180                                        STD 0173
      280 IF(BALANCE.GT.0..OR.EFAILA.EQ.0..OR.OEI.NE.0.) GO TO 290      STD 0174
          OEI=1. $ NEA=NEA*.5 $ NEF=NEF*OEILOSF $ GO TO 180             STD 0175
      290 D=D2 $ V=V2 $ T=T+DT $ W=W-((WF1+WF2)*DT/3600.)               STD 0176
          IF(PHONY.EQ.-.13) GO TO 350                                   STD 0177
          IF(D.LT.DISTMAX) GO TO 310                                    STD 0178
          PRINT 300                                                     STD 0179
      300 FORMAT(10X,*CASE TERMINATED (DISTMAX EXCEEDED)*)              STD 0180
          GO TO 730                                                     STD 0181
      310 IF(ICOUNT.GT.1000) GO TO 410                                  STD 0182
          IF(BALANCE.GE.0..OR.ROC.EQ.0.) GO TO 330                      STD 0183
          MU=0.$ AGYL=AGY $ DROCL=DROC                                  STD 0184
          AGY=(-BALANCE)*G/W                                            STD 0185
          AGYA=(AGY+AGYL)*.5                                            STD 0186
          DROC=DROCL+AGYA*DT                                            STD 0187
          AROC=(DROC+DROCL)*.5                                          STD 0188
          ROCH=ROCH+AROC*DT                                             STD 0189
          IF(IPRINT.NE.0.AND.J.EQ.I) PRINT 320,DROC,AGYA                STD 0190
      320 FORMAT(1X,*CLIMB DATA*,2(10X,E20.5))                          STD 0191
          IF(DROC.GE.ROC) GO TO 430                                     STD 0192
          GO TO 350                                                     STD 0193
      330 IF(SINKD.GT.0..AND.SINKD.LE.0) GO TO 500                      STD 0194
      340 IF(BALANCE.LE.0.) GO TO 430                                   STD 0195
      350 ICOUNT=ICOUNT+1                                               STD 0196
          GO TO 180                                                     STD 0197
      360 IF(METRIC.NE.0) GO TO 380                                     STD 0198
          PRINT 370,D,V,T,W                                             STD 0199
      370 FORMAT(10X,*DISTANCE = *,E20.5,* FT.*,/,10X,*VELOCITY = *,E20.5,* STD 0200
         (FT./SEC.*,/,10X,*TIME =*,5X,E20.5,* SEC.*,/,10X,*END WEIGHT FOR THSTD 0201
         (IS PHASE IS *,E20.5,* POUNDS MASS*)                           STD 0202
          GO TO 400                                                     STD 0203
      380 PRINT 390,D,V,T,W                                             STD 0204
      390 FORMAT(10X,*DISTANCE = *,E20.5,*  M.*,/,10X,*VELOCITY = *,E20.5,* STD 0205
         ( M./SEC.*,/,10X,*TIME =*,5X,E20.5,* SEC.*,/,10X,*END WEIGHT FOR THSTD 0206
         (IS PHASE IS *,E20.5,* KILOGRAMS  *)                           STD 0207
      400 IF(SEGMENT.EQ.0) GO TO 630                                    STD 0208
          GO TO (500,610), SEGMENT                                      STD 0209
      410 PRINT 420                                                     STD 0210
      420 FORMAT(10X,*TOO MUCH TIME*)                                   STD 0211
          GO TO 360                                                     STD 0212
      430 PRINT 440                                                     STD 0213
      440 FORMAT(10X,*VEHICLE IS AIRBORNE*)                             STD 0214
          ISINK=10H FT.                                                 STD 0215
          IF(METRIC.NE.0) ISINK=10H M.                                  STD 0216
          IF(SINKD.GT.0.) PRINT 450,DSINK,ISINK                         STD 0217
      450 FORMAT(10X,*MAXIMUM SINK DISTANCE IS*,E20.5,A10)              STD 0218
          IF(OEI.NE.0..OR.DD.NE.0.) PRINT 460                           STD 0219
      460 FORMAT (10X,*OEI AT PSEUDO LIFTOFF*)                          STD 0220
          IF(ROC.EQ.0.) GO TO 490                                       STD 0221
          IROC=10H FT./SEC.                                             STD 0222
          IF(METRIC.NE.0) IROC=10H M./SEC.                              STD 0223
          PRINT 470,ROC,IROC                                            STD 0224
      470 FORMAT(10X,*VEHICLE HAS A R/C OF *,E20.5,A10)                 STD 0225
          IROC=10H FT.                                                  STD 0226
          IF(METRIC.NE.0) IROC=10H M.                                   STD 0227
          PRINT 480,ROCH,IROC                                           STD 0228
```

```
PROGRAM STD        74/74   OPT=1                          FTN 4.5+428        81/09/28. 10.15.43        PAGE    5

      480 FORMAT(10X,*VERTICAL HEIGHT IS *,E20.5,A10)                     STD 0229
      490 GO TO 360                                                       STD 0230
      500 PRINT 510                                                       STD 0231
      510 FORMAT(10X,*AUTO ROTATION IS OCCURING*)                         STD 0232
          GO TO 630                                                       STD 0233
C         ALPHA CORRECTION      AUTO ROTATION$$$$$$$$$$$$$$$$$$$$$$$$$$$$ STD 0234
      520 IF(SEGMENT.GT.1.AND.ALPHA.GE.ALPHMIN) GO TO 550                 STD 0235
      530 CALL TLOO5(30,W,0.,0.,0.,IYYCG)                                 STD 0236
          CALL TLOO5(31,W,1.,0.,0.,XCG)                                   STD 0237
          CALL TLOO5(31,W,2.,0.,0.,YCG)                                   STD 0238
          DCGS=XCG**2+YCG**2 $ LRA=XCG $ LRF=DLEVER-XCG                   STD 0239
          IYY=IYYCG+W/G*DCGS $ IF(WRC.NE.0.)GO TO 531 $ WR=LR-YCG $ WRC=1. STD 0240
      531 LR=YCG+WR $ DALPHAR=DT**2*(-RF)*DLEVER/IYY                      STD 0241
          DALPHAD=DALPHAR*180./3.141592654                                STD 0242
          ALPHA=ALPHA+DALPHAD                                             STD 0243
          IF(SEGMENT.GT.1.AND.ALPHA.GE.ALPHMIN.AND.ITRIP.EQ.0) GO TO 550  STD 0244
          ITRIP=0                                                         STD 0245
          IF(IPRINT.NE.0.AND.J.EQ.I) PRINT 540,ALPHA,DALPHAD,IYYCG,XCG,YCG STD 0246
      540 FORMAT(10X,5(5X,E12.5),/,1X,8(15H AUTO ROTATION ))              STD 0247
          GO TO 260                                                       STD 0248
C$$$$$$$$$$ $$$$$$$ TRY TO COUNTER ROTATION BY ELEVATOR                    STD 0249
      550 DDELTAE=1. $ ITRIP=0                                            STD 0250
      560 CALL SNEST(N,RF,DELTAE,DDELTAE,010.,ABOS,DYL,ABDYL,XCHECK,XLOC) STD 0251
          IF(IPRINT.NE.0.AND.J.EQ.I) PRINT 570,N,RF,DELTAE                STD 0252
      570 FORMAT(10X,25(1H>),5X,I10,2(10X,E12.5))                         STD 0253
          IF(DELTAE.LT.DELMAX) GO TO 580                                  STD 0254
          DELTAE=DELMAX $ N=0 $ ITRIP=1                                   STD 0255
      580 CALL TLOO5(14,ALPHA,DELTAE,PH2I,VSTARR1,CL)                     STD 0256
          CALL TLOO5(13,CL,DELTAE,PH2I,VSTARR1,CD)                        STD 0257
          CALL TLOO5(17,CL,DELTAE,PH2I,VSTARR1,CM)                        STD 0258
          DR=.5*CD*V**2*A3*S                                              STD 0259
          DR=DR+EDRAG+DSTORE+DDEILDF+DDFG                                 STD 0260
          L=.5*CL*V**2*A3*S                                               STD 0261
          L=L+DLFG                                                        STD 0262
          BALANCE=W-L-FGV                                                 STD 0263
          DV=DT*G       *(FGH-DR-MU*BALANCE)/W                            STD 0264
          V2=V+DV                                                         STD 0265
          MOMENT=.5*CM*V**2*A3*S*MAC                                      STD 0266
          RF=(LEVER*BALANCE-MOMENT)/DLEVER                                STD 0267
          IF(PITCH.LE.0.) GO TO 590                                       STD 0268
          ANGRESS=LRA*COS(PITCH)+MU*LRA*SIN(PITCH)+LR*MU*COS(PITCH)-LR*SIN(PSTD 0269
         *ITCH)                                                           STD 0270
          RF=(BALANCE*ANGRESS-MOMENT)/(LRF+ANGRESS*COS(PITCH))            STD 0271
      590 D2=D+.5*DT*((V2-WDD)**2.-(V-WDD)**2.)/DV                        STD 0272
          IF(ITRIP) 530,500                                               STD 0273
      600 IF(N) 560,260                                                   STD 0274
      610 PRINT 620                                                       STD 0275
      620 FORMAT(10X,*ELEVATOR CORRECTION ATTEMPTED*)                     STD 0276
C*******************************************************************STD 0277
C                          LIFTOFF CHARATERISTICS                         STD 0278
C*******************************************************************STD 0279
      630 PRINT 640                                                       STD 0280
      640 FORMAT(//,10X,*LIFTOFF CHARACTERISTICS*,/)                      STD 0281
          AGX=(FGH-DR-MU*BALANCE)/W                                       STD 0282
          IF(PHONY.NE.-.13) GO TO 670                                     STD 0283
          PHRC=V*60.*((L+FGV-W)/FGH)                                      STD 0284
          IROC=104 FT/MIN                                                 STD 0285
```

```
      IF(METRIC.EQ.0) GO TO 650
      IROC=10H M/SEC
      PHRC=PHRC/60.
  650 PRINT 660,PHRC,IROC
  660 FORMAT(10X,*INSTANTANEOUS R/C IS *,E20.5,A10)
  670 IF(METRIC.NE.0) GO TO 690
      PRINT 680,AGX,L,DR,FGV,FGH
  680 FORMAT(10X,*HORIZONTAL ACCELERATION =*,E20.5,* G(S*,/,10X,
     **LIFT =*,19X,E20.5,* POUNDS FORCE*,/,10X,*DRAG =*,19X,E20.5,
     ** POUNDS FORCE*,/,10X,*VERTICAL GROSS THRUST =*,2X,E20.5,
     ** POUNDS FORCE*,/,10X,*HORIZONTAL GROSS THRUST =*,E20.5,
     ** POUNDS FORCE*)
      GO TO 710
  690 PRINT 700,AGX,L,DR,FGV,FGH
  700 FORMAT(10X,*HORIZONTAL ACCELERATION =*,E20.5,* G(S*,/,10X,
     **LIFT =*,19X,E20.5,* NEWTONS      *,/,10X,*DRAG =*,19X,E20.5,
     ** NEWTONS      *,/,10X,*VERTICAL GROSS THRUST =*,2X,E20.5,
     ** NEWTONS      *,/,10X,*HORIZONTAL GROSS THRUST =*,E20.5,
     ** NEWTONS      *)
  710 IF(RUN.LE.0.) GO TO 730
      CALL UPDATE(AGDATA,D,AGX)
      IF(PHONY.EQ.-.13) CALL UPDATE(PHDATA,D,PHRC)
      IF(PSINT.LE.0.) GO TO 720
      CALL UPDATE(RUNDATA,D,PS)              $ GO TO 730
  720 CALL UPDATE(RUNDATA,D,TOGW)
  730 PRINT 740
  740 FORMAT(/,1X,22(6H NEXT ),/)
      GO TO 10
  750 IF(RUN.LE.0.) STOP
      IF(PHDATA(1).EQ.0.) GO TO 770
      PHROC=SPLN01(1,PHDATA,RUN)
      PRINT 760,PHROC,IROC
  760 FORMAT(10X,*INSTANTANEOUS INTERPOLATED R/C IS *,E20.5,A10)
  770 AG=SPLN01(1,AGDATA,RUN)
      WRUN=SPLN01(1,RUNDATA,RUN)
      K(1)=6H FEET  $ K(2)=6H TOGW  $ K(3)=10H POUNDS MA  $ K(4)=2HSS
      IF(METRIC.EQ.0.AND.PSINT.EQ.0.) GO TO 790
      K(1)=6H    M.  $ K(3)=10H KILOGRAMS  $ K(4)=2H
      IF(PSINT.EQ.0.) GO TO 780
      K(2)=6H  PS    $ K(3)=10H M./SEC.
      IF(METRIC.NE.0) GO TO 780
      K(1)=6H FEET  $ K(3)=10H FT./SEC.
  780 PRINT 790,RUN,K(1),K(2),WRUN,K(3),K(4),AG
  790 FORMAT(10X,*BY CUBIC SPLINE INTERPOLATION OF THE ABOVE DATA POINTS
     **,/,25X,*FOR A RUN OF *,E20.5,A6,*THE*,A5,*IS*,,E20.5,A10,A3,/,60X
     *,*AND THE HORIZONTAL ACCELERATION IS *,E20.5,* G(S*)
      STOP
C?????????????????          SINK OFF THE BOW CALCULATIONS
  800 IF(NU.EQ.0) GO TO 810
      IF(PS.GT.0.) PS=V $ IF(RS.GT.0.) RS=V $ IF(RSF.GT.0.) RSF=V $ NU=J
  810 ASINKL=ASINK $ VSINKL=VSINK $ DSINKL=DSINK
      ASINK=BALANCE*G/W
      ASINKA=(ASINK+ASINKL)*.5
      VSINK= VSINKL+ASINKA*DT
      VSINKA=(VSINK+VSINKL)*.5
      DSINK=DSINKL+VSINKA*DT
      IF(IPRINT.NE.0.AND.J.EQ.I) PRINT 920,ASINK,VSINK,DSINK
```

```
PROGRAM STD        74/74    OPT=1                    FTN 4.6+428        81/09/29. 10.19.43        PAGE     7

          820 FORMAT(1X,*SINK DATA*,3(10X,E20.5))                         STD 0343
              GO TO 340                                                   STD 0344
         C****************************************************************STD 0345
              END                                                         STD 0346
```

```
SUBROUTINE TAKE5      74/74   OPT=1                      FTN 4.6+452       81/09/29. 10.13.43       PAGE     1

        CTAKE5:                                                              TAK50001
              SUBROUTINE TAKE5(II,W,X,Y,Z,FWXYZ)                             TAK50002
        C***   MODIFIED GTREAD TO INCLUDE FOUR INDEPENDENT VARIABLES- DBK 3/77 TAK50003
              COMMON /TSIZE/NMAX,TDATA(3300)                                 TAK50004
              COMMON/PRINT/NPRINT                                            TAK50005
              DIMENSION A(100),IDD(5),SIRIUS(30)                             TAK50006
              DATA NMAX,NTBL/3300,0/                                         TAK50007
              DATA NPRINT/0/                                                 TAK50008
              ENTRY TREAS                                                    TAK50009
              MRIGEL=0                                                       TAK50010
              ITPRT   = NPRINT                                               TAK50011
              IF(NTBL.NE.0) GO TO 20                                         TAK50012
              LOC=61                                                         TAK50013
              DO 10 M=1,NMAX                                                 TAK50014
           10 TDATA(M)=0.                                                    TAK50015
              ILAST=1                                                        TAK50016
           20 READ 30, IP,ITABNO                                             TAK50017
           30 FORMAT (I1,I4,75X                                              TAK50018
             1                      )                                        TAK50019
              IF(ITABNO.EQ.0) GO TO 110                                      TAK50020
              NTBL    = NTBL+1                                               TAK50021
              ENIF=TDATA(NTBL)=ITABNO                                        TAK50022
              TDATA(NTBL+30)=LOC                                             TAK50023
           40 IF(NTBL.LE.1) GO TO 210                                        TAK50024
              DO 50 LYRA=2,NTBL                                              TAK50025
              IF(ENIF.EQ.TDATA(LYRA-1)) GO TO 60                             TAK50026
           50 CONTINUE                                                       TAK50027
              GO TO 210                                                      TAK50028
           60 IARIES=MERAK=TDATA(LYRA+29)                                    TAK50029
              MRIGEL=MRIGEL+1                                                TAK50030
              SIRIUS(MRIGEL)=ENIF                                            TAK50031
              LIBRAM=100000                                                  TAK50032
              IZAR=LOC-1                                                     TAK50033
              DO 70 IRK=1,NTBL                                               TAK50034
              LIBRA=TDATA(IRK+30)                                            TAK50035
              IF((LIBRA.GT.MERAK).AND.(LIBRA.LT.LIBRAM)) LIBRAM=LIBRA        TAK50036
           70 CONTINUE                                                       TAK50037
              LED=LIBRAM-MERAK                                               TAK50038
              DO 80 NEKKAR=LIBRAM,IZAR                                       TAK50039
              TDATA(MERAK)=TDATA(NEKKAR)                                     TAK50040
           80 MERAK=MERAK+1                                                  TAK50041
              DO 90 NEKKAR=1,NTBL                                            TAK50042
              LLOC=TDATA(NEKKAR+30)                                          TAK50043
              IF(LLOC.GT.IARIES) TDATA(NEKKAR+30)=LLOC-LED                   TAK50044
           90 CONTINUE                                                       TAK50045
              TDATA(LYRA+29)=LOC-LED                                         TAK50046
              DO 100 IBALT=MERAK,LOC                                         TAK50047
          100 TDATA(IBALT)=0.                                                TAK50048
              LOC=MERAK                                                      TAK50049
              NTBL=NTBL-1                                                    TAK50050
              GO TO 210                                                      TAK50051
          110 NMEM=NMAX-LOC                                                  TAK50052
              IF(NTBL.LE.1) GO TO 140                                        TAK50053
        C*** RE ORDER TABLE REFERENCE NUMBERS                                TAK50054
          120 NDONE=1                                                        TAK50055
              DO 130 L=2,NTBL                                                TAK50056
              K1=L-1                                                         TAK50057
```

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SUBROUTINE TAKE5      74/74   OPT=1                    FTN 4.6+425       81/03/26. 10.18.43        PAGE    2

          K2=L                                                                  TAK50058
          IF(TDATA(K1).LT.TDATA(K2)) GO TO 130                                  TAK50059
          XSAVE=TDATA(K1)                                                       TAK50060
          TDATA(K1)=TDATA(K2)                                                   TAK50061
          TDATA(K2)=XSAVE                                                       TAK50062
          XSAVE=TDATA(K1+30)                                                    TAK50063
          TDATA(K1+30)=TDATA(K2+30)                                             TAK50064
          TDATA(K2+30)=XSAVE                                                    TAK50065
          NDONE=6                                                               TAK50066
      130 CONTINUE                                                              TAK50067
          IF(NDONE.EQ.0) GO TO 120                                              TAK50068
      140 IF(II.LE.0) GO TO 470                                                 TAK50069
          IF(NPRINT.EQ.0) GO TO 150                                             TAK50070
          PRINT 150                                                             TAK50071
      150 FORMAT(1H1)                                                           TAK50072
      160 PRINT 170,NTBL                                                        TAK50073
      170 FORMAT (     35X,24HTABLE DATA INPUT SUMMARY,1XI2,1X,5HTABLES,//,25TAK50074
         1X,48HTABLE NUMBER  REFERENCE NUMBER   ARRAY LOCATION )                TAK50075
          PRINT 180,((N,TDATA(N),TDATA(N+30)),N=1,NTBL)                         TAK50076
      180 FORMAT (32X,I2,12X,F5.0,15X,F5.0)                                     TAK50077
          PRINT 190, NMAX,NREM                                                  TAK50078
      190 FORMAT (//,35X,24HDATA STORAGE ALLOCATION ,I4,/35X,24HDATA STORAGETAK50079
         1 NOT USED    ,I4,/)                                                   TAK50080
          IF(NRIGEL.GT.0) PRINT 200,(SIRIUS(IO),IO=1,NRIGEL)                    TAK50081
      200 FORMAT(10X,*THE FOLLOWING TABLES HAVE BEEN REPLACED*,5(5X,F10.0,*,TAK50082
         Z*),/,(8(5X,F10.0,*,*)))                                               TAK50083
C         PRINT 1111,((N,TDATA(N)),N=1, LOC)                                    TAK50084
C1111 FORMAT(5(1X,I4,1X,E12.5))                                                 TAK50085
          RETURN                                                                TAK50086
      210 IP=1                                                                  TAK50087
          IF(NPRINT.EQ.0) IP=0                                                  TAK50088
          PRINT 30, IP,ITABNO                                                   TAK50089
          IF(NPRINT.NE.0) PRINT 220                                             TAK50090
      220 FORMAT(///////)                                                       TAK50091
          ICC     = 0                                                           TAK50092
          L=LOC                                                                 TAK50093
          ID=44                                                                 TAK50094
          DO 230 ICL=1,5                                                        TAK50095
      230 IDD(ICL)=4H                                                           TAK50096
      240 IDL=ID                                                                TAK50097
          READ 250,ID,N,(A(I),I=1,N)                                            TAK50098
      250 FORMAT(A4,I3,3X,(T11,7F10.0))                                         TAK50099
          IF(ID.EQ.4HEOT )  GO TO 20                                            TAK50100
          ICC=ICC+1                                                             TAK50101
          IF(ICC.LE.5) IDD(ICC)=ID                                              TAK50102
          IF(ID.EQ.IDL)      GO TO 350                                          TAK50103
          IF(ID.NE.IDD(5))      GO TO 260                                       TAK50104
          IF(IDL.EQ.IDD(3))      GO TO 350                                      TAK50105
          LOC=LE                                                                TAK50106
          L=LX                                                                  TAK50107
          GO TO 280                                                             TAK50108
      260 TDATA(LOC)=N                                                          TAK50109
          L=LOC                                                                 TAK50110
          IF(ID.EQ.IDD(2)) GO TO 390                                            TAK50111
      270 IF(ID.EQ.IDD(4)) LX=L                                                 TAK50112
          IF(ID.NE.IDD(3))             GO TO 330                                TAK50113
          LY=L                                                                  TAK50114
```

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SUBROUTINE TAKES      74/74    OPT=1                     FTN 4.6+428        81/03/26. 10.13.43        PAGE     3

              LZ=LZ+1                                                             TAK50115
              GO TO 330                                                           TAK50116
          280 IF(IP.EQ.0) GO TO 330                                               TAK50117
              LY=LY+1                                                             TAK50118
              IF(NPRINT.NE.0) PRINT 290,IDD(1),TDATA(LX)                          TAK50119
          290 FORMAT(1X,A4,1H=,E13.5)                                             TAK50120
              IF(NPRINT.NE.0) PRINT 300,IDD(2),TDATA(LZ),IDD(3),TDATA(LY)         TAK50121
          300 FORMAT(1X,A4,1H=,E13.5,1X,A4,1H=,E13.5)                             TAK50122
              JF=0                                                                TAK50123
              M=N                                                                 TAK50124
              LF=LX                                                               TAK50125
          310 NP=M                                                                TAK50126
              IF(M.GT.8)NP=8                                                      TAK50127
              M=M-NP                                                              TAK50128
              LE=LF+NP                                                            TAK50129
              LF=LF+1                                                             TAK50130
              IF(NPRINT.NE.0) PRINT 320,IDD(4),(TDATA(I),I=LF,LE)                 TAK50131
          320 FORMAT(20X,A4,1X,8E13.5)                                            TAK50132
              LF=LE                                                               TAK50133
              JE=JF+NP                                                            TAK50134
              JF=JF+1                                                             TAK50135
              IF(NPRINT.NE.0) PRINT 320,IDD(5),(A(I),I=JF,JE)                     TAK50136
              JF=JE                                                               TAK50137
              IF(M.GT.0) GO TO 310                                                TAK50138
          330 DO 340 I=1,N                                                        TAK50139
              LOC=LOC+1                                                           TAK50140
          340 TDATA(LOC)=A(I)                                                     TAK50141
              LE=LOC                                                              TAK50142
              IF(ID.EQ.IDD(5)) TDATA(LOC+2)=1.                                    TAK50143
              LOC=L+3*N+3                                                         TAK50144
              IF(LOC.GT.NMAX)370,240                                              TAK50145
          350 TDATA(LOC)=TDATA(LX)                                                TAK50146
              L=LOC                                                               TAK50147
              DO 360 I=1,N                                                        TAK50148
              LOC=LOC+1                                                           TAK50149
          360 TDATA(LOC)=TDATA(LX+I)                                              TAK50150
              GO TO 280                                                           TAK50151
          370 PRINT 380, ITABNO                                                   TAK50152
          380 FORMAT (1X,32H*********TABLE OVER FLOW ,TABLE ,I5,11H NOT LOADED) TAK50153
              GO TO 40                                                            TAK50154
          390 LZ=LOC $ LW=LW+1 $ GO TO 270                                        TAK50155
              ENTRY TLOOK                                                         TAK50156
      C********************************************************************      TAK50157
              IF(II.LE.0) RETURN                                                  TAK50158
      C*** SEARCH FOR CORRECT TABLE                                               TAK50159
              NH=NTBL+1                                                           TAK50160
              NL=1                                                                TAK50161
              K=ILAST                                                             TAK50162
              XTAB=II                                                             TAK50163
              KT=0                                                                TAK50164
          400 KT=KT+1                                                             TAK50165
              IF(KT.GT.6) GO TO 470                                               TAK50166
              IF((XTAB-TDATA(K)).EQ.0.) GO TO 430                                 TAK50167
              IF((XTAB-TDATA(K)).LT.0.) GO TO 410                                 TAK50168
              NL     = K                                                          TAK50169
              GO TO 420                                                           TAK50170
          410 NH=K                                                                TAK50171
```

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SUBROUTINE TAKES      74/74   OPT=1                        FTN 4.5+428       81/09/28. 10.18.43       PAGE    4

            420 K=(NH-NL)/2+NL                                              TAKS0172
                GO TO 400                                                   TAKS0173
            430 ILAST=K                                                     TAKS0174
                IZ=TDATA(K+300)                                             TAKS0175
                INZ=TDATA(IZ)                                               TAKS0176
                IY=3*INZ+IZ+3                                               TAKS0177
                IX=IY                                                       TAKS0178
                IZ1=IZ+INZ+1                                                TAKS0179
                IZ2=IZ+2*INZ                                                TAKS0180
                DO 450 IZS=IZ1,IZ2                                          TAKS0181
                INY=TDATA(IY)                                               TAKS0182
                IX=3*INY+IX+3                                               TAKS0183
                IW=IX                                                       TAKS0184
                IY1=IY+INY+1                                                TAKS0185
                IY2=IY+2*INY                                                TAKS0186
                DO 450 IYS=IY1,IY2                                          TAKS0187
                INX=TDATA(IX)                                               TAKS0188
                IW=3*INX+IW+3                                               TAKS0189
                IX1=IX+INX+1                                                TAKS0190
                IX2=IX+2*INX                                                TAKS0191
                DO 440 IXS=IX1,IX2                                          TAKS0192
                TDATA(IXS)=SPLN01(IW,TDATA,W)                               TAKS0193
            440 IW=IW+3*TDATA(IW)+3                                         TAKS0194
                TDATA(IYS)=SPLN01(IX,TDATA,X)                               TAKS0195
            450 IX=IW                                                       TAKS0196
                TDATA(IZS)=SPLN01(IY,TDATA,Y)                               TAKS0197
            460 IY=IX                                                       TAKS0198
                FWXYZ=SPLN01(IZ,TDATA,Z)                                    TAKS0199
            470 RETURN                                                      TAKS0200
                END                                                         TAKS0201
```

APPENDIX D

Program Logic

Flow charts for the main STO program and the subroutine TAKE5 are presented.

```
CSTO

PROGRAM STO (INPUT,OUTPUT,TAPE8,TAPE9=INPUT)

C*****************************************************************
C   CREATED BY KOBUS ON APRIL 1977.
C*****************************************************************

DIMENSION TITLE(8),ICOPY(10),RUNDATA(33),X(4),AGDATA(33),
 PHDATA(33)

COMMON/PRINT/NPRINT
REAL MACH,NEF,NEA,MU,L,LR,LRA,LRF,MAC,MOMENT,LEVER,IYY,IYYCG
INTEGER SEGMENT

NAMELIST/DATA/ALPHA,S,DELTAE,NEF,NEA,MU,W,LR,LRA,LRF,REVTIME,DT,
IPRINT,NPRINT,VSTARR,MAC,SEGMENT,IYYCG,XCG,YCG,E1,DELMAX,PHIL,
ANGFRL,FLDTEMP,ALPHMIN,PHI2,PHI2AR,PHI2RR,RS,ALPHARR,ALPHAAR,SLT,
 RUN,EDATUM,NOCORAG,NOSTORE,EFAILA,DEILOST,NOCCCI,METRIC,FS,WOD,
DEITAS,RSF,PHILRR,PHILAR,PSINT,ROC,DISTMAX,SINKO,ROSCALE,RAN,PHONY

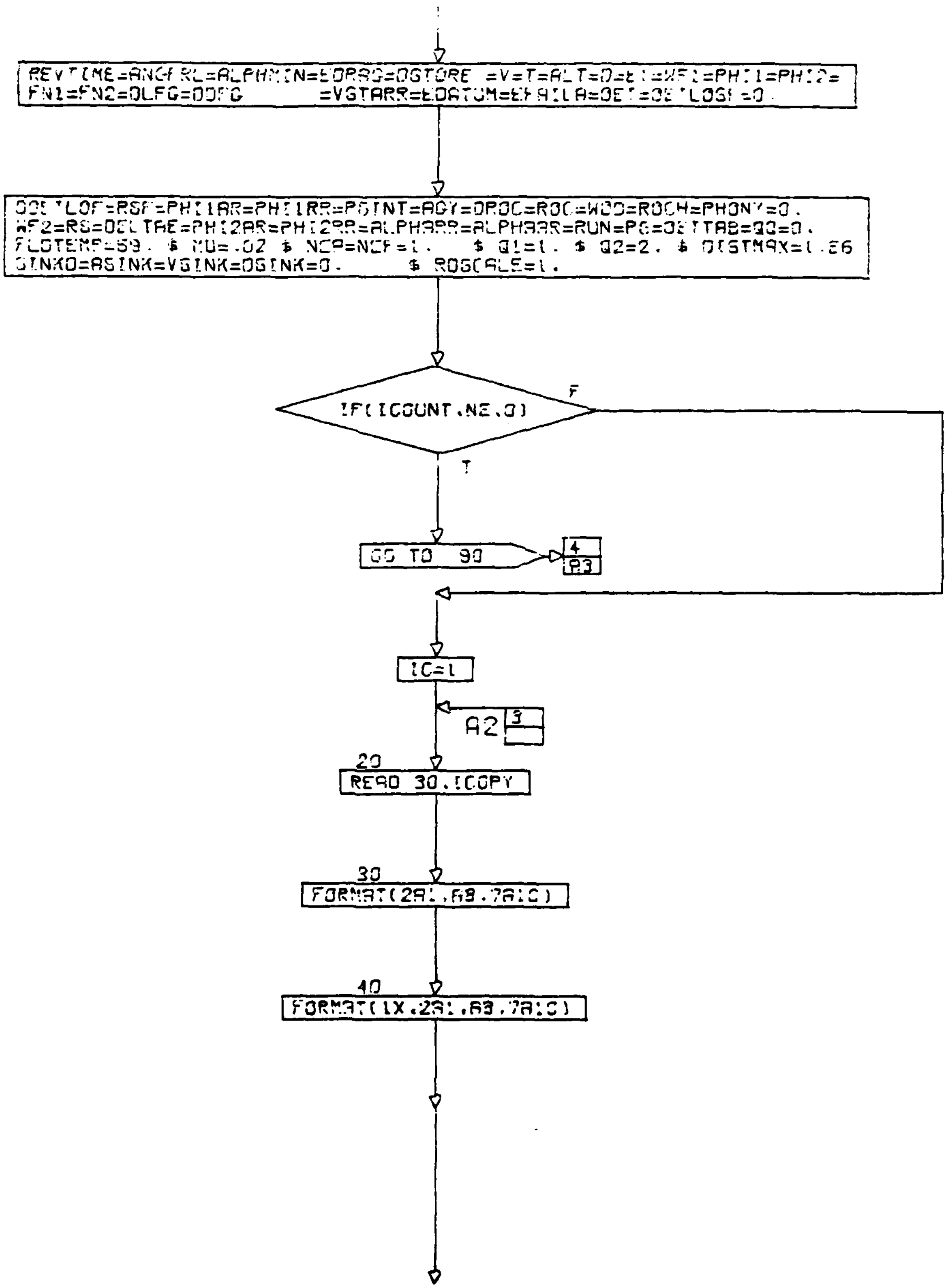
ICOUNT=0 $ RUN=RUNDATA(1)=AGDATA(1)=PHDATA(1)=0.

A1 35

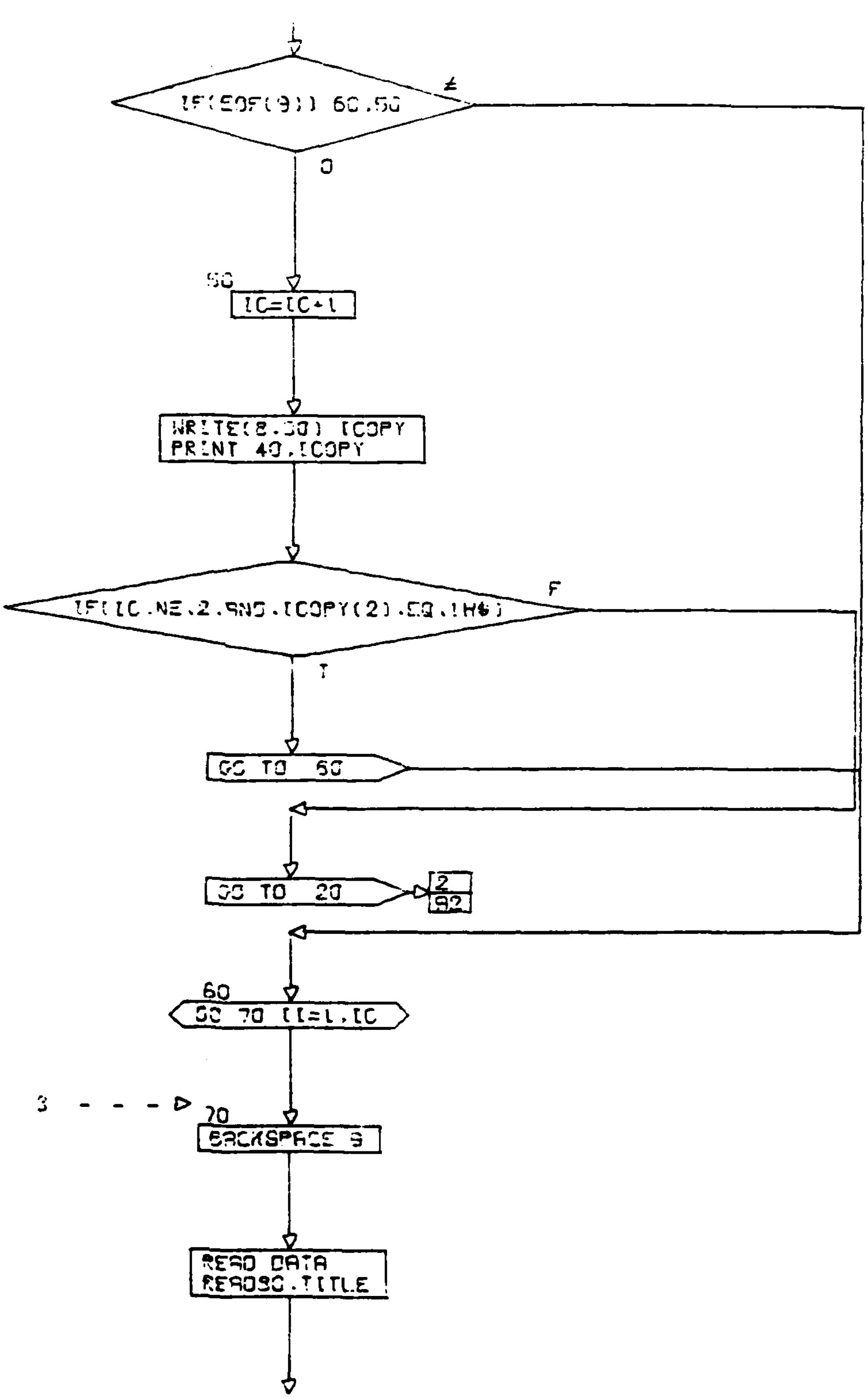
10
N=SEGMENT=NPRINT=IPRINT=NOCORAG=NOSTORE=METRIC=NOCCCI=0

FLOSSA=FLOSSF=0.
DT=.05          $        RAN=1.
```

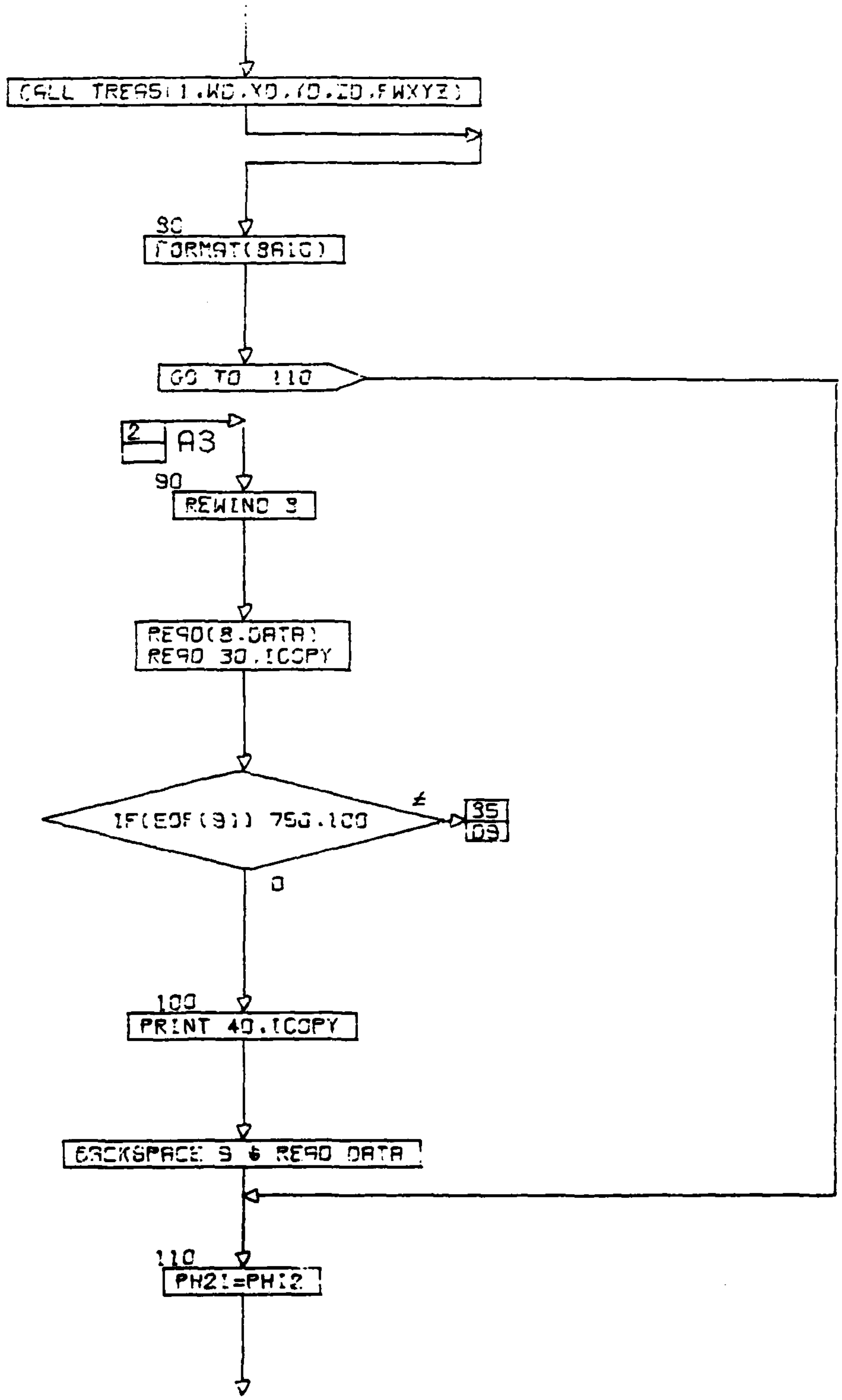
CONT. ON PG 2


REVTIME=ANGFRL=ALPHMIN=EDRAG=DSTORE =V=T=ALT=D=E1=WF1=PHI1=PHI2=
FN1=FN2=DLFG=DDFG =VSTARR=EDATUM=EFAILA=DET=DELLOSS=0.
DELLOF=RSF=PHI1AR=PHI1RR=PSINT=AGY=DROC=ROC=WDD=ROCH=PHONY=0.
WF2=RS=DELTAE=PHI2AR=PHI2RR=ALPHARR=ALPHAAR=RUN=PG=DETTAB=QQ=0.
FLOTEMP=59. $ MU=.02 $ NCP=NCF=1. $ Q1=1. $ Q2=2. $ DISTMAX=1.E6
SINKO=ASINK=VSINK=DSINK=0. $ ROSCALE=1.
IF(ICOUNT.NE.0)
F
T
GO TO 90
4
A3
IC=1
A2
3
20
READ 30,ICOPY
30
FORMAT(2A1,A9,7A10)
40
FORMAT(1X,2A1,A9,7A10)

CONT. ON PG 3

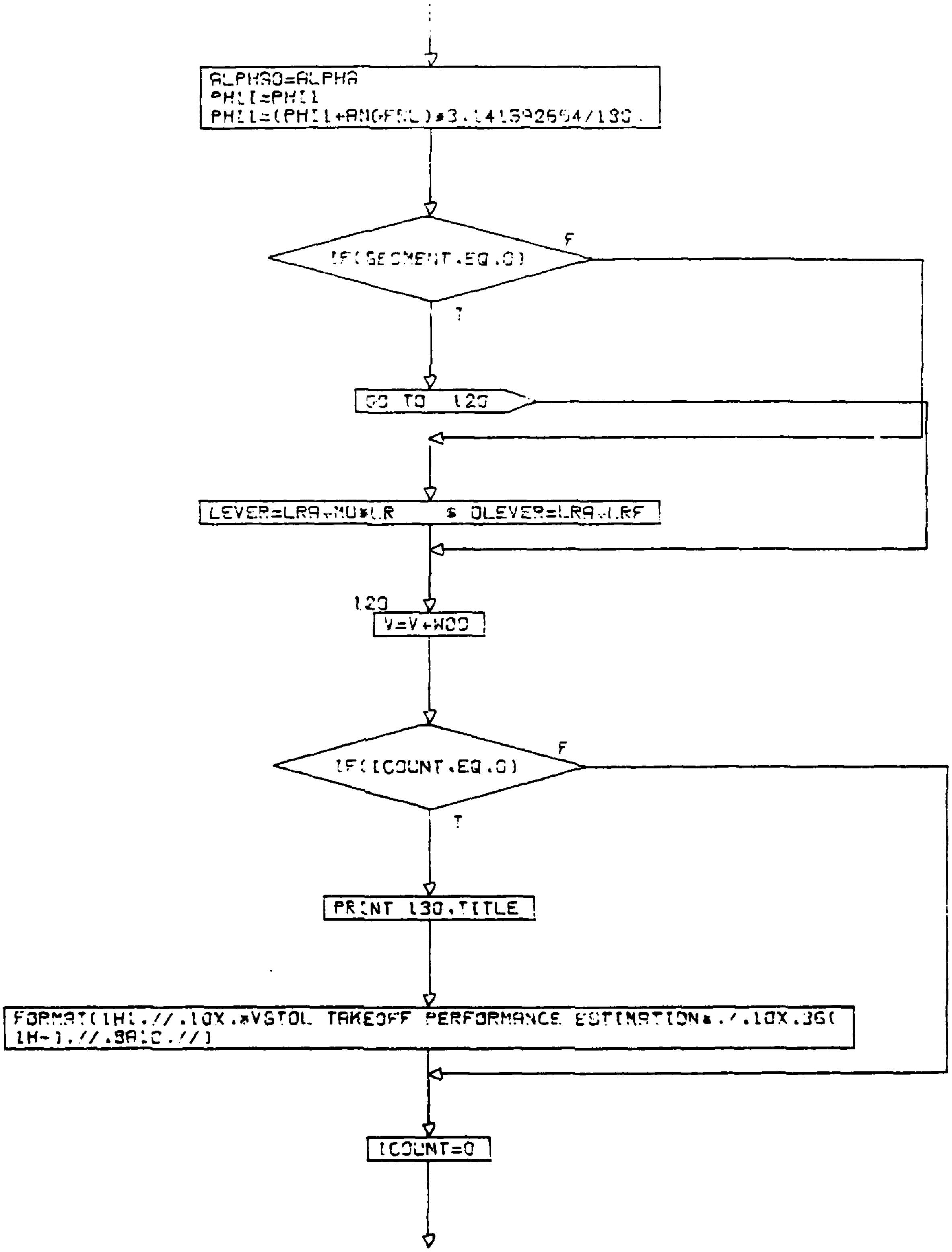

IF(EOF(9)) 60,50
≠
0
50
IC=IC+1
WRITE(8,30) ICOPY
PRINT 40,ICOPY
IF(IC.NE.2.AND.ICOPY(2).EQ.1H$)
F
T
GO TO 60
GO TO 20
2
92
60
DO 70 II=1,IC
3
70
BACKSPACE 9
READ DATA
READ30,TITLE

CONT. ON PG 4

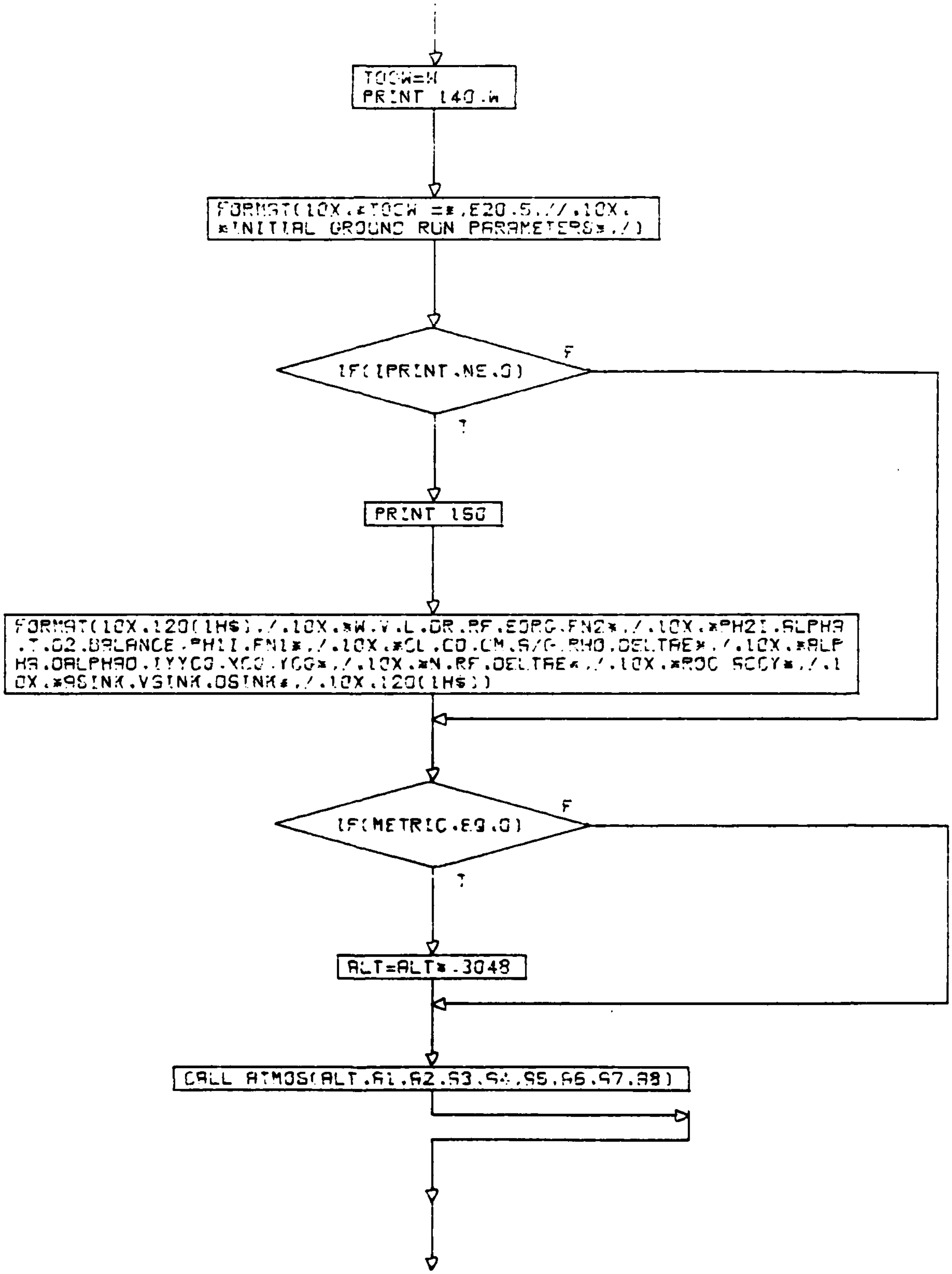


CALL TRE9S(1.WD.XD.YD.ZD.FWXYZ)
80
FORMAT(8A10)
GO TO 110
2
A3
90
REWIND 8
READ(8.DATA)
READ 30.ICOPY
IF(EOF(8)) 750.100
≠
35
D9
0
100
PRINT 40.ICOPY
BACKSPACE 8 & READ DATA
110
PH2I=PHI2

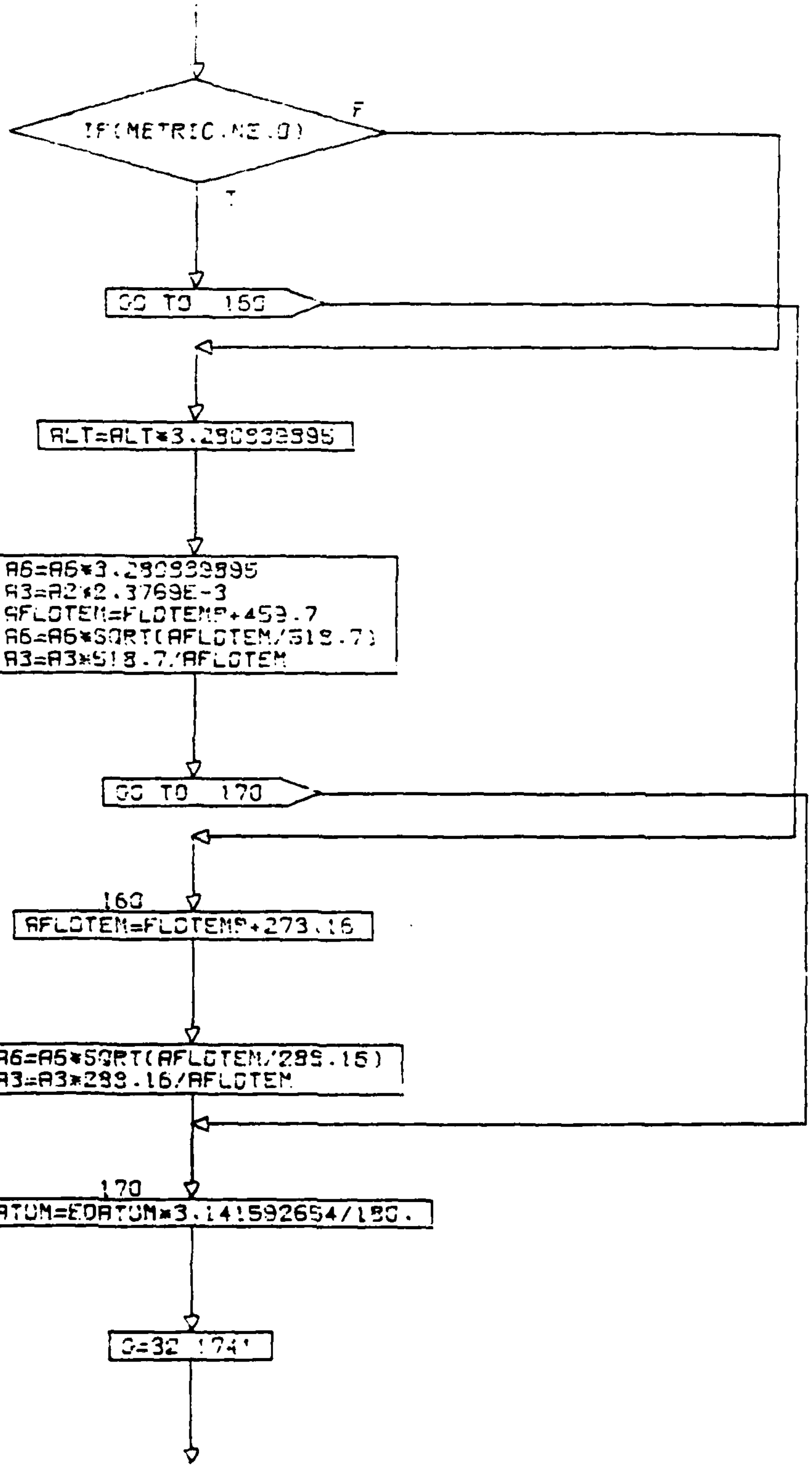
CONT. ON PG 5


ALPHAO=ALPHA
PHII=PHI1
PHI1=(PHI1+ANGFSL)*3.141592654/180.
IF(SEGMENT.EQ.0)
F
T
GO TO 120
LEVER=LRA+MU*LR $ DLEVER=LRA+LRF
120
V=V+W00
IF(ICOUNT.EQ.0)
F
T
PRINT 130,TITLE
FORMAT(1H1,//,10X,*VSTOL TAKEOFF PERFORMANCE ESTIMATION*,/,10X,36(
1H-),//,8A10,//)
ICOUNT=0

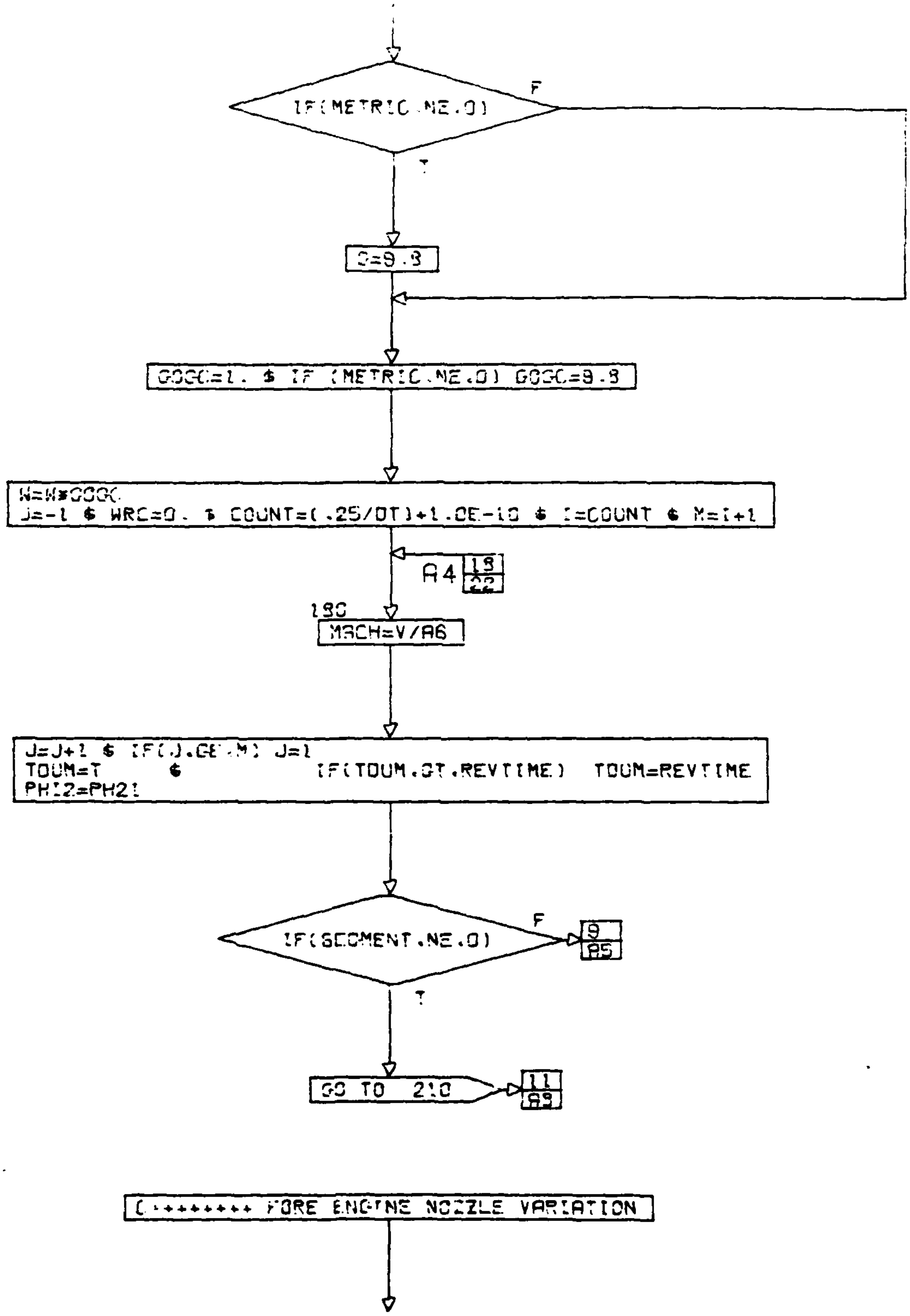
CONT. ON PG 6


TOCW=W
PRINT 140.W
FORMAT(10X.*TOCW =*.E20.5.//.10X.
INITIAL GROUND RUN PARAMETERS./)
IF(IPRINT.NE.0)
F
T
PRINT 150
FORMAT(10X.120(1H$)./.10X.*W.V.L.DR.RF.EORG.FN2*./.10X.*PH2I.ALPHA
.T.D2.BALANCE.PH1I.FN1*./.10X.*CL.CD.CM.S/G.RHO.DELTAE*./.10X.*ALP
HA.DALPHAD.IYYCG.XCG.YCG*./.10X.*N.RF.DELTAE*./.10X.*ROC SCCY*./.1
0X.*ASINK.VSINK.DSINK*./.10X.120(1H$))
IF(METRIC.EQ.0)
F
T
ALT=ALT*.3048
CALL ATMOS(ALT.A1.A2.A3.A4.A5.A6.A7.A8)

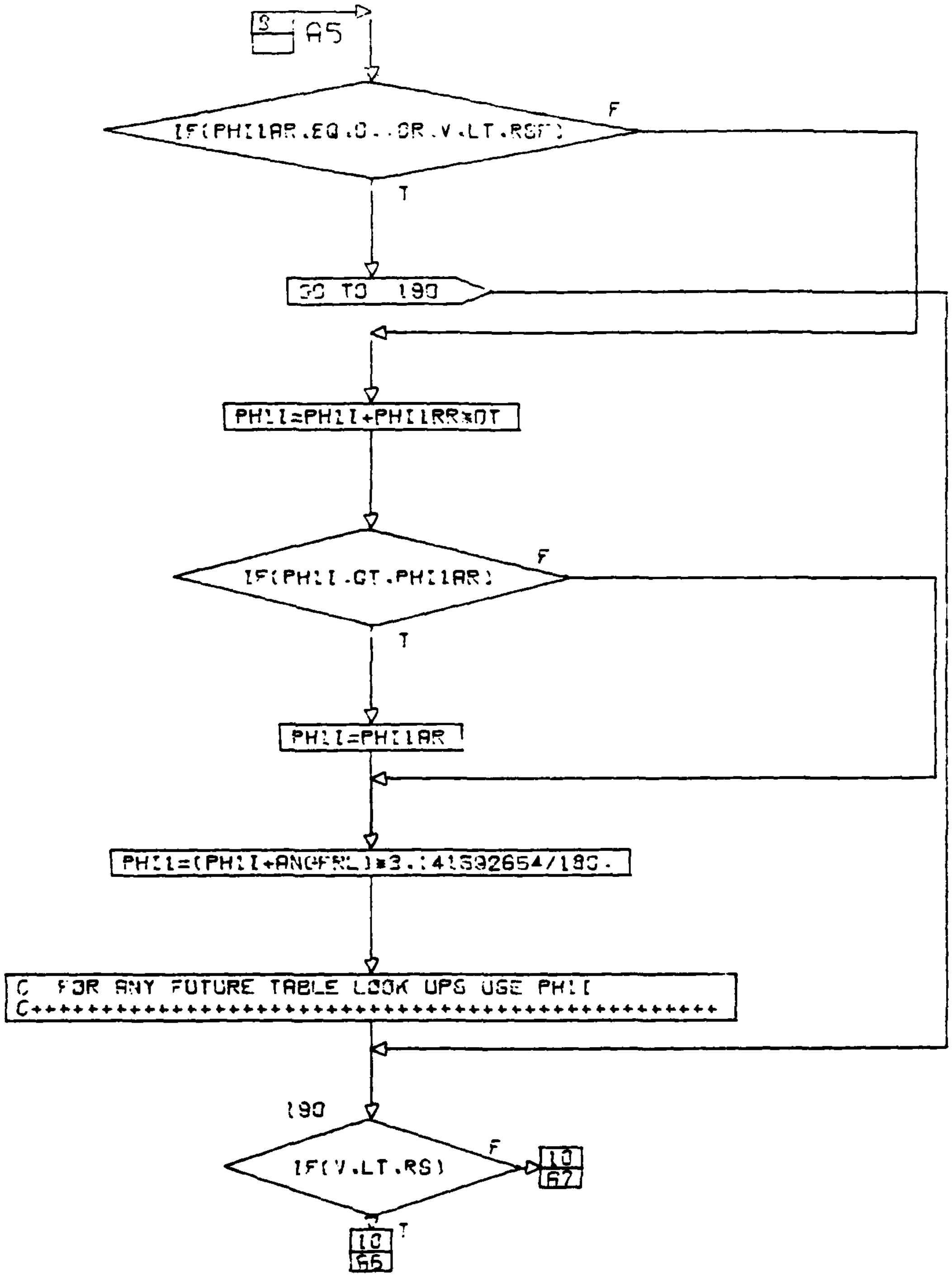
CONT. ON PG 7


IF(METRIC.NE.0)
F
T
GO TO 160
ALT=ALT*3.280839895
A6=A6*3.280839895
A3=A2*2.3769E-3
AFLOTEM=FLOTEMP+459.7
A6=A6*SQRT(AFLOTEM/518.7)
A3=A3*518.7/AFLOTEM
GO TO 170
160
AFLOTEM=FLOTEMP+273.16
A6=A5*SQRT(AFLOTEM/288.15)
A3=A3*288.16/AFLOTEM
170
EDATUM=EDATUM*3.141592654/180.
G=32.174

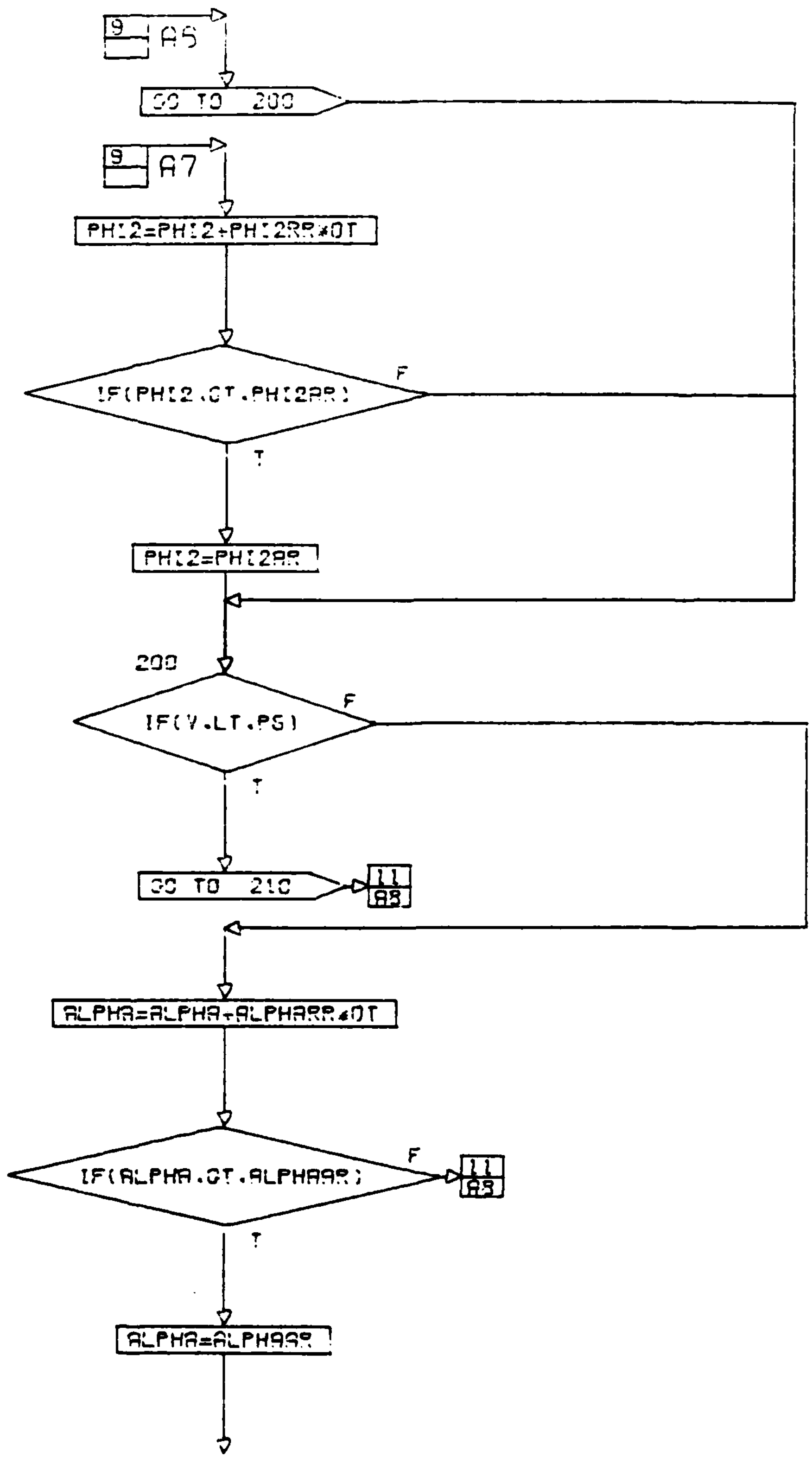
CONT. ON PG 8


IF(METRIC.NE.0)
F
T
G=9.8
GOGC=1. $ IF (METRIC.NE.0) GOGC=9.8
W=W*GOGC
J=-1 $ WRC=0. $ COUNT=(.25/DT)+1.0E-10 $ I=COUNT $ M=I+1
A4 18/22
180
MACH=V/A6
J=J+1 $ IF(J.GE.M) J=1
TOUM=T $ IF(TOUM.GT.REVTIME) TOUM=REVTIME
PHI2=PH21
IF(SEGMENT.NE.0)
F
9/A5
T
GO TO 210
11/A9
C++++++++ FORE ENGINE NOZZLE VARIATION

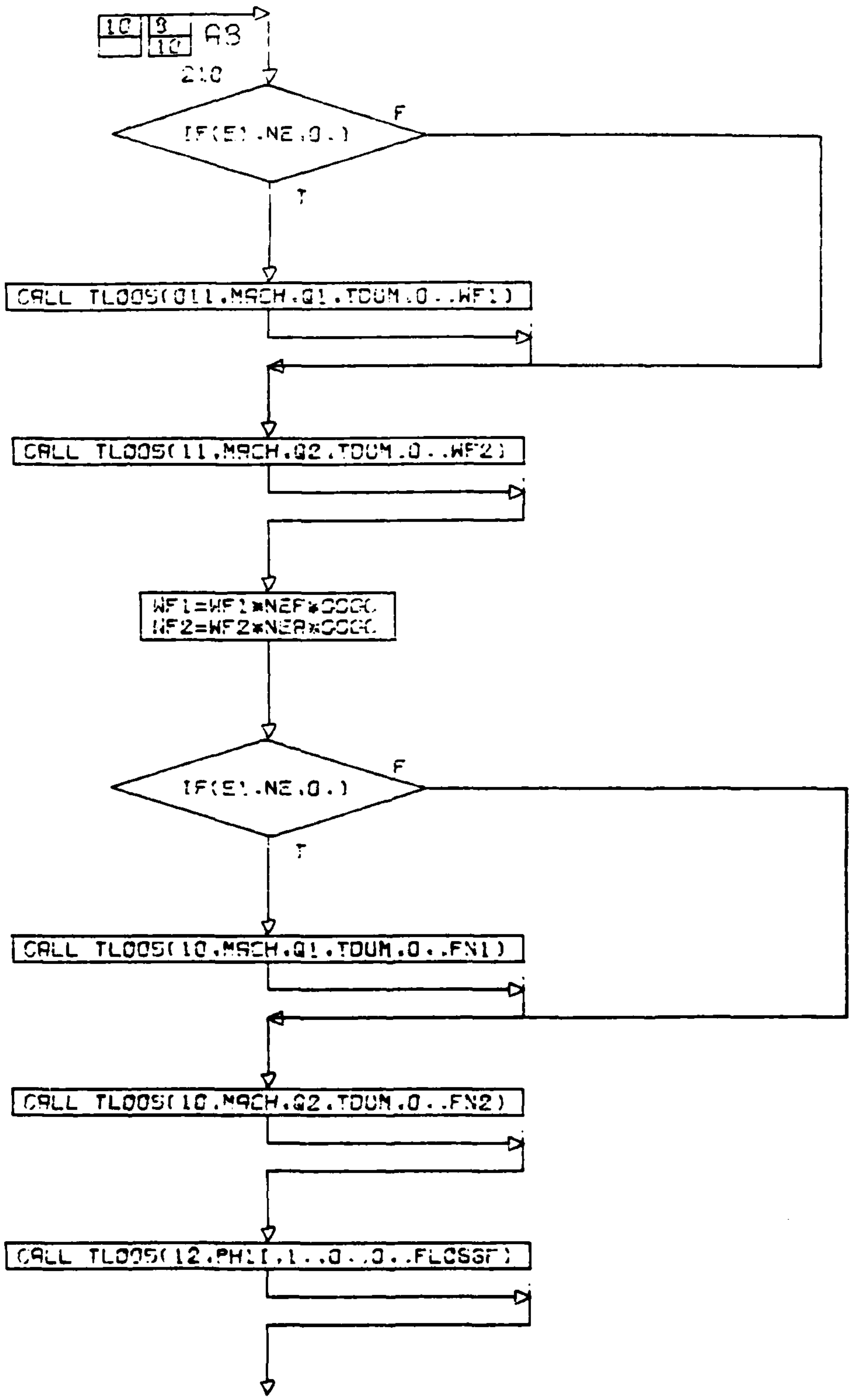
CONT. ON PG 9


A5
IF(PHI1AR.EQ.0..OR.V.LT.RSF)
F
T
GO TO 190
PHI1=PHI1+PHI1RR*DT
IF(PHI1.GT.PHI1AR)
F
T
PHI1=PHI1AR
PHI1=(PHI1+ANGFRL)*3.141592654/180.
C FOR ANY FUTURE TABLE LOOK UPS USE PHI1
C++
190
IF(V.LT.RS)
F
T
10
67
10
66

CONT. ON PG 10

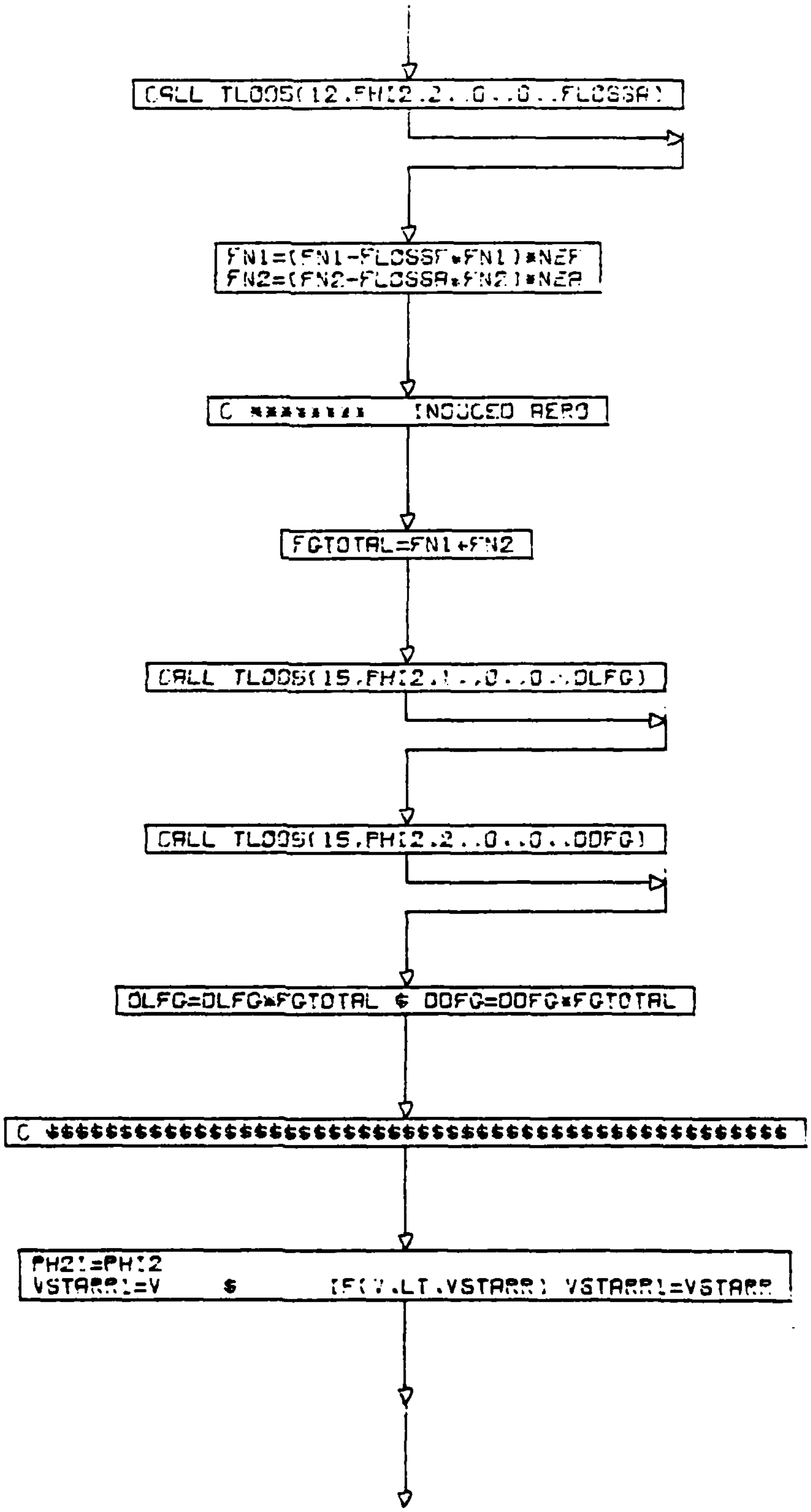

9 A5
GO TO 200
9 A7
PHI2=PHI2+PHI2RR*DT
IF(PHI2.GT.PHI2AR)
F
T
PHI2=PHI2AR
200
IF(V.LT.PS)
F
T
GO TO 210
11 A8
ALPHA=ALPHA+ALPHARR*DT
IF(ALPHA.GT.ALPHAAR)
F
11 A8
T
ALPHA=ALPHAAR

CONT. ON PG 11

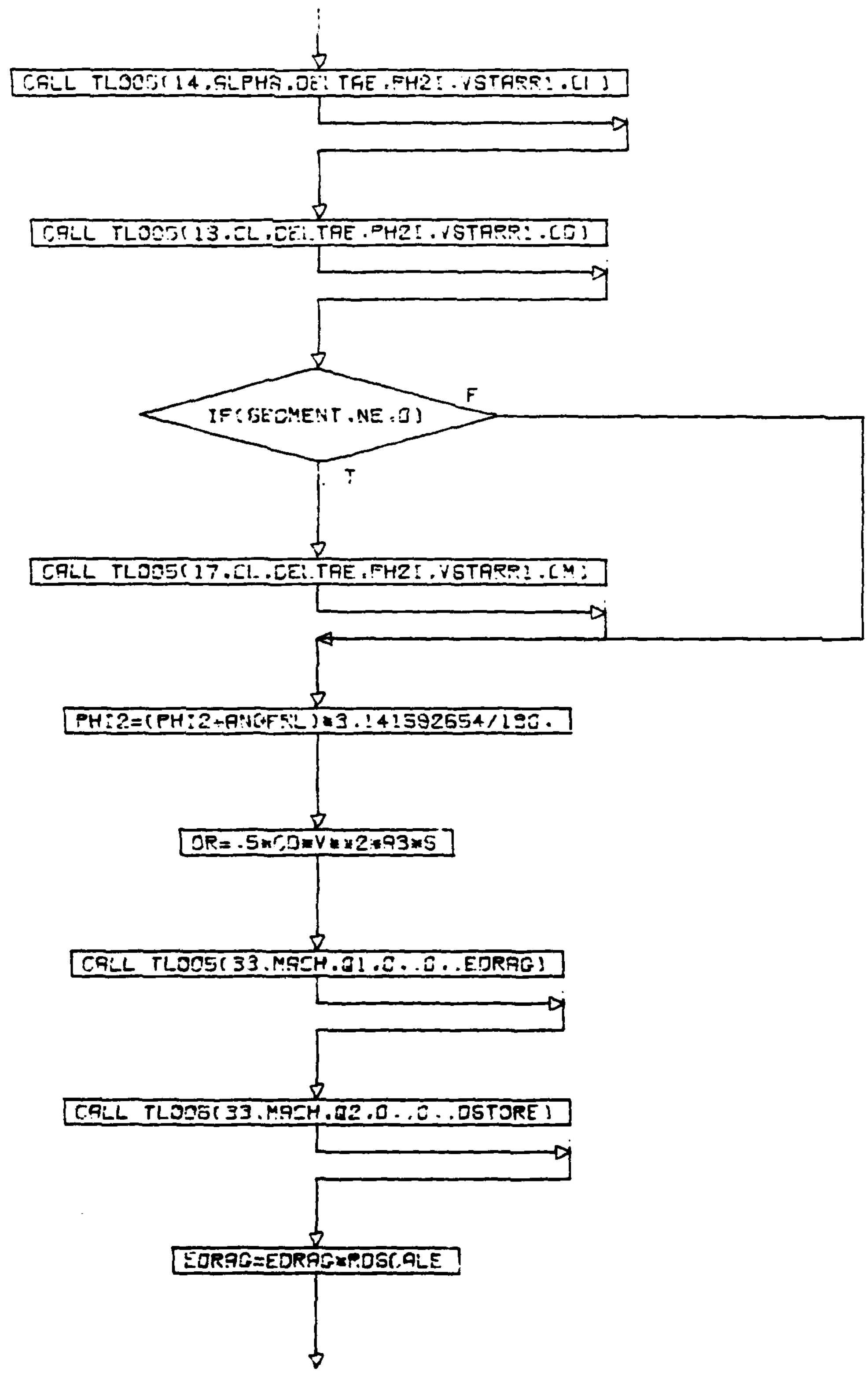


10
9
10
A8
210
IF(E1.NE.0.)
F
T
CALL TLOOS(011.MACH.Q1.TOUM.0..WF1)
CALL TLOOS(11.MACH.Q2.TOUM.0..WF2)
WF1=WF1*NEF*CCCC
WF2=WF2*NEA*CCCC
IF(E1.NE.0.)
F
T
CALL TLOOS(10.MACH.Q1.TOUM.0..FN1)
CALL TLOOS(10.MACH.Q2.TOUM.0..FN2)
CALL TLOOS(12.PHI(.1..0..0..FLOSSF)

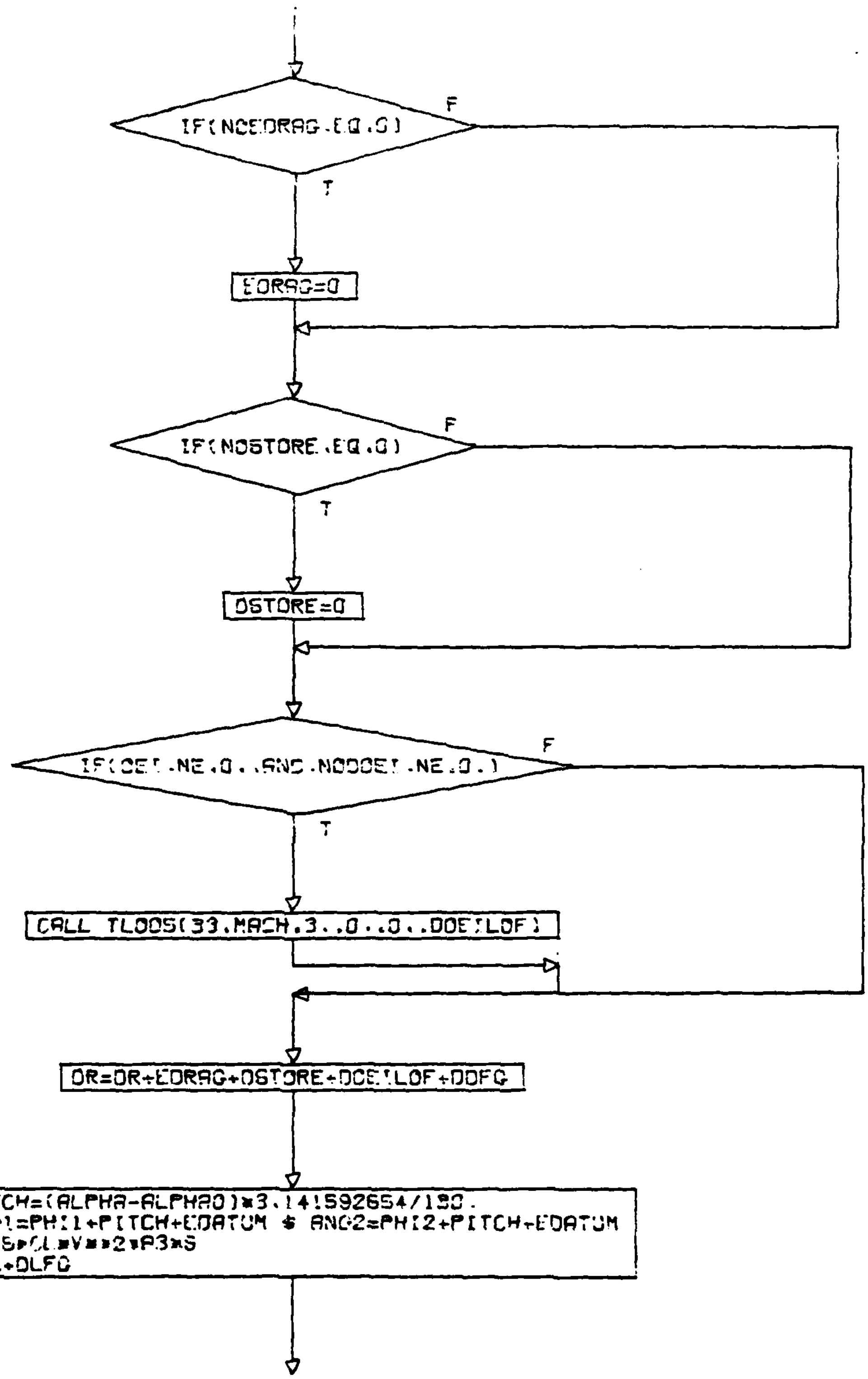
CONT. ON PG 12


CALL TLOSS(12,PHI2,2.,0.,0.,FLOSSA)
FN1=(FN1-FLOSSF*FN1)*NEF
FN2=(FN2-FLOSSA*FN2)*NEA
C ******** INDUCED AERO
FGTOTAL=FN1+FN2
CALL TLOSS(15,PHI2,1.,0.,0.,DLFG)
CALL TLOSS(15,PHI2,2.,0.,0.,DDFG)
DLFG=DLFG*FGTOTAL $ DDFG=DDFG*FGTOTAL
C $$$
PH21=PHI2
VSTARR1=V $ IF(V.LT.VSTARR) VSTARR1=VSTARR

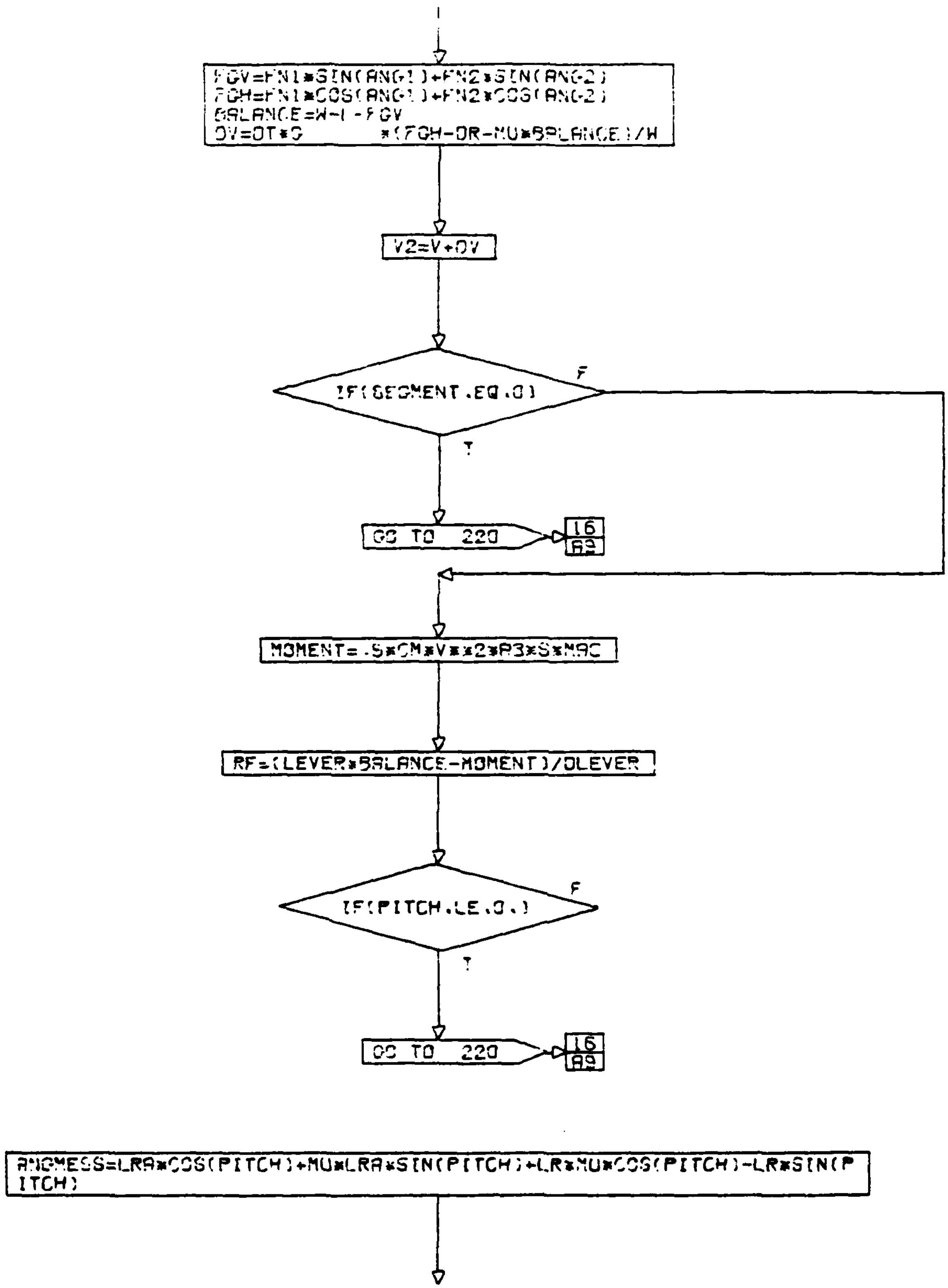
CONT. ON PG 13


CALL TLOO5(14.ALPHA.DELTAE.PH2I.VSTARR1.CL)
CALL TLOO5(13.CL.DELTAE.PH2I.VSTARR1.CD)
IF(GEOMENT.NE.0)
F
T
CALL TLOO5(17.CL.DELTAE.PH2I.VSTARR1.CM)
PHI2=(PHI2+ANGFSL)*3.141592654/180.
DR=.5*CD*V**2*A3*S
CALL TLOO5(33.MACH.Q1.0..0..EDRAG)
CALL TLOO6(33.MACH.Q2.0..0..DSTORE)
EDRAG=EDRAG*RDSCALE

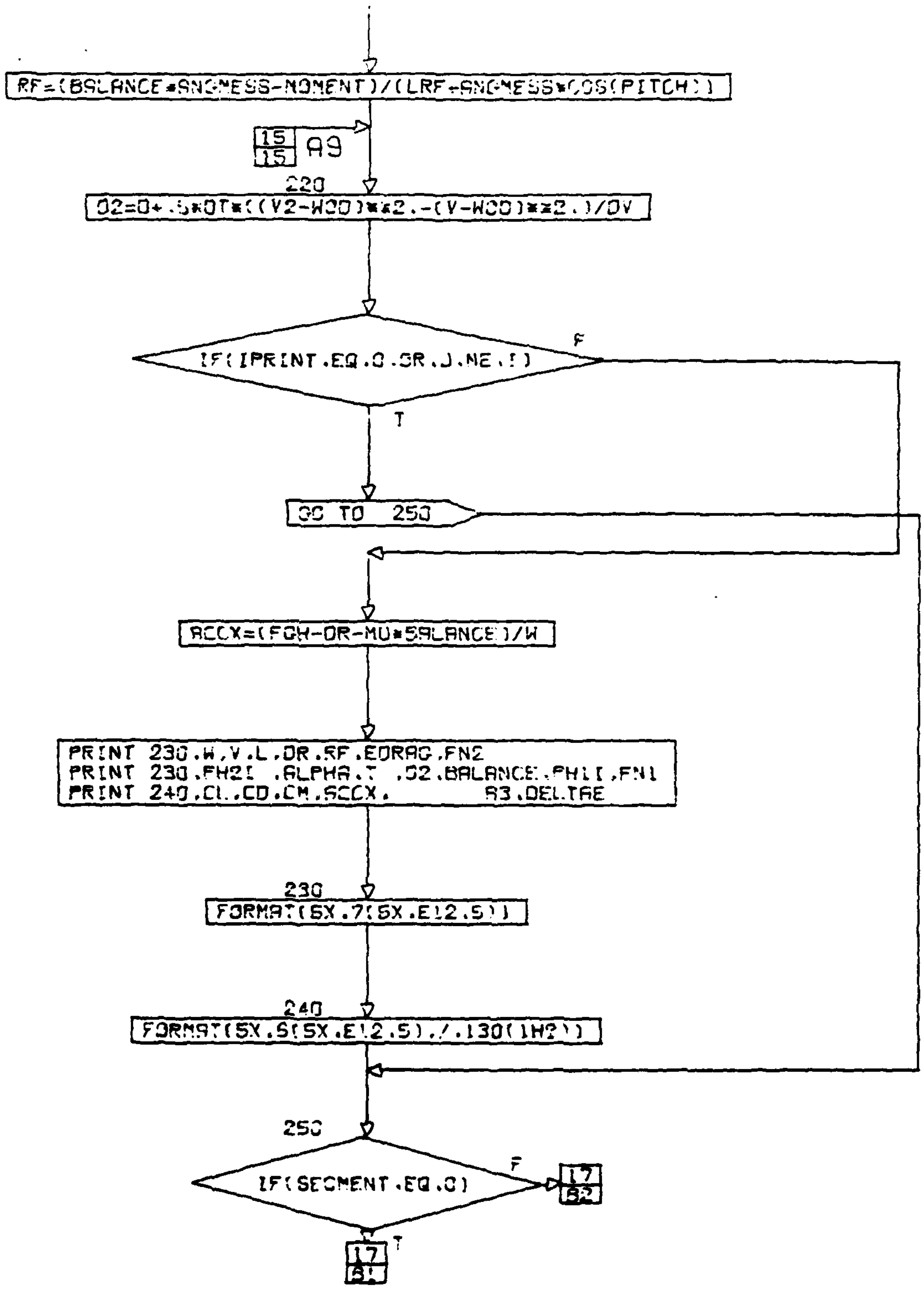
CONT. ON PG 14


IF(NCEDRAG.EQ.0)
F
T
EDRAG=0
IF(NOSTORE.EQ.0)
F
T
DSTORE=0
IF(CET.NE.0..AND.NODCET.NE.0.)
F
T
CALL TLOOS(33,MACH,3.,0.,0.,DCETLOF)
DR=DR+EDRAG+DSTORE+DCETLOF+DDFG
PITCH=(ALPHA-ALPHA0)*3.141592654/180.
ANG1=PHI1+PITCH+EDATUM $ ANG2=PHI2+PITCH+EDATUM
L=.5*CL*V**2*P3*S
L=L+DLFG

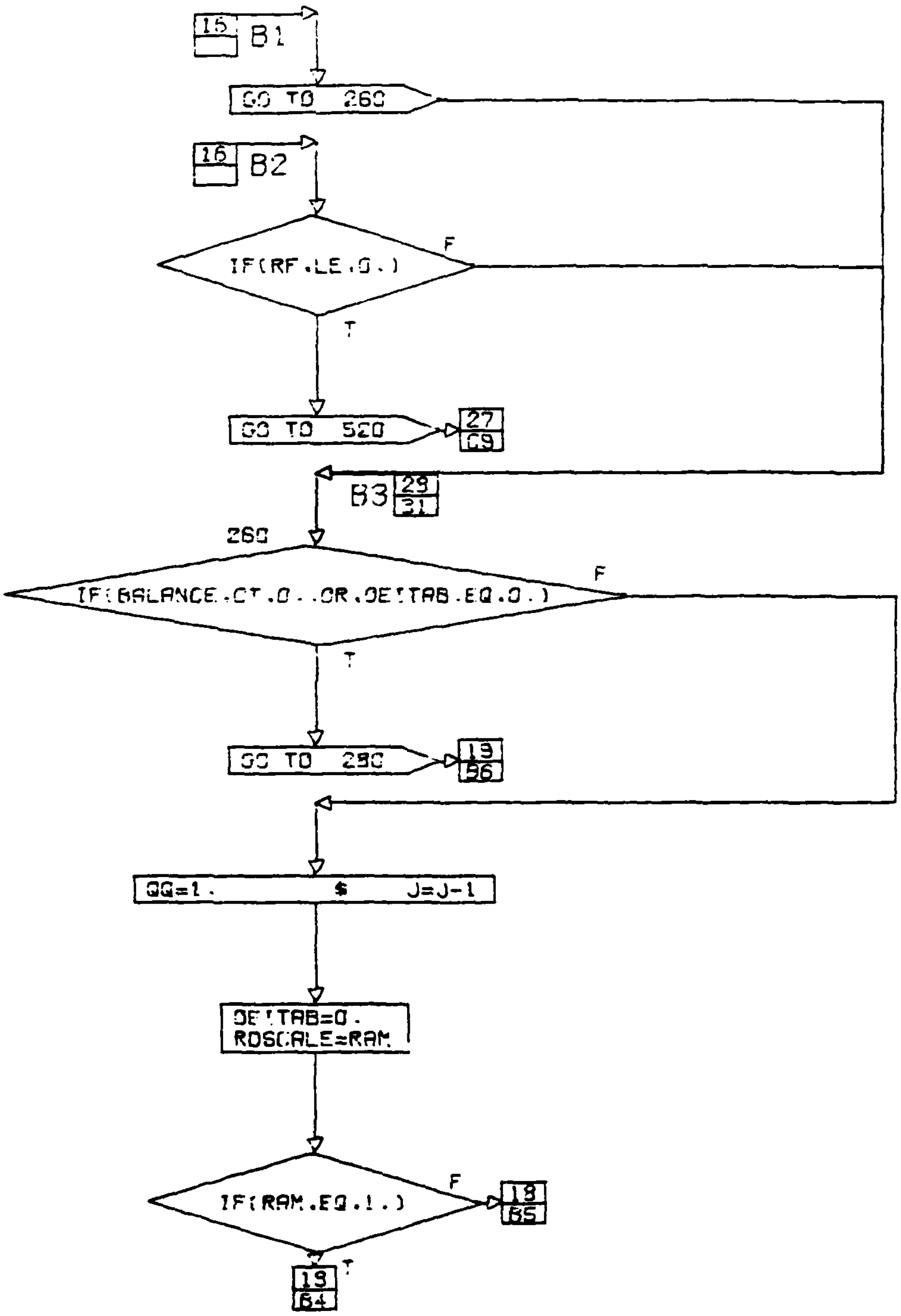
CONT. ON PG 15


FGV=FN1*SIN(ANG1)+FN2*SIN(ANG2)
FGH=FN1*COS(ANG1)+FN2*COS(ANG2)
BALANCE=W-L-FGV
DV=DT*G *(FGH-DR-MU*BALANCE)/W
V2=V+DV
IF(SEGMENT.EQ.0)
F
T
GO TO 220
16
A9
MOMENT=.5*CM*V**2*R3*S*MAC
RF=(LEVER*BALANCE-MOMENT)/DLEVER
IF(PITCH.LE.0.)
F
T
GO TO 220
16
A9
ANGMESS=LRA*COS(PITCH)+MU*LRA*SIN(PITCH)+LR*MU*COS(PITCH)-LR*SIN(P
ITCH)

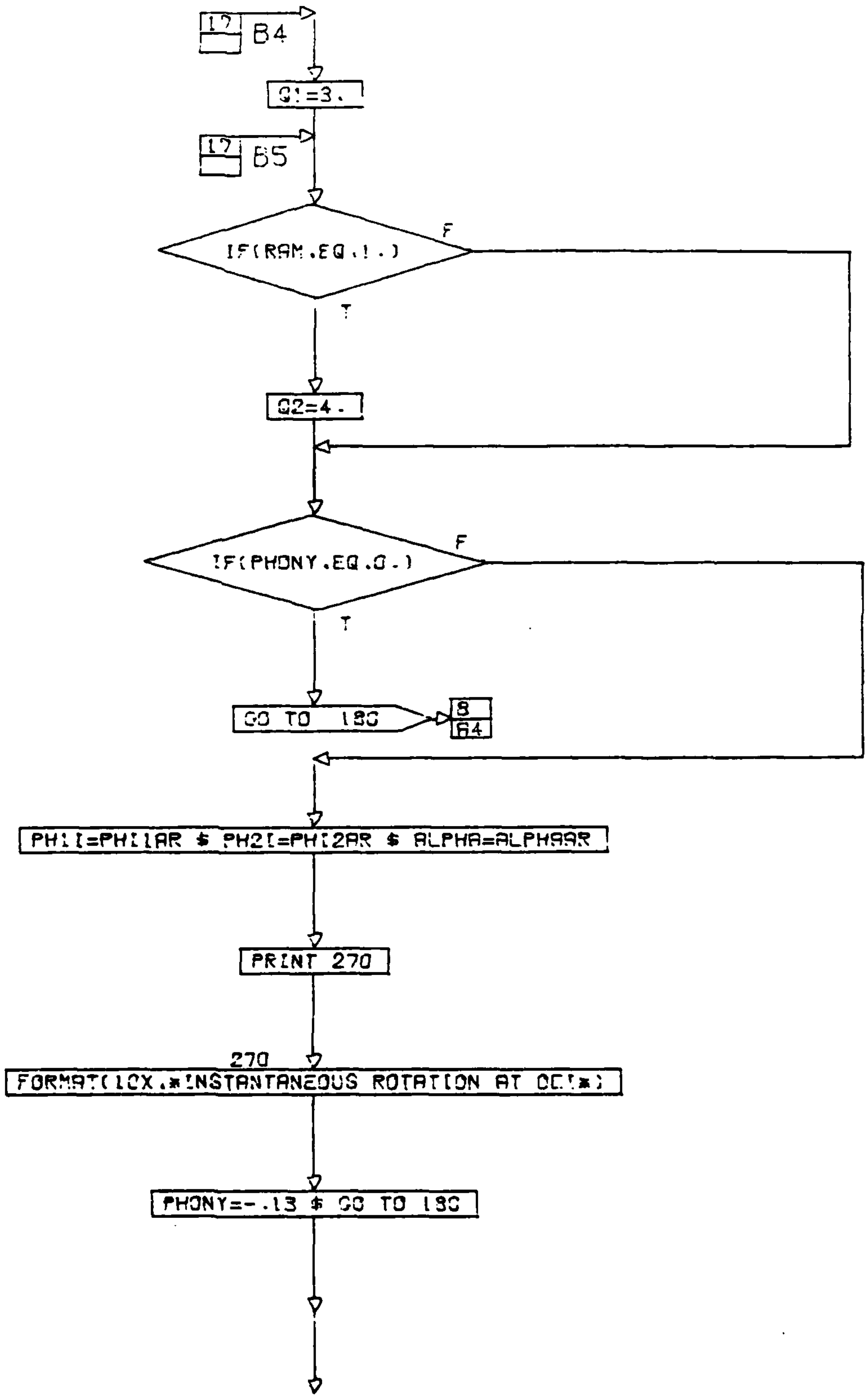
CONT. ON PG 16


RF=(BALANCE*ANGMESS-MOMENT)/(LRF+ANGMESS*COS(PITCH))
15
15
A9
220
D2=D+.5*DT*((V2-WOD)**2.-(V-WOD)**2.)/DV
IF(IPRINT.EQ.0.OR.J.NE.1)
F
T
GO TO 250
ACCX=(FGH-DR-MU*BALANCE)/W
PRINT 230,W,V,L,DR,RF,EDRAG,FN2
PRINT 230,FH2I ,ALPHA,T ,D2,BALANCE,PHI1,FN1
PRINT 240,CL,CD,CM,ACCX, A3,DELTAE
230
FORMAT(6X,7(5X,E12.5))
240
FORMAT(6X,6(5X,E12.5),/,130(1H?))
250
IF(SEGMENT.EQ.0)
F
17
B2
T
17
B1

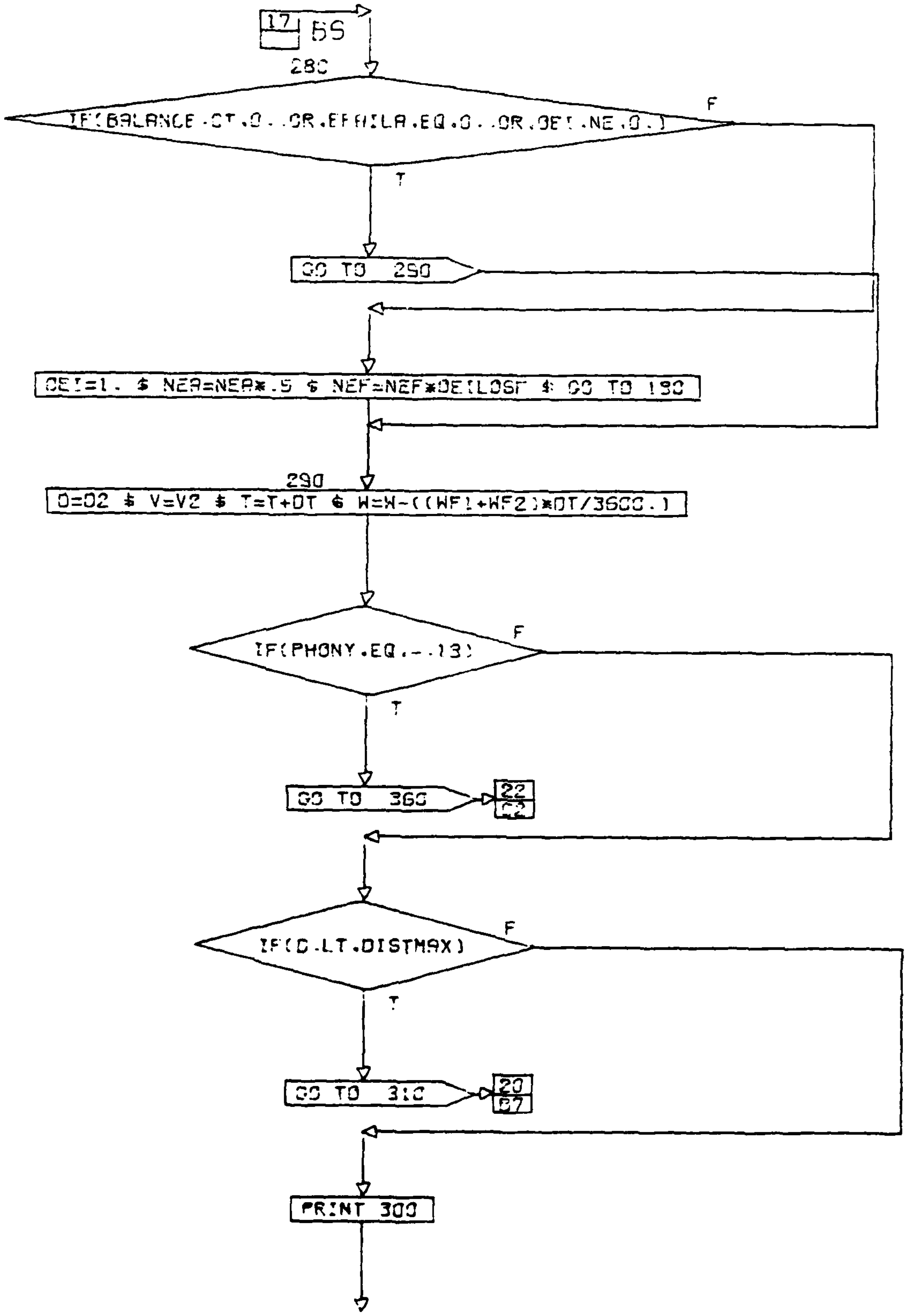
CONT. ON PG 17


15
B1
GO TO 260
16
B2
IF(RF.LE.0.)
F
T
GO TO 520
27
C9
B3
29
31
260
IF(BALANCE.GT.0..OR.DELTAB.EQ.0.)
F
T
GO TO 280
19
B6
QQ=1. $ J=J-1
DELTAB=0.
ROSCALE=RAM
IF(RAM.EQ.1.)
F
18
B5
T
19
B4

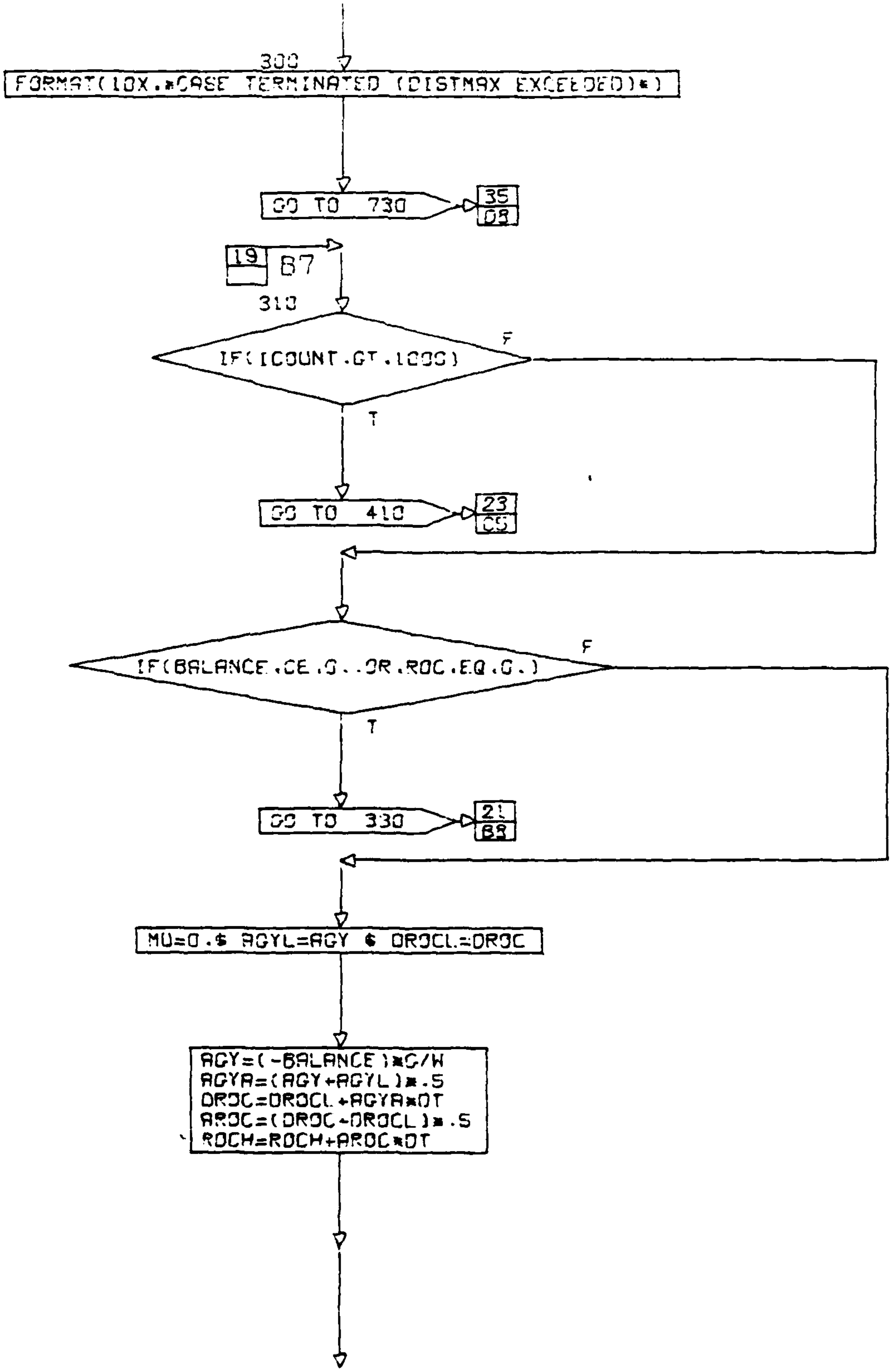
CONT. ON PG 19


17
B4
Q1=3.
17
B5
IF(RAM.EQ.1.)
F
T
Q2=4.
IF(PHONY.EQ.0.)
F
T
GO TO 180
8
B4
PHII=PHIIAR $ PH2I=PHI2AR $ ALPHA=ALPHAAR
PRINT 270
270
FORMAT(10X,*INSTANTANEOUS ROTATION AT CC!*)
PHONY=-.13 $ GO TO 180

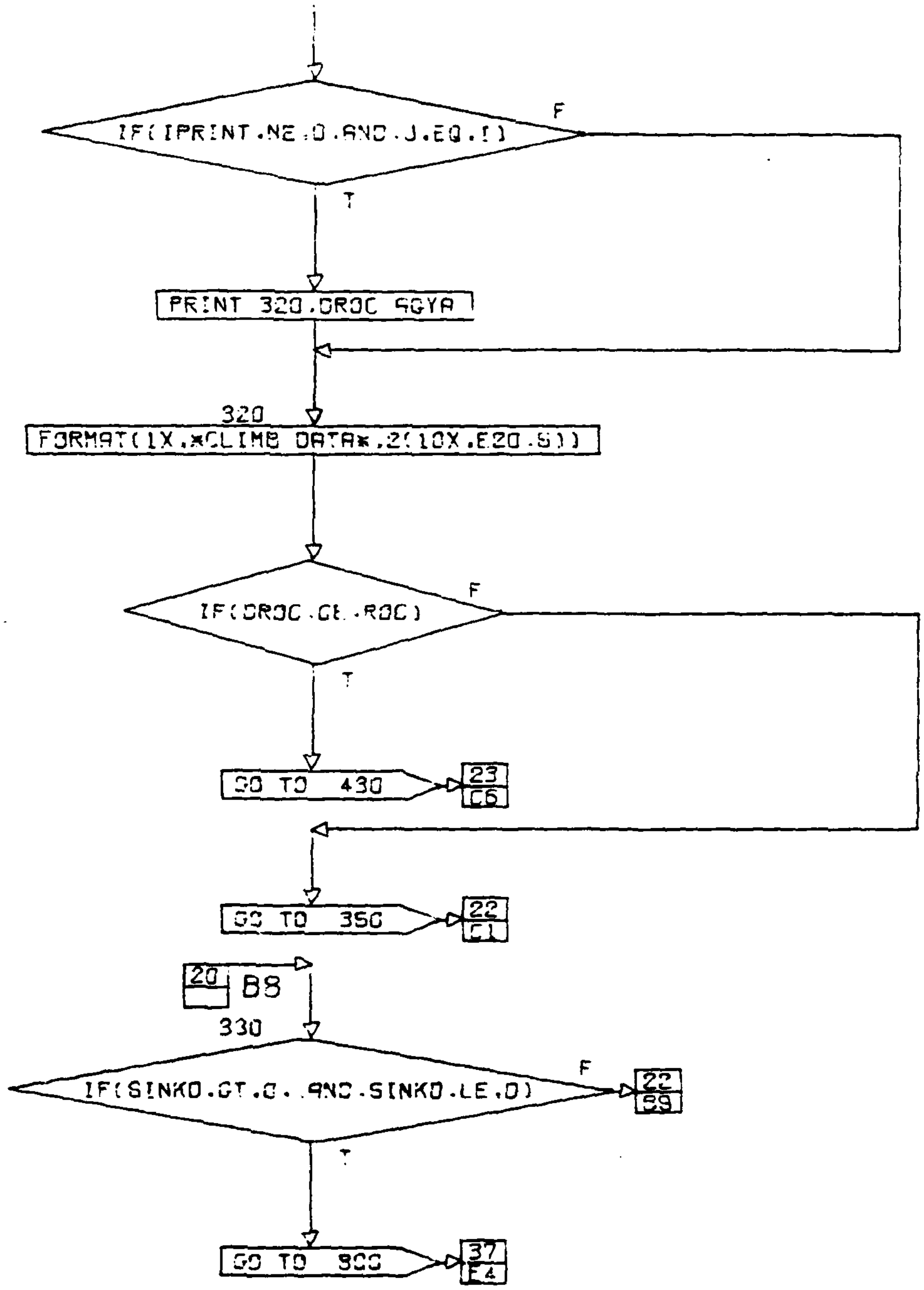
CONT. ON PG 19


17
65
280
IF(BALANCE.GT.0..OR.EFFILA.EQ.0..OR.OEI.NE.0.)
F
T
GO TO 290
OEI=1. $ NEA=NEA*.5 $ NEF=NEF*OEILOSF $ GO TO 190
290
D=D2 $ V=V2 $ T=T+DT $ W=W-((WF1+WF2)*DT/3600.)
IF(PHONY.EQ.-.13)
F
T
GO TO 360
22
62
IF(D.LT.DISTMAX)
F
T
GO TO 310
20
87
PRINT 300

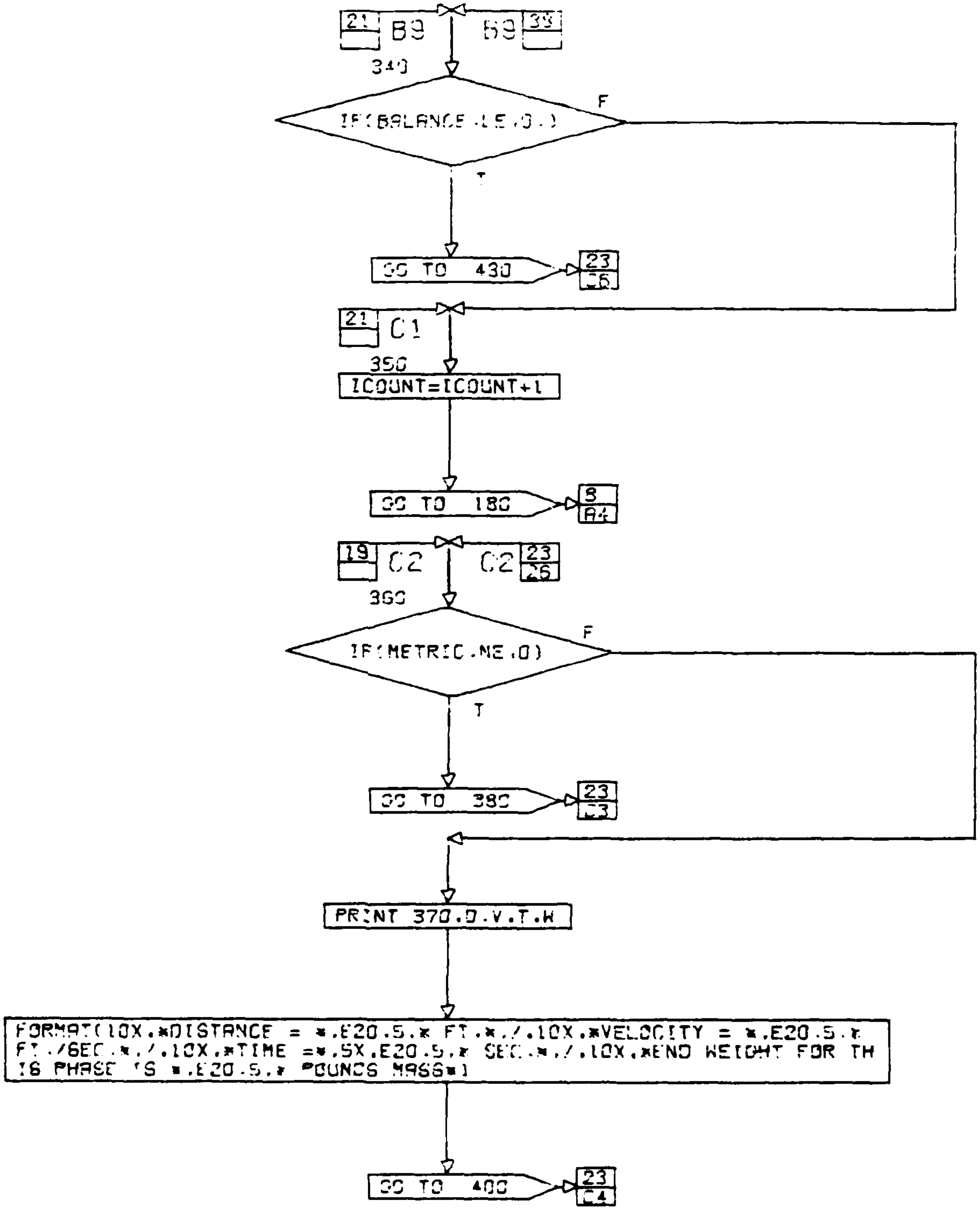
CONT. ON PG 20


300
FORMAT(10X,*CASE TERMINATED (DISTMAX EXCEEDED)*)
GO TO 730
35
D8
19
B7
310
IF(ICOUNT.GT.1000)
F
T
GO TO 410
23
C5
IF(BALANCE.GE.0..OR.ROC.EQ.0.)
F
T
GO TO 330
21
B8
MU=0.$ AGYL=AGY $ DROCL=DROC
AGY=(-BALANCE)*G/W
AGYA=(AGY+AGYL)*.5
DROC=DROCL+AGYA*DT
AROC=(DROC-DROCL)*.5
ROCH=ROCH+AROC*DT

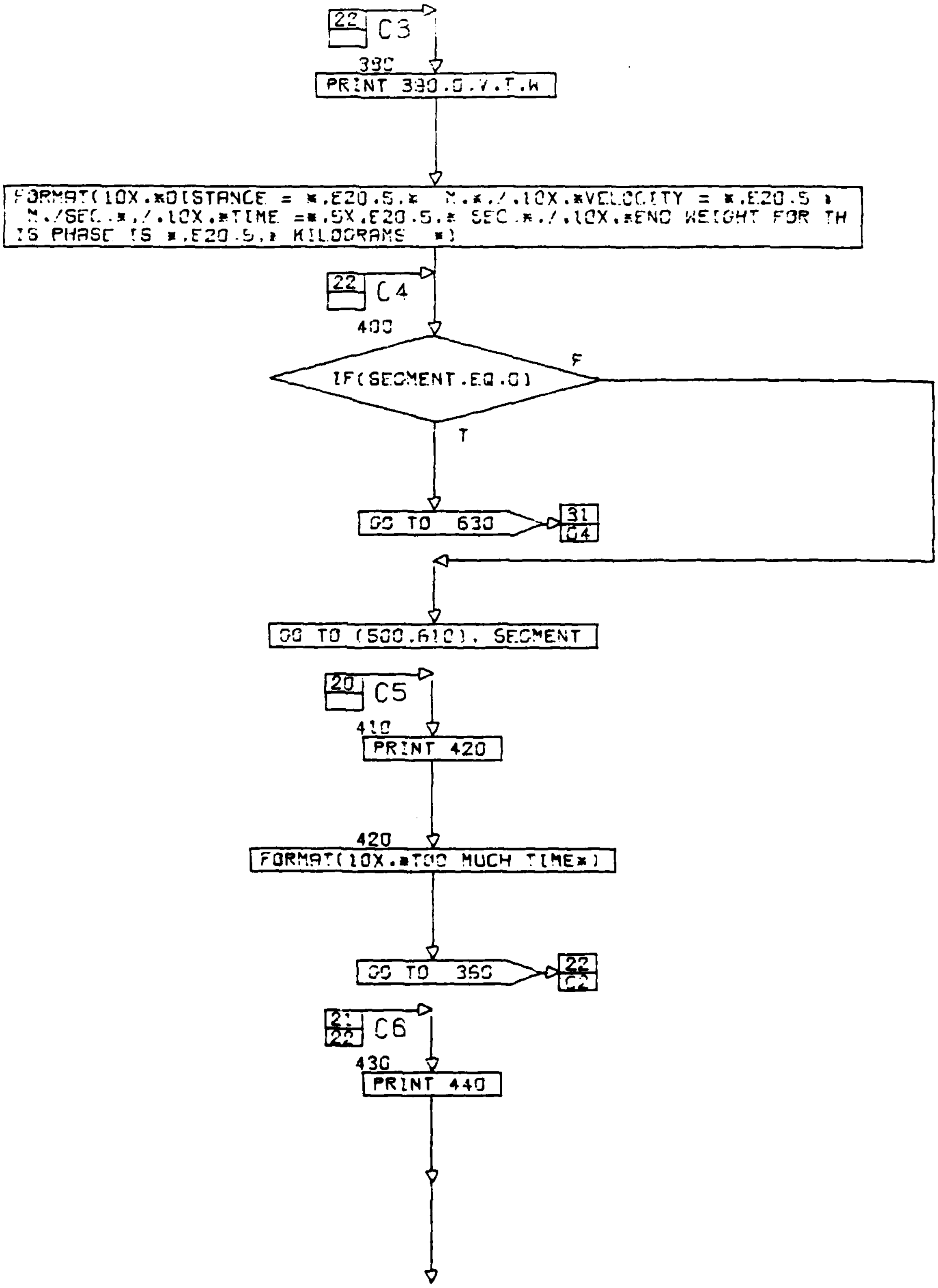
CONT. ON PG 21


IF(IPRINT.NE.0.AND.J.EQ.1)
F
T
PRINT 320,DROC AGYA
320
FORMAT(1X,*CLIMB DATA*,2(10X,E20.8))
IF(DROC.GE.ROC)
F
T
GO TO 430
23
C6
GO TO 350
22
C1
20
B8
330
IF(SINKO.GT.0..AND.SINKO.LE.0)
F
22
59
T
GO TO 800
37
F4

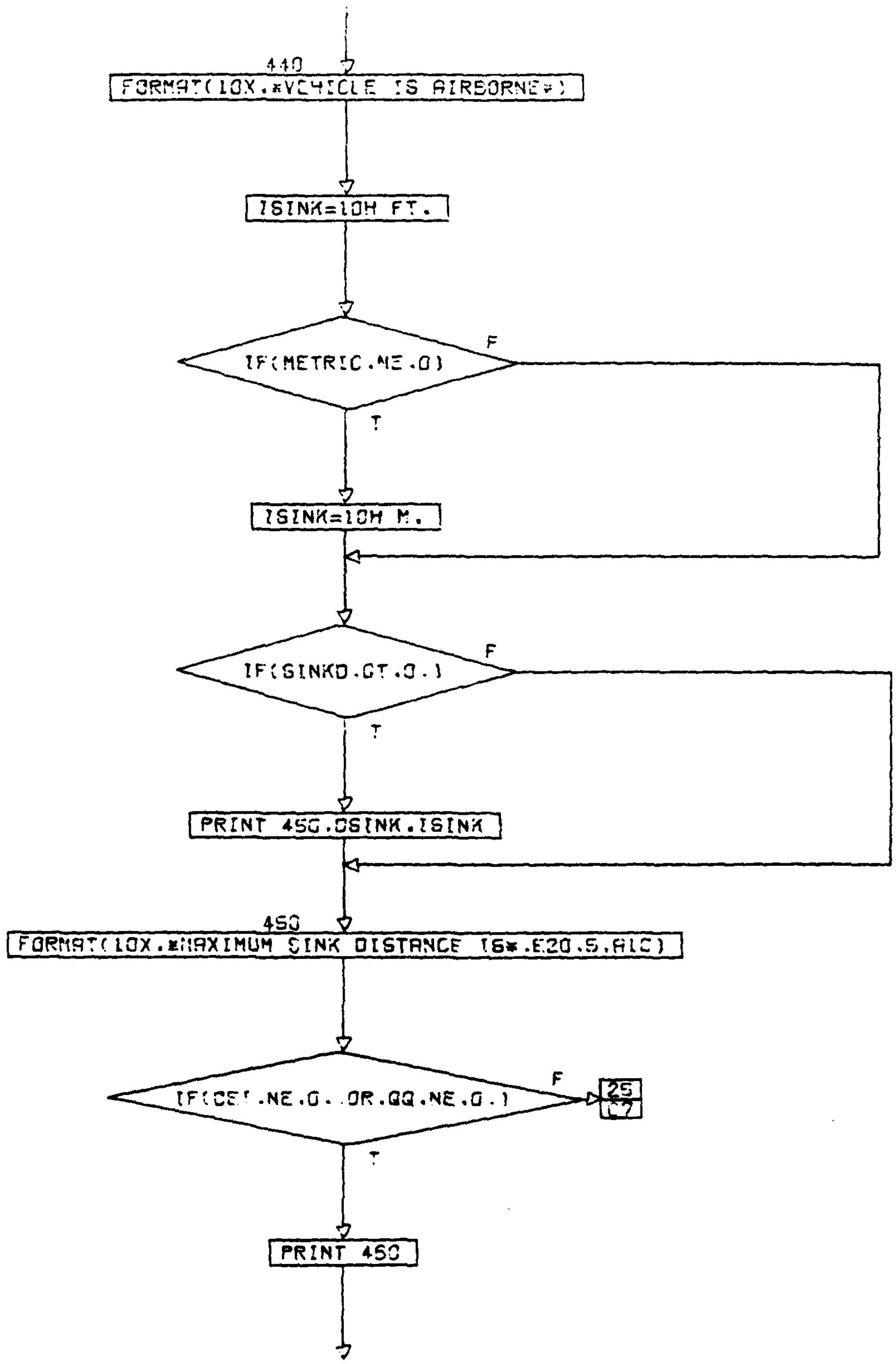
CONT. ON PG 22


21 B9
B9 39
340
IF(BALANCE.LE.0.)
F
T
GO TO 430
23
C6
21 C1
350
ICOUNT=ICOUNT+1
GO TO 180
8
A4
19 C2
C2 23
26
360
IF(METRIC.NE.0)
F
T
GO TO 380
23
C3
PRINT 370,D,V,T,W
FORMAT(10X,*DISTANCE = *,E20.5,* FT.*,/,10X,*VELOCITY = *,E20.5,*
FT./SEC.*,/,10X,*TIME =*,5X,E20.5,* SEC.*,/,10X,*END WEIGHT FOR TH
IS PHASE IS *,E20.5,* POUNDS MASS*)
GO TO 400
23
C4

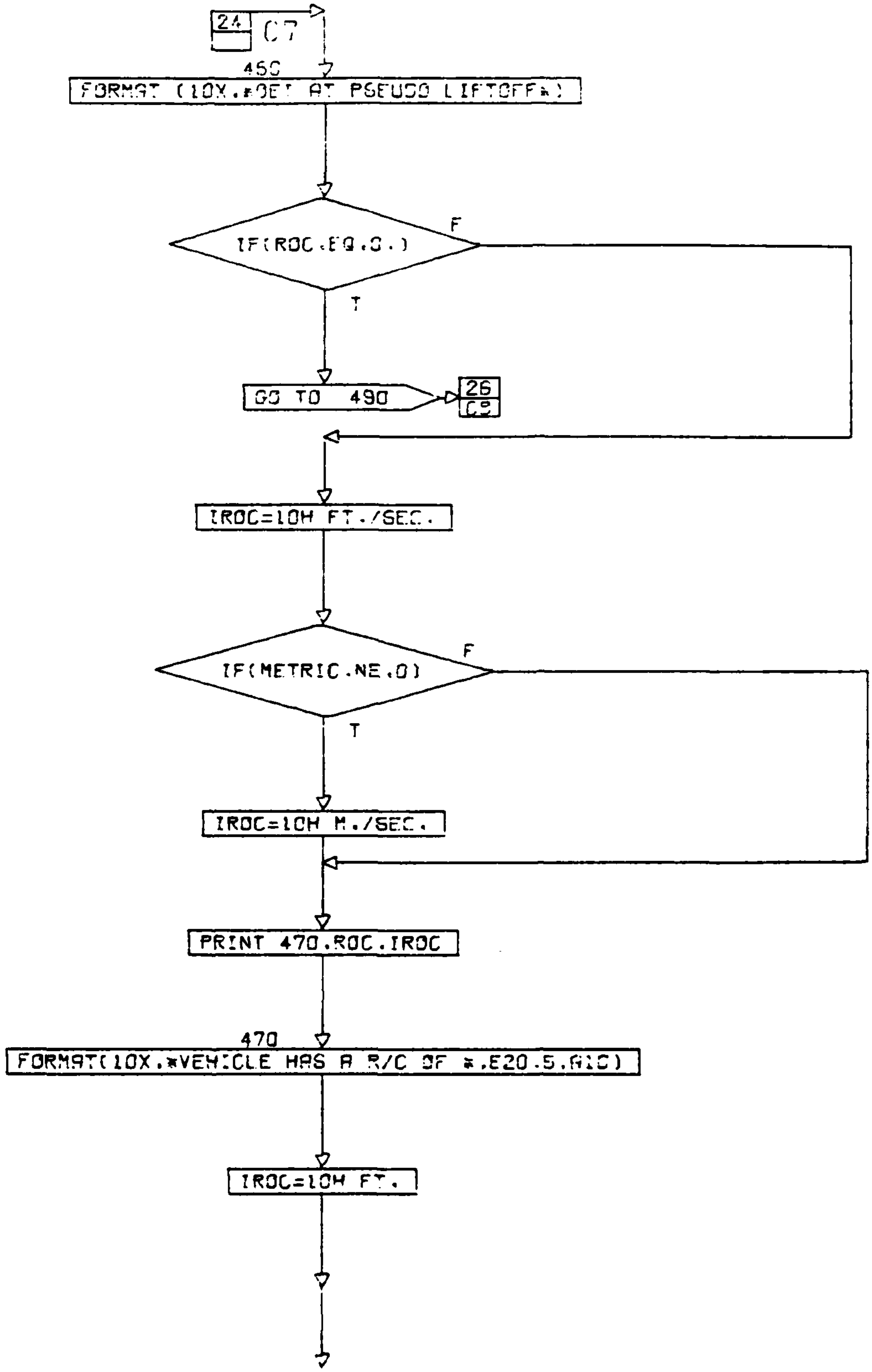
CONT. ON PG 23


22 C3
380
PRINT 380.S.V.T.W
FORMAT(10X.*DISTANCE = *.E20.5.* M.*./.10X.*VELOCITY = *.E20.5 * M./SEC.*./.10X.*TIME =*.5X.E20.5.* SEC.*./.10X.*END WEIGHT FOR THIS PHASE IS *.E20.5.* KILOGRAMS *)
22 C4
400
IF(SEGMENT.EQ.0)
F
T
GO TO 630
31 C4
GO TO (500.610). SEGMENT
20 C5
410
PRINT 420
420
FORMAT(10X.*TOO MUCH TIME*)
GO TO 360
22 C2
C6
430
PRINT 440

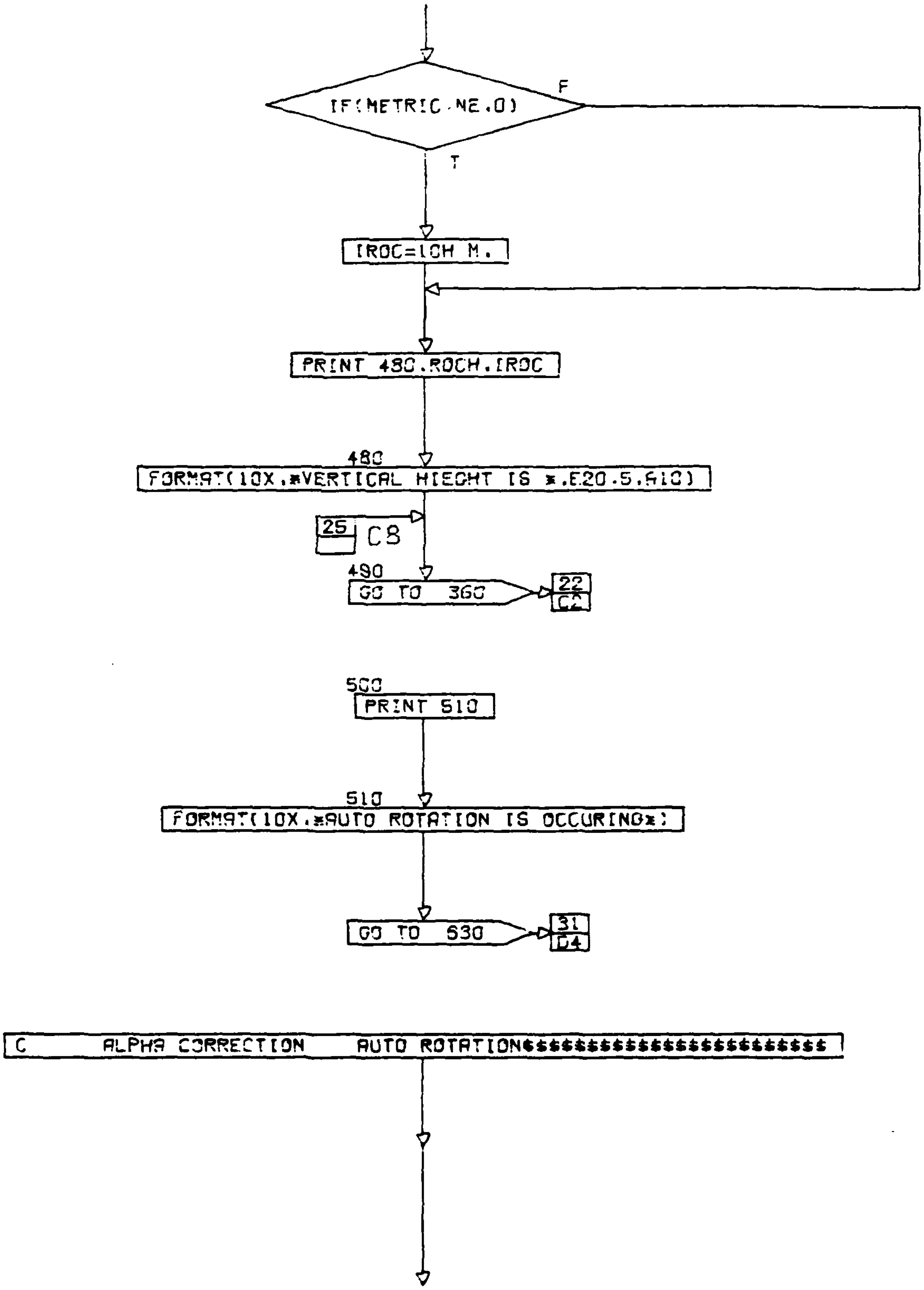
CONT. ON PG 24


440
FORMAT(10X,*VEHICLE IS AIRBORNE*)
ISINK=10H FT.
IF(METRIC.NE.0)
F
T
ISINK=10H M.
IF(SINKD.GT.0.)
F
T
PRINT 450,DSINK,ISINK
450
FORMAT(10X,*MAXIMUM SINK DISTANCE (6*.E20.5,A10)
IF(CE .NE.0. .OR.QQ.NE.0.)
F
25
T
PRINT 450

CONT. ON PG 25

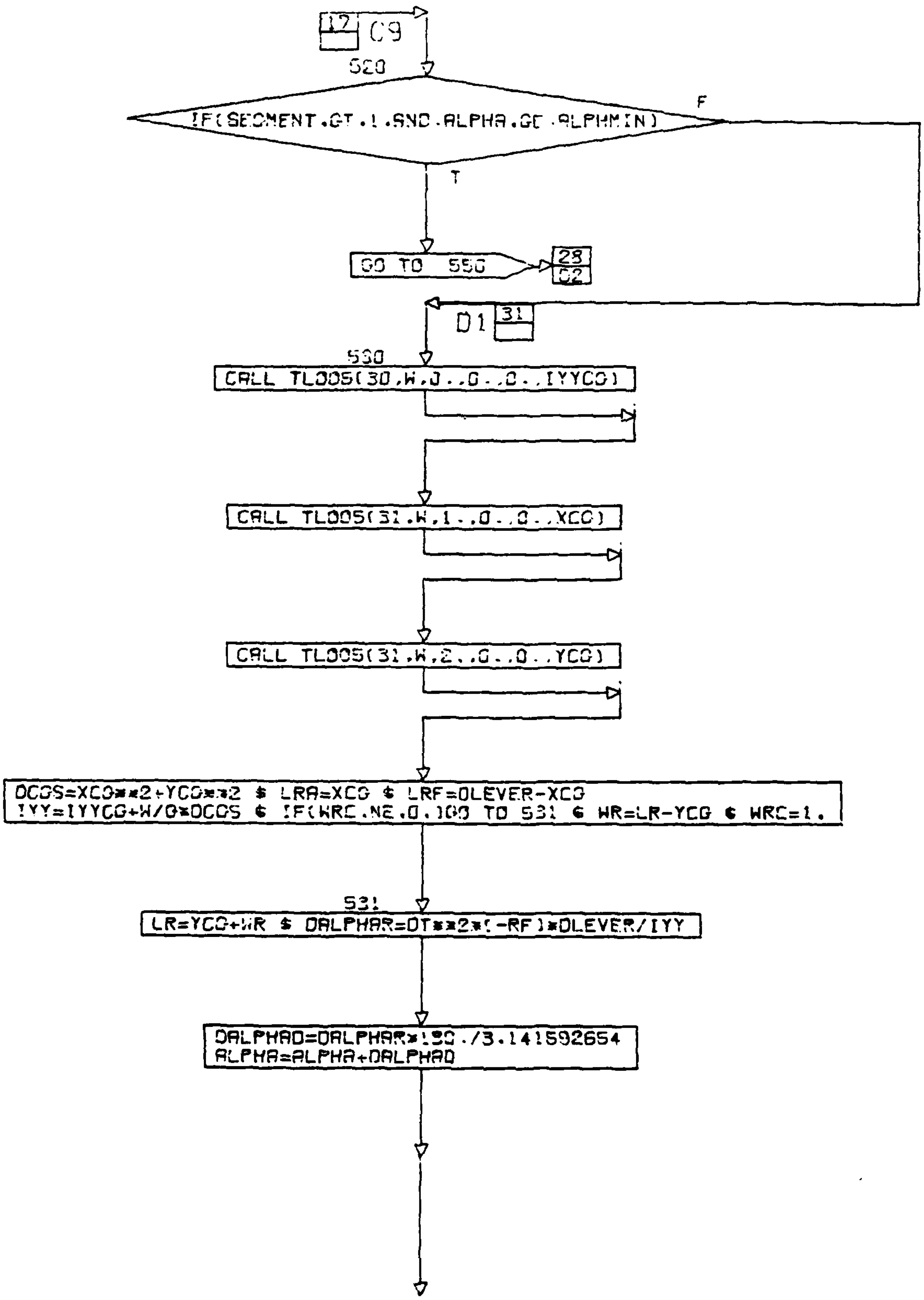

24
C7
450
FORMAT (10X,*DET AT PSEUDO LIFTOFF*)
IF(ROC.EQ.0.)
F
T
GO TO 490
26
C8
IROC=10H FT./SEC.
IF(METRIC.NE.0)
F
T
IROC=10H M./SEC.
PRINT 470,ROC,IROC
470
FORMAT(10X,*VEHICLE HAS A R/C OF *,E20.5,A10)
IROC=10H FT.

CONT. ON PG 26

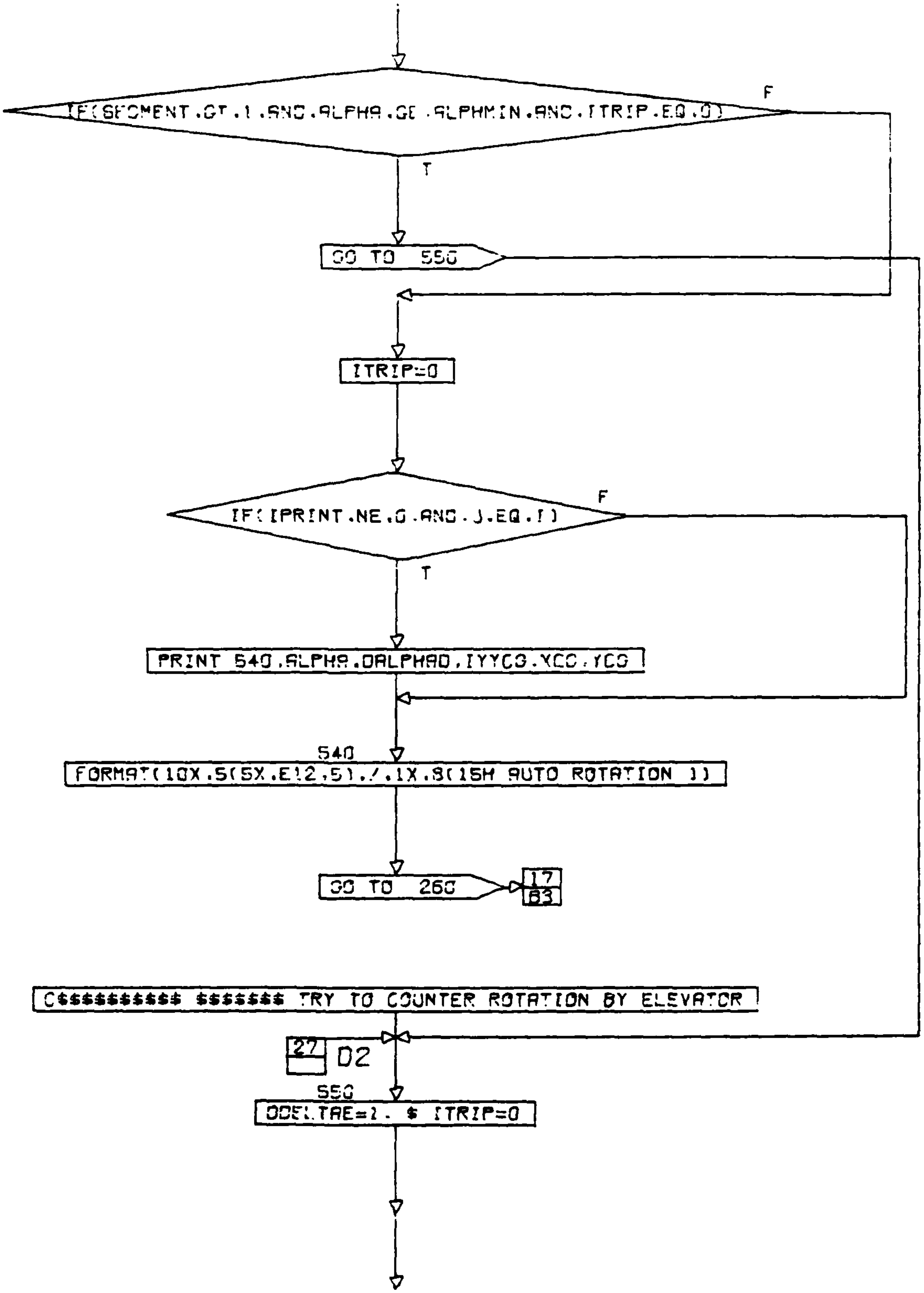


IF(METRIC.NE.0)
F
T
IROC=ICH M.
PRINT 480,ROCH,IROC
480
FORMAT(10X,*VERTICAL HIEGHT IS *,E20.5,A10)
25
C8
490
GO TO 360
22
C2
500
PRINT 510
510
FORMAT(10X,*AUTO ROTATION IS OCCURING*)
GO TO 630
31
D4
C ALPHA CORRECTION AUTO ROTATION$$$$$$$$$$$$$$$$$$$$$$$$$

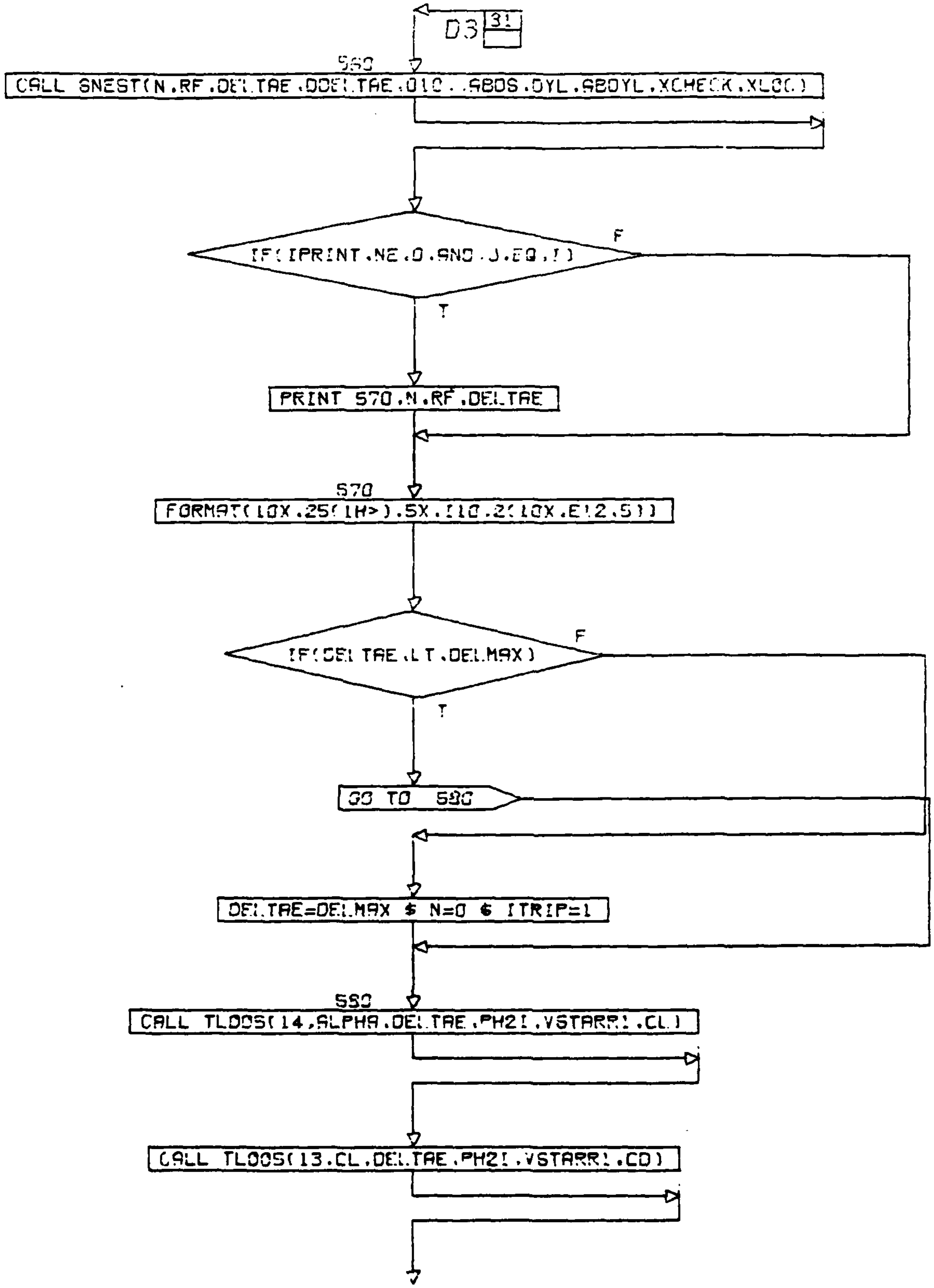
CONT. ON PG 27


17
C9
520
IF(SEGMENT.GT.1.AND.ALPHA.GE.ALPHMIN)
F
T
GO TO 550
28
C2
D1
31
530
CALL TLOOS(30,W,0.,0.,0.,IYYCG)
CALL TLOOS(31,W,1.,0.,0.,XCG)
CALL TLOOS(31,W,2.,0.,0.,YCG)
DCGS=XCG**2+YCG**2 $ LRA=XCG $ LRF=DLEVER-XCG
IYY=IYYCG+W/G*DCGS $ IF(WRC.NE.0.)GO TO 531 $ WR=LR-YCG $ WRC=1.
531
LR=YCG+WR $ DALPHAR=DT**2*(-RF)*DLEVER/IYY
DALPHAD=DALPHAR*180./3.141592654
ALPHA=ALPHA+DALPHAD

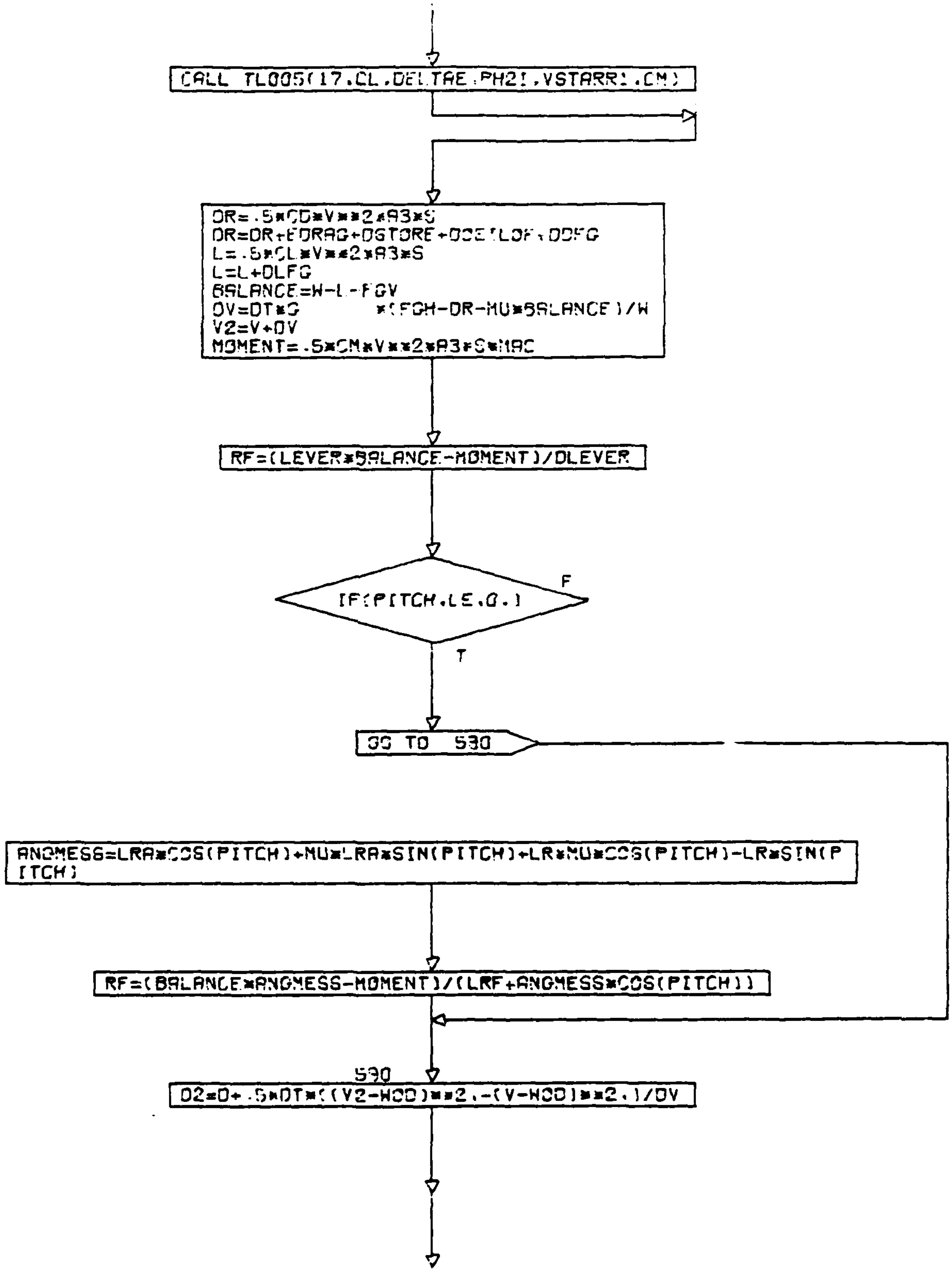
CONT. ON PG 28


IF(SEGMENT.GT.1.AND.ALPHA.GE.ALPHMIN.AND.ITRIP.EQ.0)
F
T
GO TO 550
ITRIP=0
IF(IPRINT.NE.0.AND.J.EQ.1)
F
T
PRINT 540,ALPHA,DALPHAD,IYYCG,XCG,YCG
540
FORMAT(10X,5(5X,E12.5),/,1X,8(15H AUTO ROTATION))
GO TO 260
17
83
C$$$$$$$$$$ $$$$$$$ TRY TO COUNTER ROTATION BY ELEVATOR
27
D2
550
DDELTAE=1. $ ITRIP=0

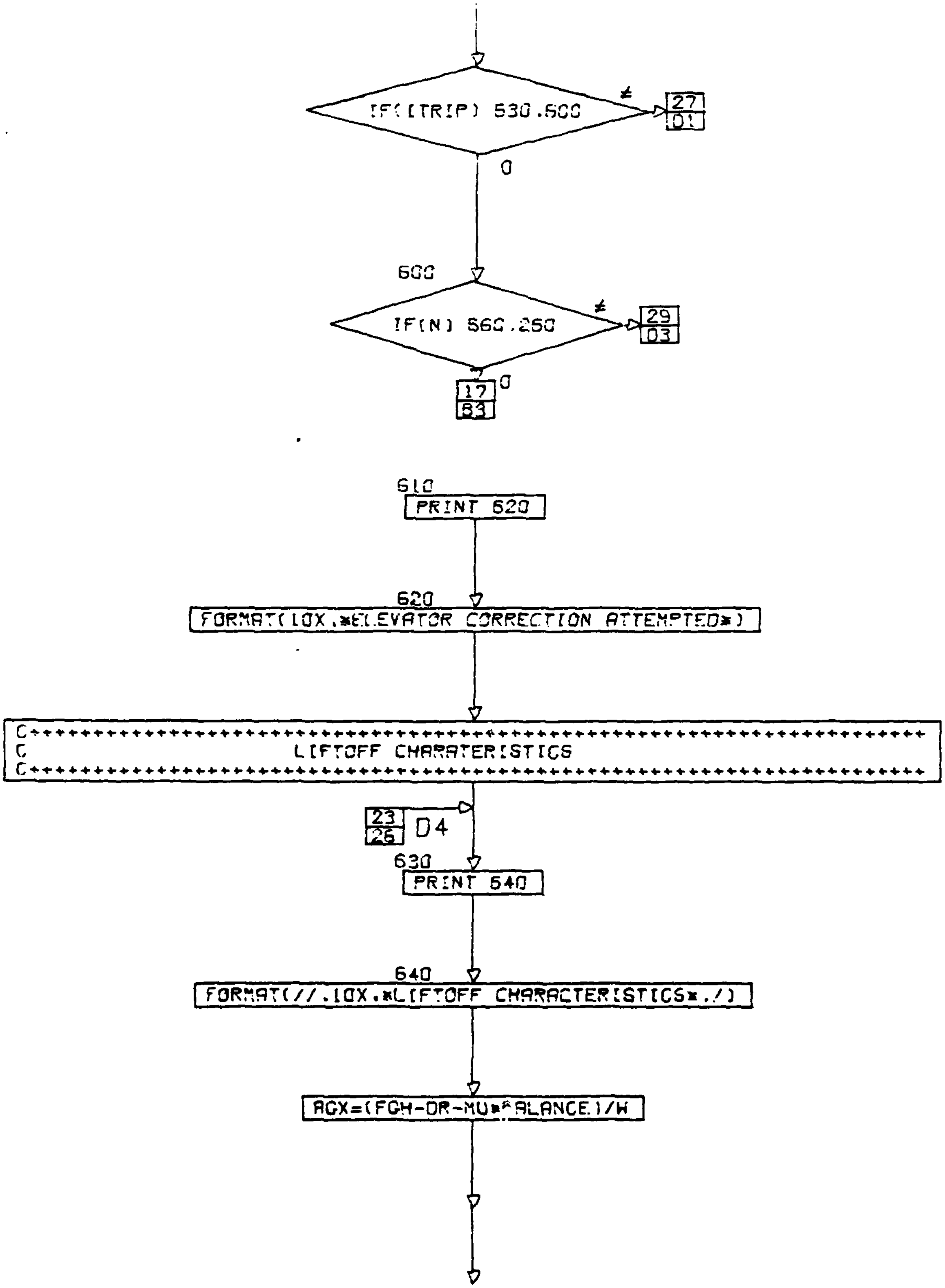
CONT. ON PG 29


D3 31
560
CALL SNEST(N,RF,DELTAE,DDELTAE,010,,ABDS,DYL,ABDYL,XCHECK,XLOC)
IF(IPRINT.NE.0.AND.J.EQ.1)
F
T
PRINT 570,N,RF,DELTAE
570
FORMAT(10X,25(1H>),5X,I10,2(10X,E12.5))
IF(DELTAE.LT.DELMAX)
F
T
GO TO 580
DELTAE=DELMAX $ N=0 $ ITRIP=1
580
CALL TLOOS(14,ALPHA,DELTAE,PH2I,VSTARRI,CL)
CALL TLOOS(13,CL,DELTAE,PH2I,VSTARRI,CD)

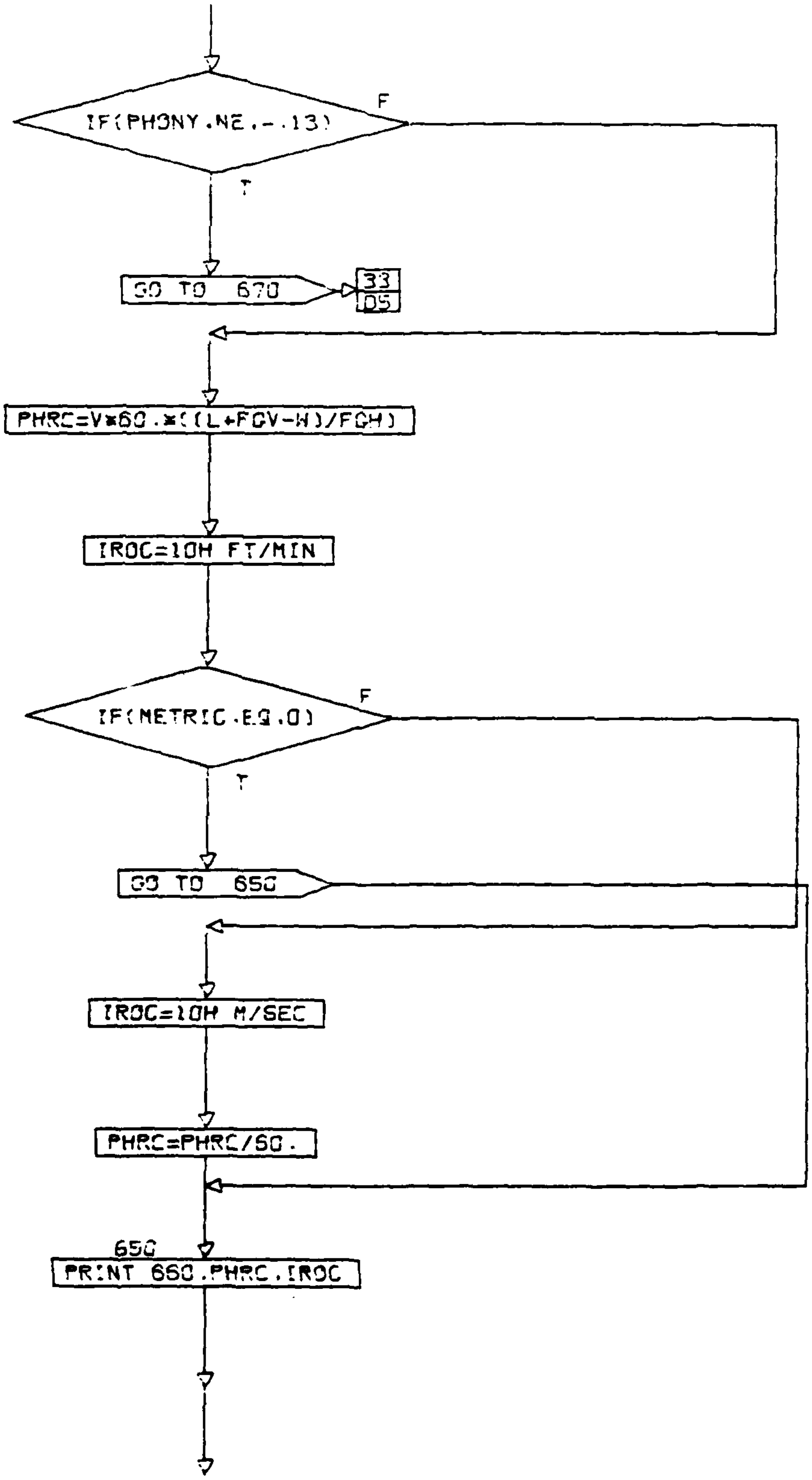
CONT. ON PG 30


CALL TLOO5(17.CL.DELTAE.PH2I.VSTARRI.CM)
DR=.5*CD*V**2*A3*S
DR=DR+EDRAG+DGTORE+DDEILOF+DDFG
L=.5*CL*V**2*A3*S
L=L+DLFG
BALANCE=W-L-FGV
DV=DT*G *(FGH-DR-MU*BALANCE)/W
V2=V+DV
MOMENT=.5*CM*V**2*A3*S*MAC
RF=(LEVER*BALANCE-MOMENT)/DLEVER
IF(PITCH.LE.0.)
F
T
GO TO 530
ANGMESS=LRA*COS(PITCH)+MU*LRA*SIN(PITCH)+LR*MU*COS(PITCH)-LR*SIN(PITCH)
RF=(BALANCE*ANGMESS-MOMENT)/(LRF+ANGMESS*COS(PITCH))
530
D2=D+.5*DT*((V2-HOD)**2.-(V-HOD)**2.)/DV

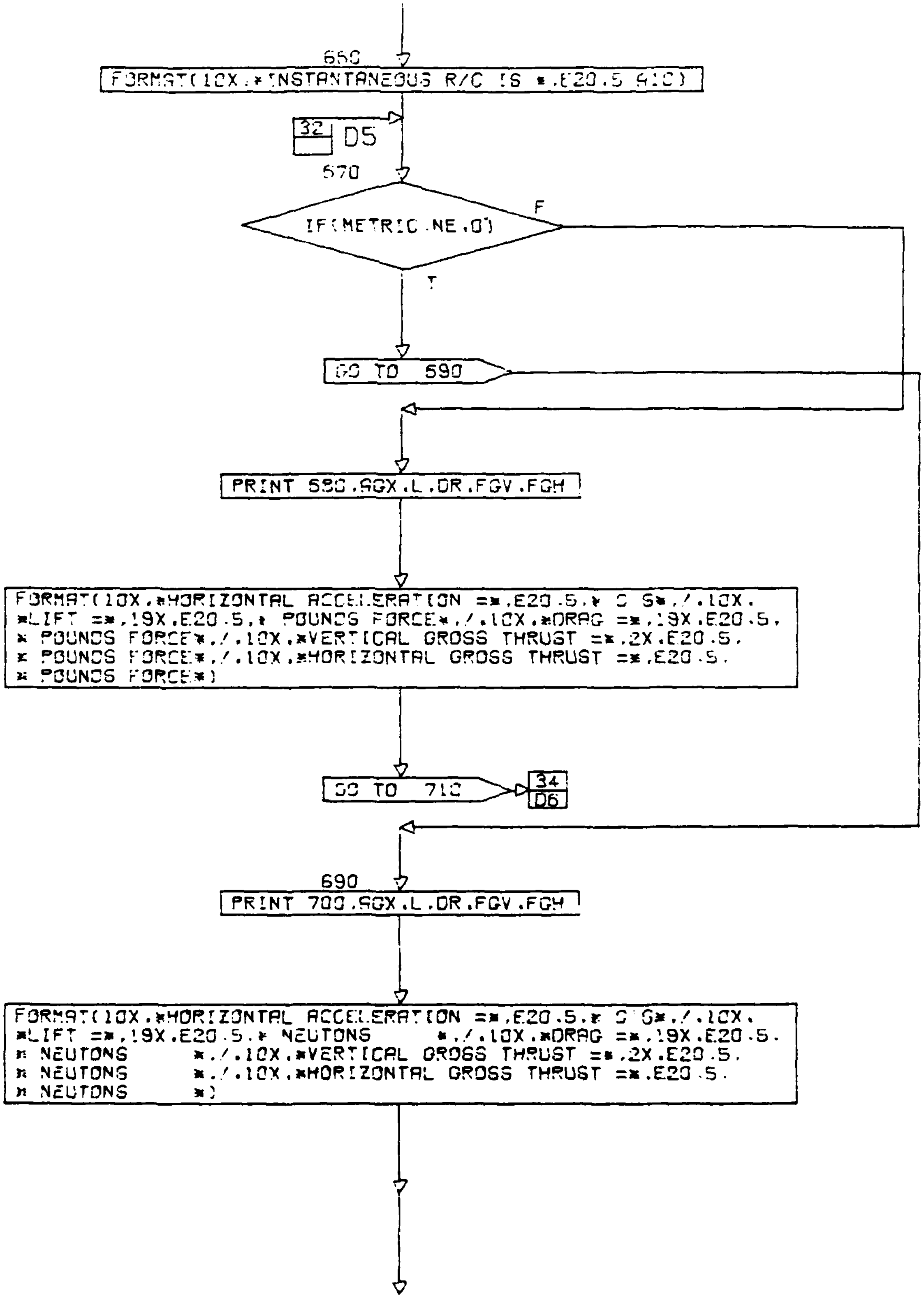
CONT. ON PG 31


IF(ITRIP) 530,600
≠
27
01
0
600
IF(N) 560,250
≠
29
03
0
17
63
610
PRINT 620
620
FORMAT(10X,*ELEVATOR CORRECTION ATTEMPTED*)
C++
C LIFTOFF CHARATERISTICS
C++
23
26
D4
630
PRINT 640
640
FORMAT(//,10X,*LIFTOFF CHARACTERISTICS*,/)
AGX=(FGH-DR-MU*BALANCE)/W

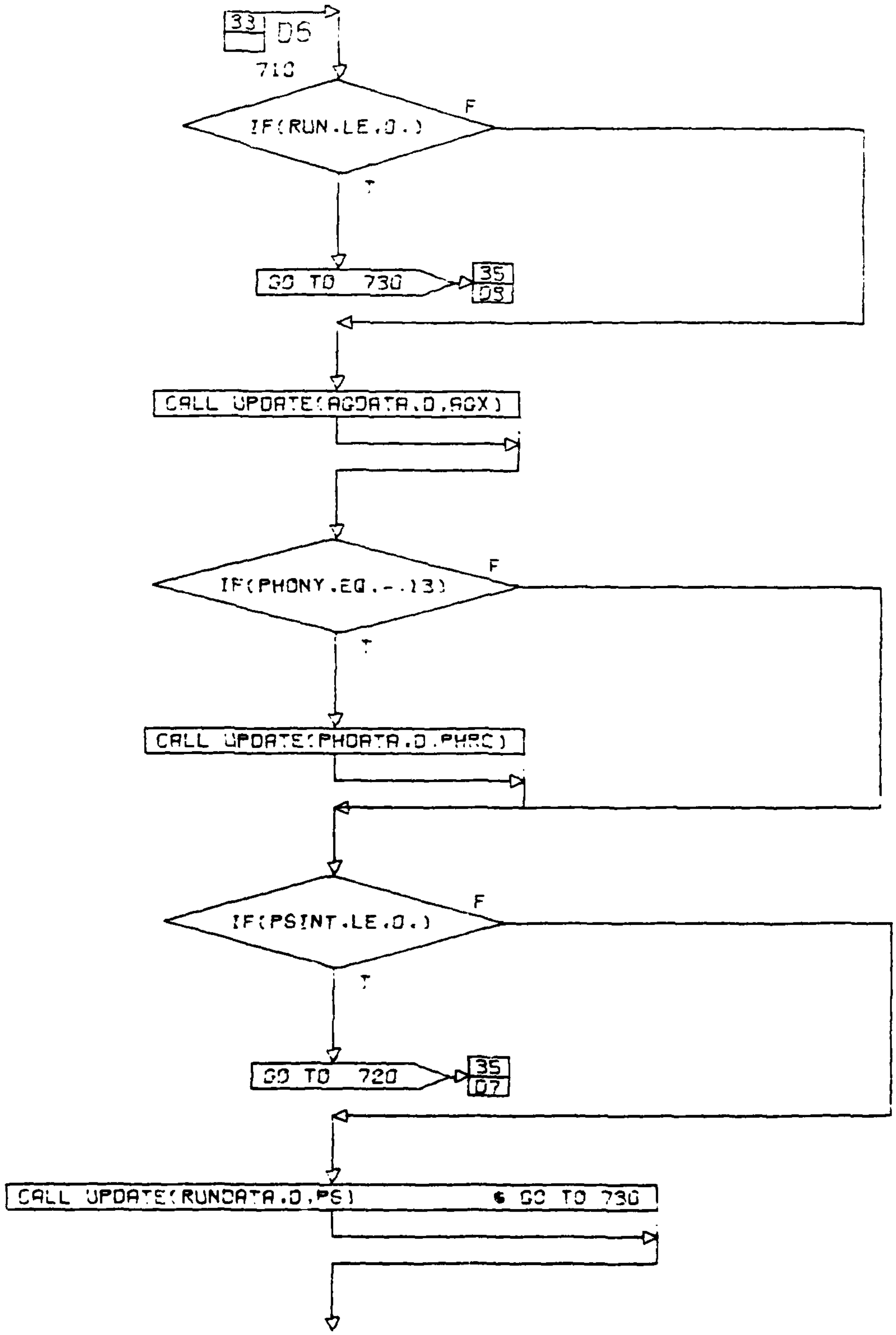
CONT. ON PG 32


IF(PHONY.NE.-.13)
F
T
GO TO 670
33
05
PHRC=V*60.*((L+FGV-W)/FGH)
IROC=10H FT/MIN
IF(METRIC.EQ.0)
F
T
GO TO 650
IROC=10H M/SEC
PHRC=PHRC/60.
650
PRINT 660,PHRC,IROC

CONT. ON PG 33


660
FORMAT(10X,*INSTANTANEOUS R/C IS *,E20.5 A10)
32
D5
670
IF(METRIC.NE.0)
F
T
GO TO 690
PRINT 680,AGX,L,DR,FGV,FGH
FORMAT(10X,*HORIZONTAL ACCELERATION =*,E20.5,* G S*,/,10X,
LIFT =,19X,E20.5,* POUNDS FORCE*,/,10X,*DRAG =*,19X,E20.5,
* POUNDS FORCE*,/,10X,*VERTICAL GROSS THRUST =*,2X,E20.5,
* POUNDS FORCE*,/,10X,*HORIZONTAL GROSS THRUST =*,E20.5,
* POUNDS FORCE*)
GO TO 710
34
D6
690
PRINT 700,AGX,L,DR,FGV,FGH
FORMAT(10X,*HORIZONTAL ACCELERATION =*,E20.5,* G G*,/,10X,
LIFT =,19X,E20.5,* NEUTONS *,/,10X,*DRAG =*,19X,E20.5,
* NEUTONS *,/,10X,*VERTICAL GROSS THRUST =*,2X,E20.5,
* NEUTONS *,/,10X,*HORIZONTAL GROSS THRUST =*,E20.5,
* NEUTONS *)

CONT. ON PG 34

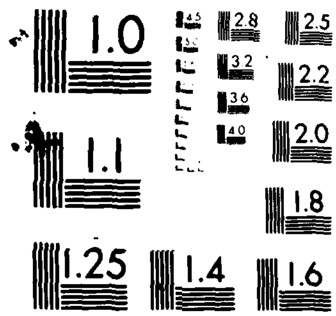

33
D6
710
IF(RUN.LE.0.)
F
T
GO TO 730
35
D5
CALL UPDATE(AGDATA,D,AGX)
IF(PHONY.EQ.-.13)
F
T
CALL UPDATE(PHDATA,D,PHRC)
IF(PSINT.LE.0.)
F
T
GO TO 720
35
D7
CALL UPDATE(RUNDATA,D,PS) $ GO TO 730

CONT. ON PG 35

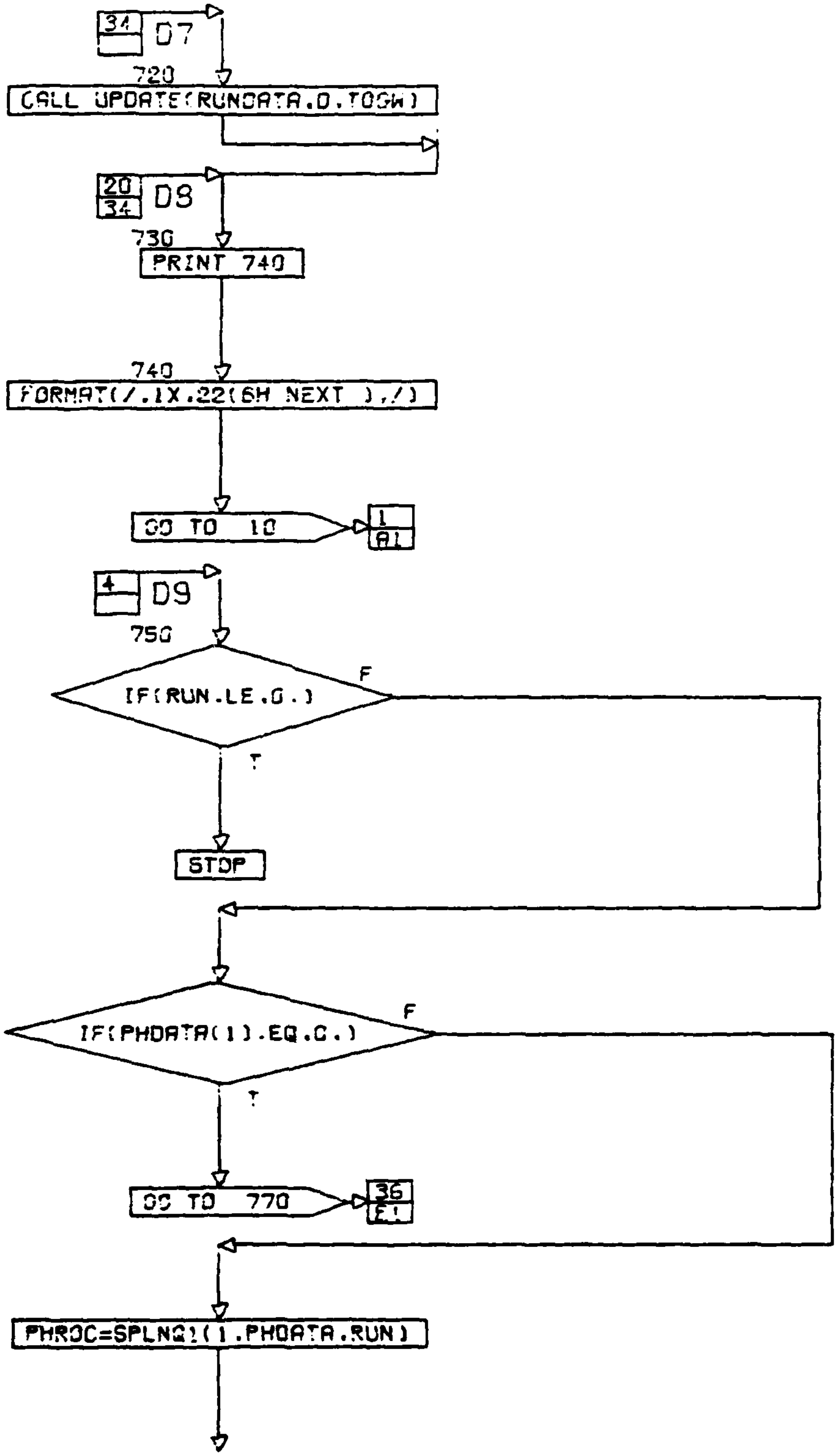
AD-A109 861   NAVAL AIR DEVELOPMENT CENTER WARMINSTER PA AIRCRAFT --ETC   F/G 1/3
A SHORT TAKEOFF PERFORMANCE COMPUTER PROGRAM.(U)
NOV 81   D B KOBUS
UNCLASSIFIED   NADC-81259-60   NL

2 2

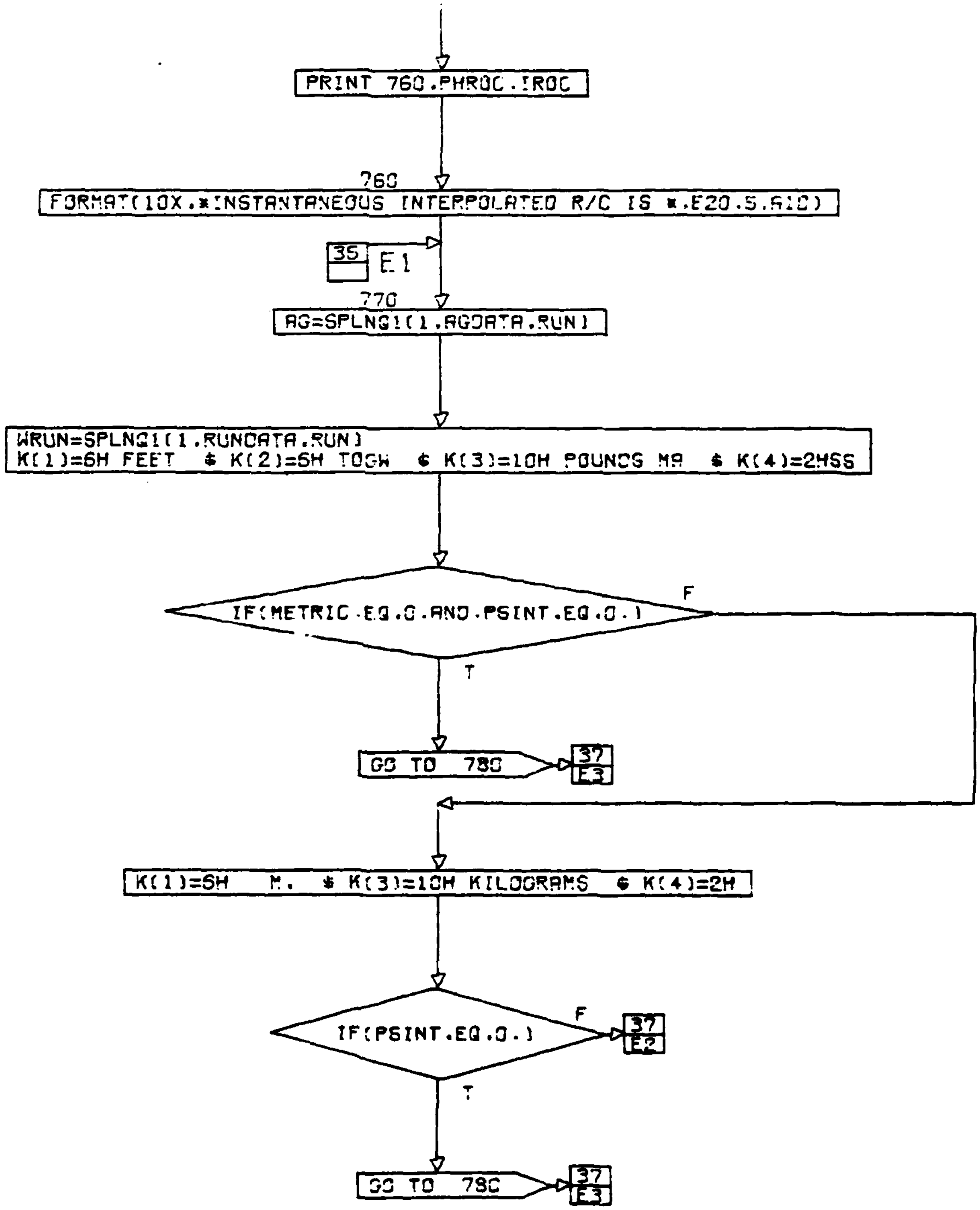
END
DATE FILMED
2 82
DTIC



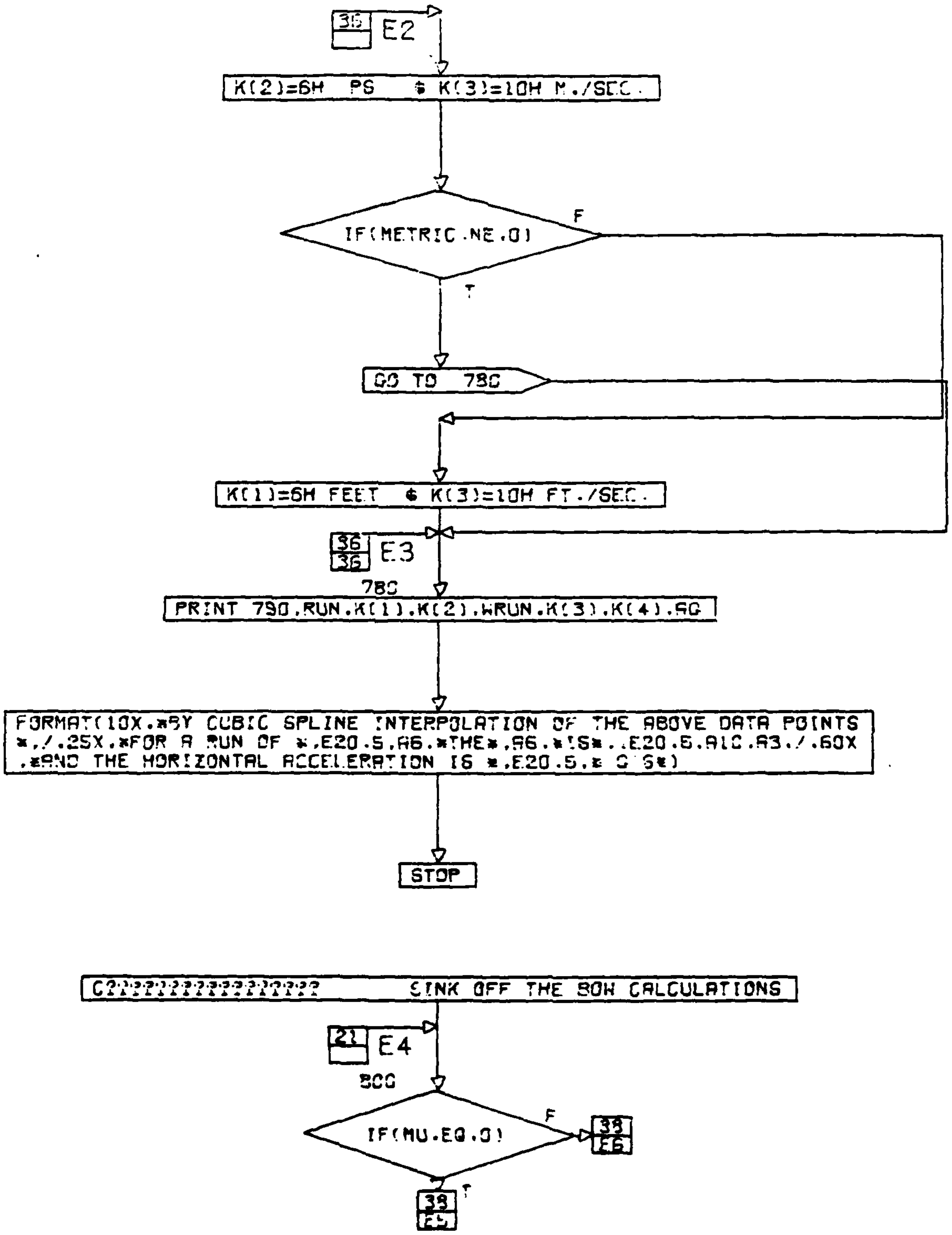
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A


34
D7
720
CALL UPDATE(RUNDATA,0,TOGW)
20
34
D8
730
PRINT 740
740
FORMAT(/,1X,22(6H NEXT),/)
GO TO 10
1
A1
4
D9
750
IF(RUN.LE.0.)
F
T
STOP
IF(PHDATA(1).EQ.0.)
F
T
GO TO 770
36
E1
PHROC=SPLN01(1,PHDATA,RUN)

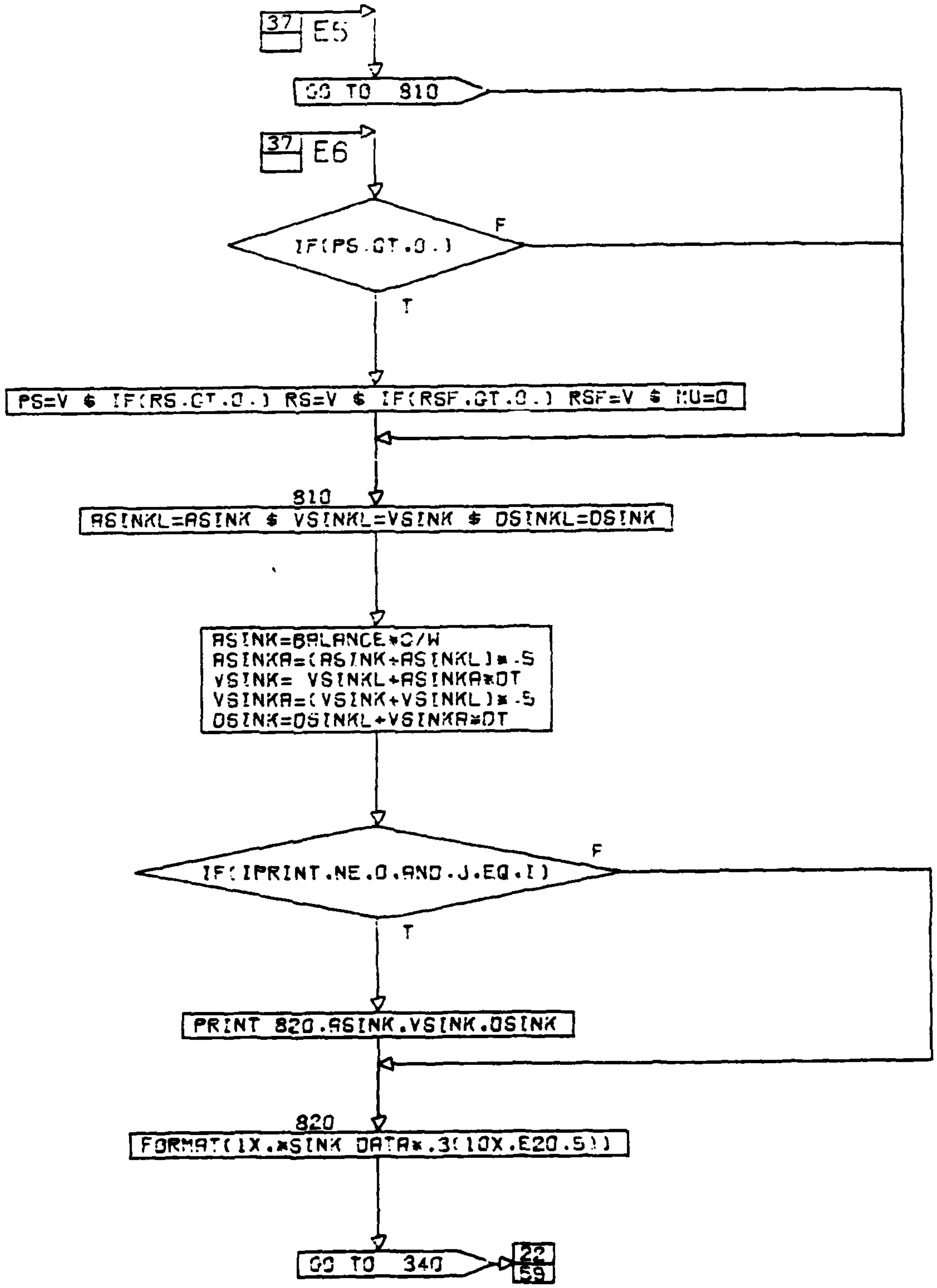
CONT. ON PG 36


PRINT 760.PHROC.IROC
760
FORMAT(10X.*INSTANTANEOUS INTERPOLATED R/C IS *.E20.5.A10)
35
E1
770
AG=SPLNG1(1.AGDATA.RUN)
WRUN=SPLNG1(1.RUNDATA.RUN)
K(1)=6H FEET $ K(2)=6H TOGW $ K(3)=10H POUNDS MA $ K(4)=2HSS
IF(METRIC.EQ.0.AND.PSINT.EQ.0.)
F
T
GO TO 780
37
E3
K(1)=6H M. $ K(3)=10H KILOGRAMS $ K(4)=2H
IF(PSINT.EQ.0.)
F
37
E2
T
GO TO 780
37
E3

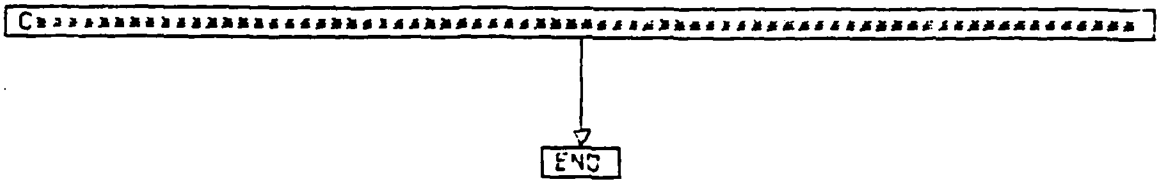
CONT. ON PG 37


35
E2
K(2)=6H PS $ K(3)=10H M./SEC.
IF(METRIC.NE.0)
F
T
GO TO 780
K(1)=6H FEET $ K(3)=10H FT./SEC.
36
36
E3
780
PRINT 790,RUN,K(1),K(2),WRUN,K(3),K(4),AG
FORMAT(10X,*BY CUBIC SPLINE INTERPOLATION OF THE ABOVE DATA POINTS
*,/,25X,*FOR A RUN OF *,E20.5,A6,*THE*,A6,*IS*,,E20.5,A10,A3,/,60X
,*AND THE HORIZONTAL ACCELERATION IS *,E20.5,* G S*)
STOP
C?????????????????? SINK OFF THE BOW CALCULATIONS
21
E4
800
IF(MU.EQ.0)
F
38
E6
T
38
E5

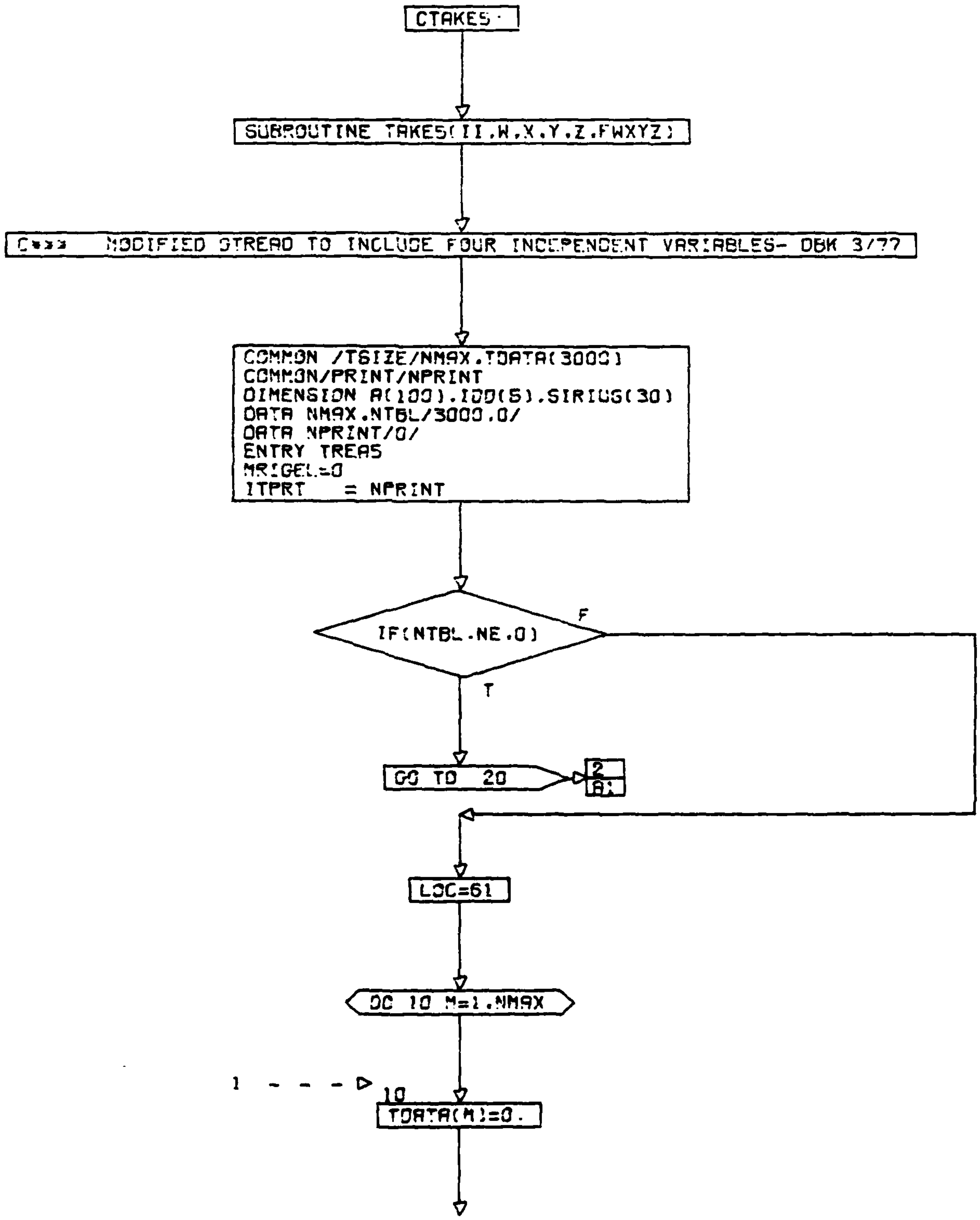
CONT. ON PG 38


37 E5
GO TO 810
37 E6
IF(PS.GT.0.)
F
T
PS=V $ IF(RS.GT.0.) RS=V $ IF(RSF.GT.0.) RSF=V $ MU=0
810
ASINKL=ASINK $ VSINKL=VSINK $ DSINKL=DSINK
ASINK=BALANCE*G/W
ASINKA=(ASINK+ASINKL)*.5
VSINK= VSINKL+ASINKA*DT
VSINKA=(VSINK+VSINKL)*.5
DSINK=DSINKL+VSINKA*DT
IF(IPRINT.NE.0.AND.J.EQ.I)
F
T
PRINT 820.ASINK.VSINK.DSINK
820
FORMAT(1X.*SINK DATA*.3(10X.E20.5))
GO TO 340
22
59

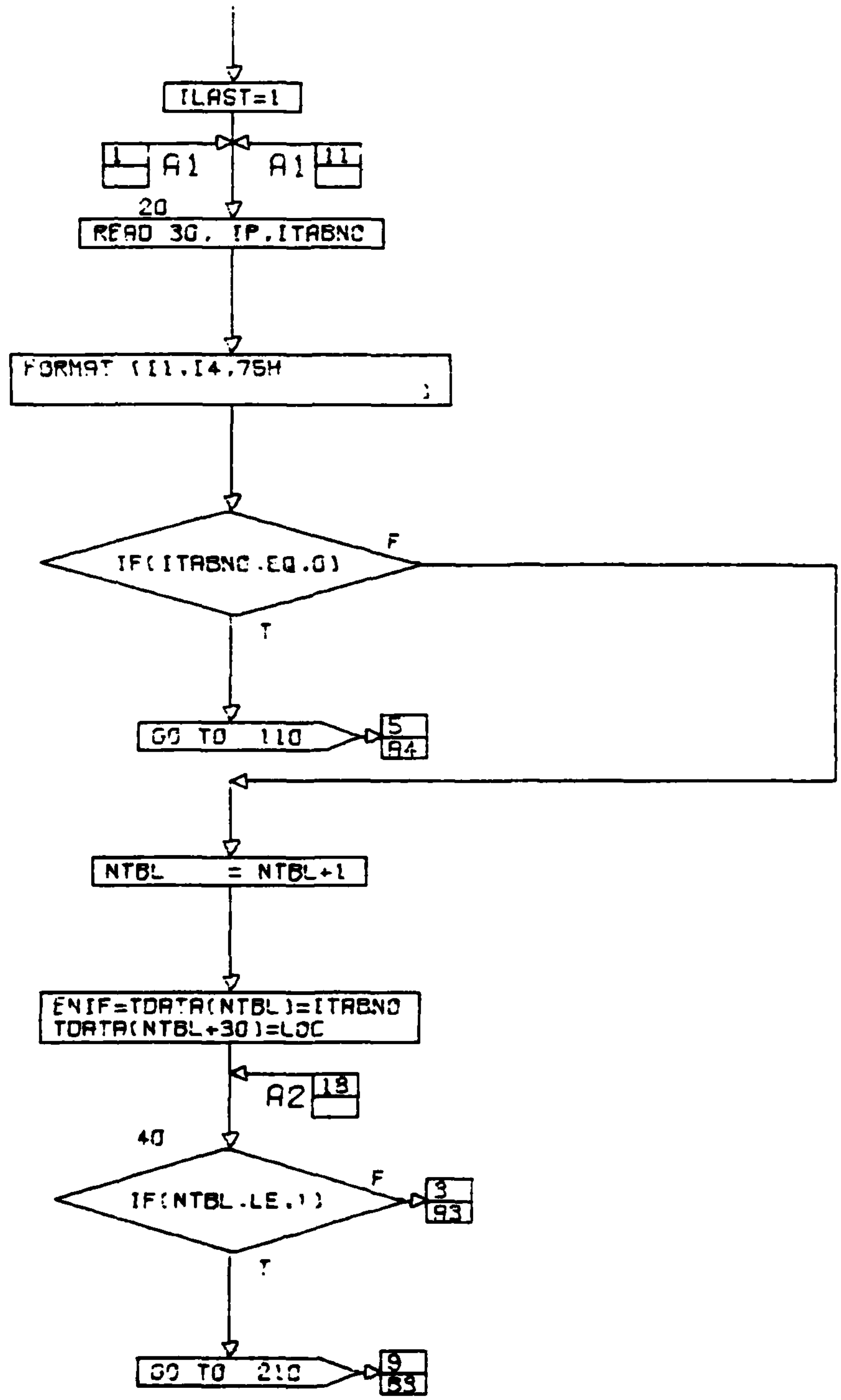
CONT. ON PG 39



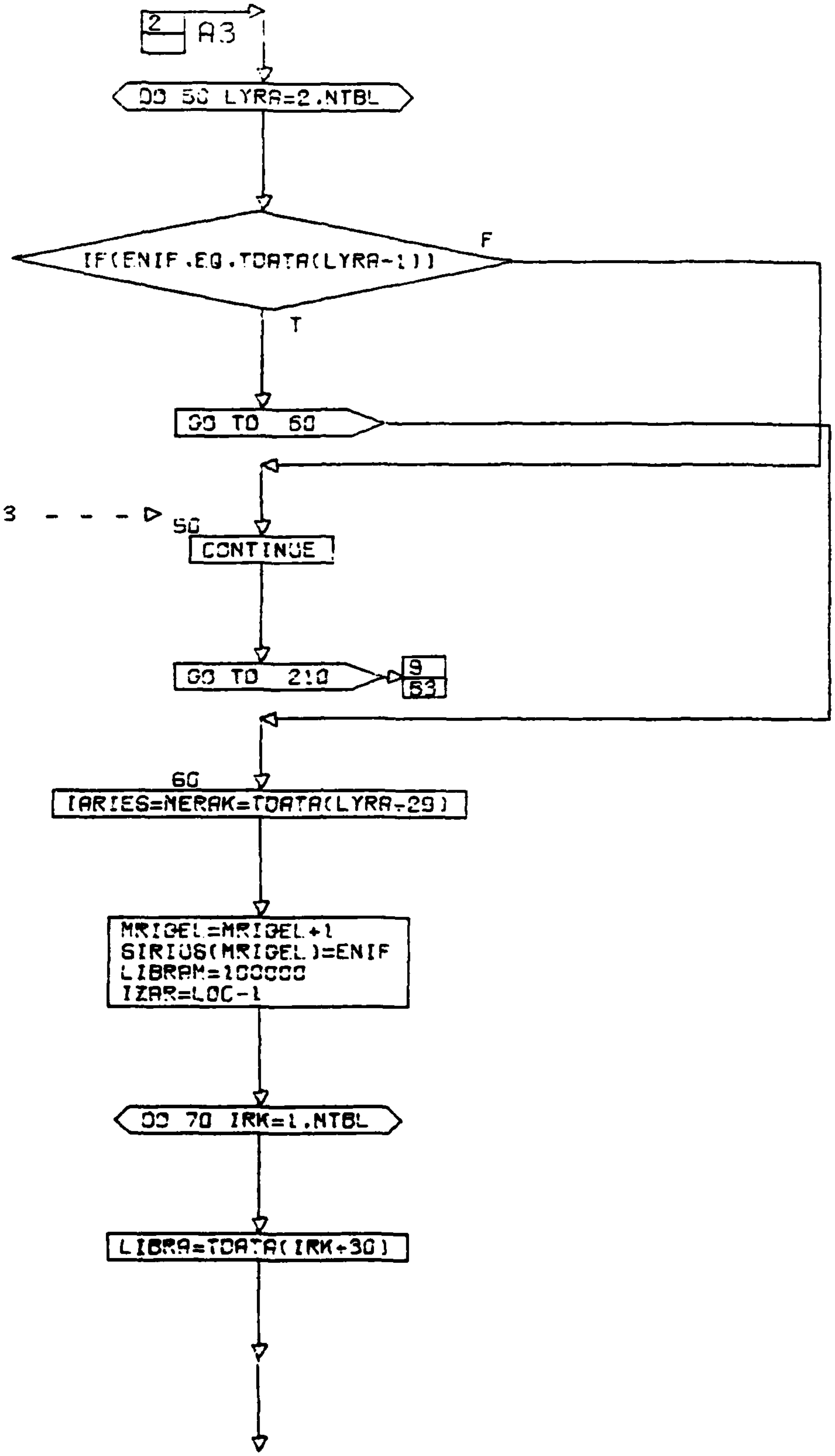
PG 39 FINAL


CTAKES
SUBROUTINE TAKES(II,W,X,Y,Z,FWXYZ)
C*** MODIFIED STREAD TO INCLUDE FOUR INDEPENDENT VARIABLES- DBK 3/77
COMMON /TSIZE/NMAX,TDATA(3000)
COMMON/PRINT/NPRINT
DIMENSION A(100),IDD(5),SIRIUS(30)
DATA NMAX,NTBL/3000,0/
DATA NPRINT/0/
ENTRY TREAS
MRIGEL=0
ITPRT = NPRINT
IF(NTBL.NE.0)
F
T
GO TO 20
2
A1
LOC=61
DO 10 M=1,NMAX
1
10
TDATA(M)=0.

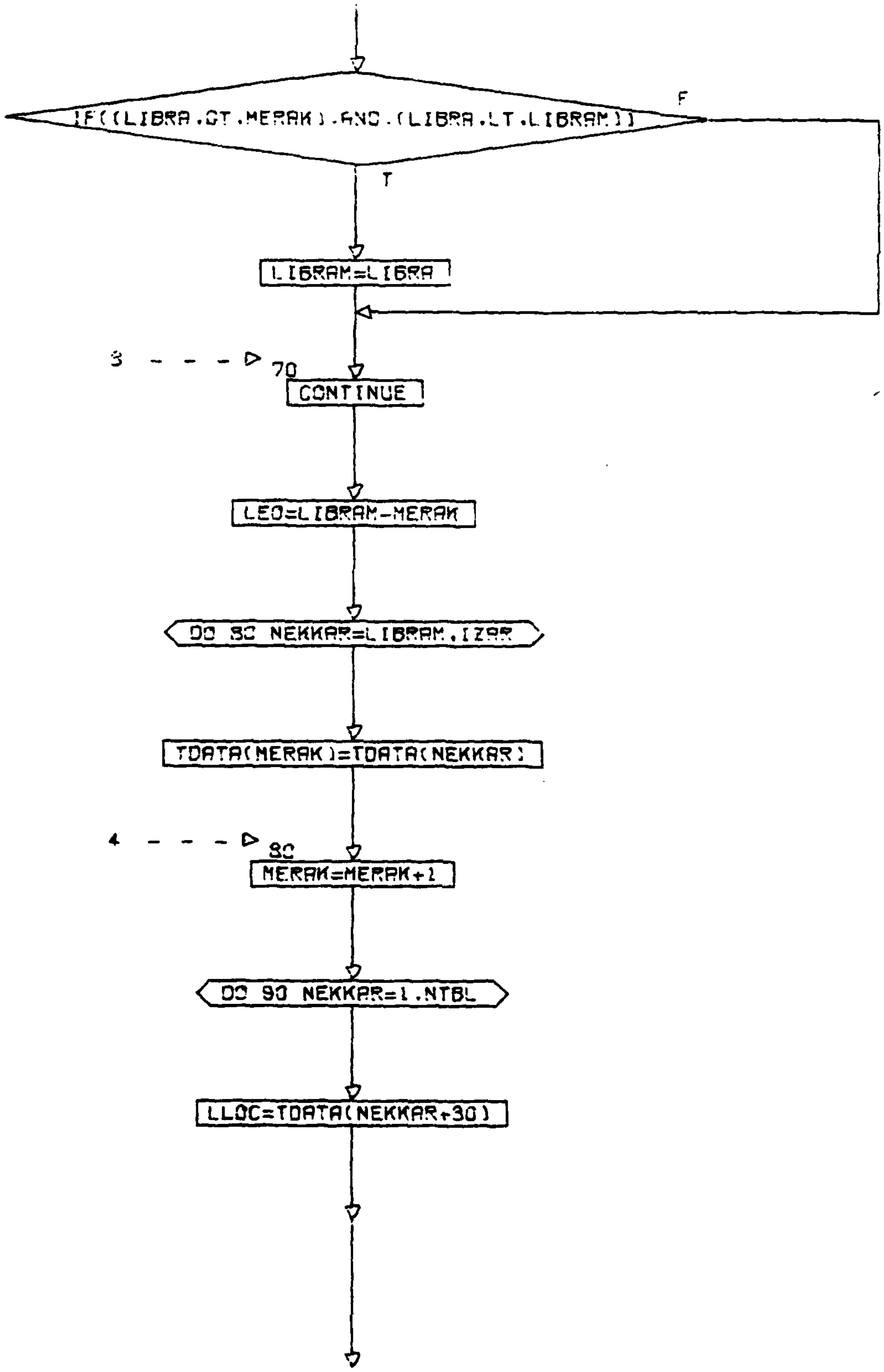
CONT. ON PG 2


ILAST=1
1
A1
A1
11
20
READ 30, IP,ITABNC
FORMAT (I1,I4,75H
IF(ITABNC.EQ.0)
F
T
GO TO 110
5
A4
NTBL = NTBL+1
ENIF=TDATA(NTBL)=ITABNO
TDATA(NTBL+30)=LOC
A2
18
40
IF(NTBL.LE.1)
F
3
A3
T
GO TO 210
9
A3

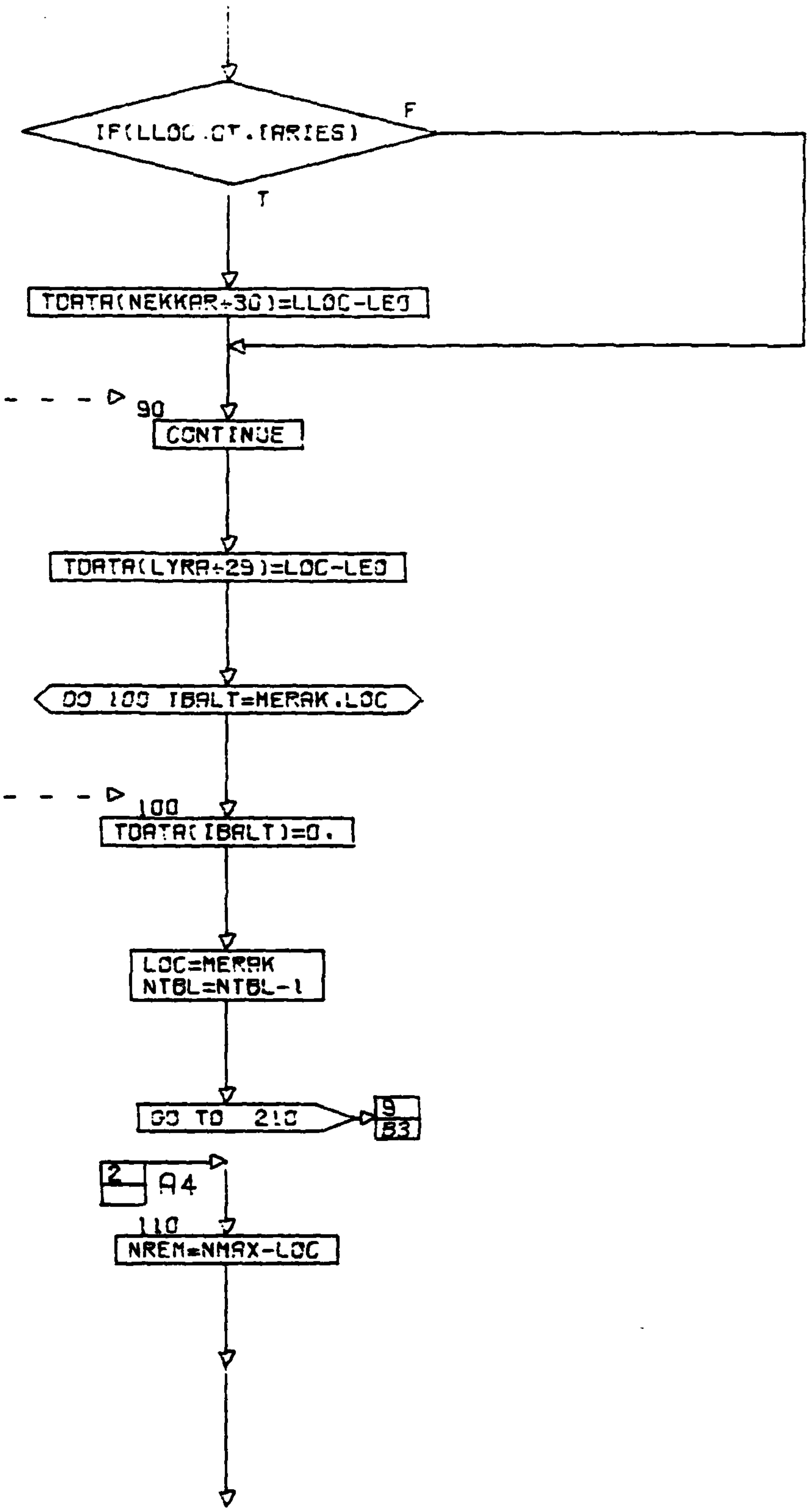
CONT. ON PG 3


2
A3
DO 50 LYRA=2,NTBL
IF(ENIF.EQ.TDATA(LYRA-1))
F
T
GO TO 60
3
50
CONTINUE
GO TO 210
9
53
60
IARIES=NERAK=TDATA(LYRA+29)
MRIGEL=MRIGEL+1
SIRIUS(MRIGEL)=ENIF
LIBRAM=100000
IZAR=LOC-1
DO 70 IRK=1,NTBL
LIBRA=TDATA(IRK+30)

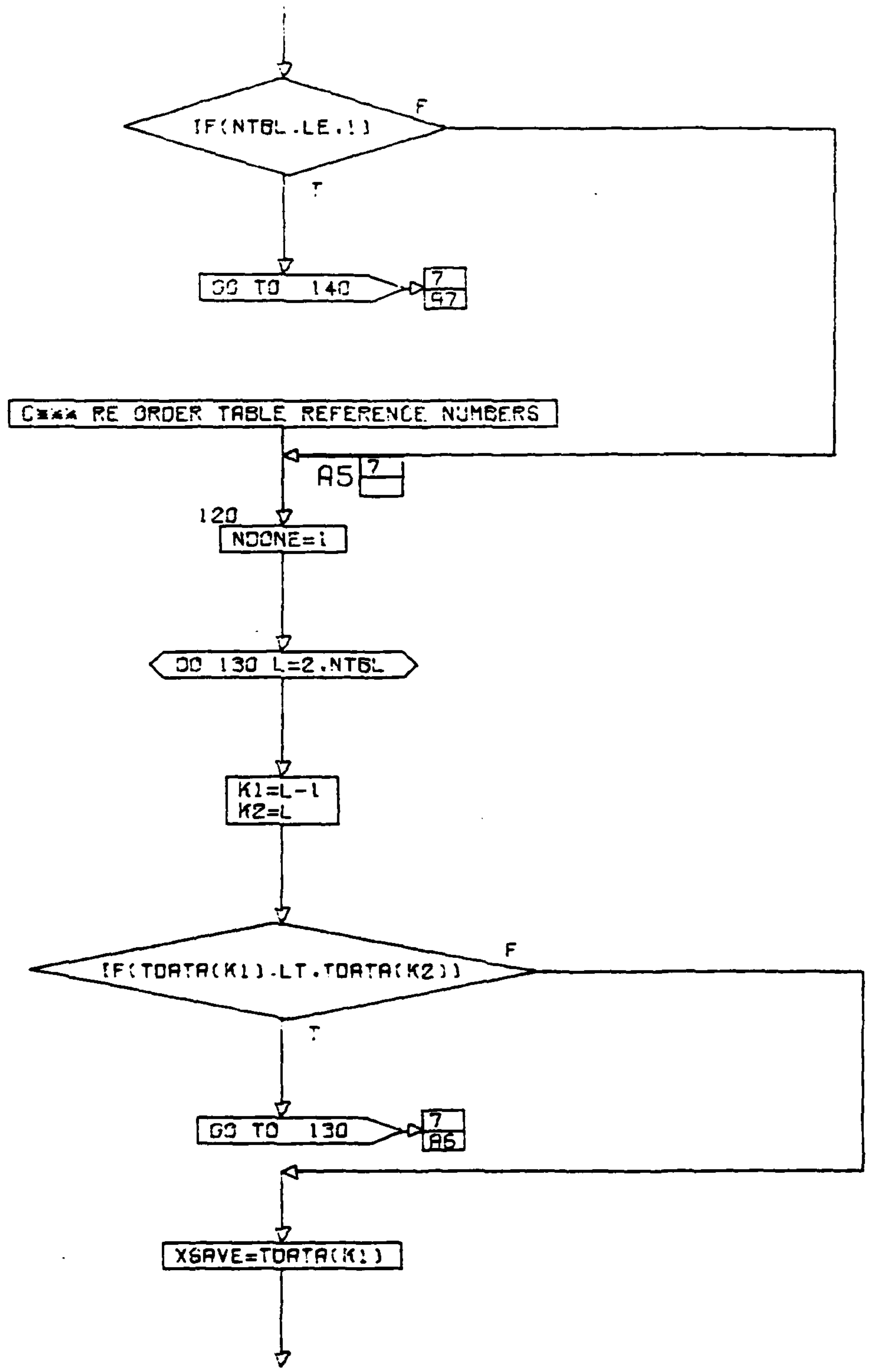
CONT. ON PG 4


IF((LIBRA.GT.MERAK).AND.(LIBRA.LT.LIBRAM))
F
T
LIBRAM=LIBRA
3
70
CONTINUE
LEO=LIBRAM-MERAK
DO 80 NEKKAR=LIBRAM,IZAR
TDATA(MERAK)=TDATA(NEKKAR)
4
80
MERAK=MERAK+1
DO 90 NEKKAR=1,NTBL
LLOC=TDATA(NEKKAR+30)

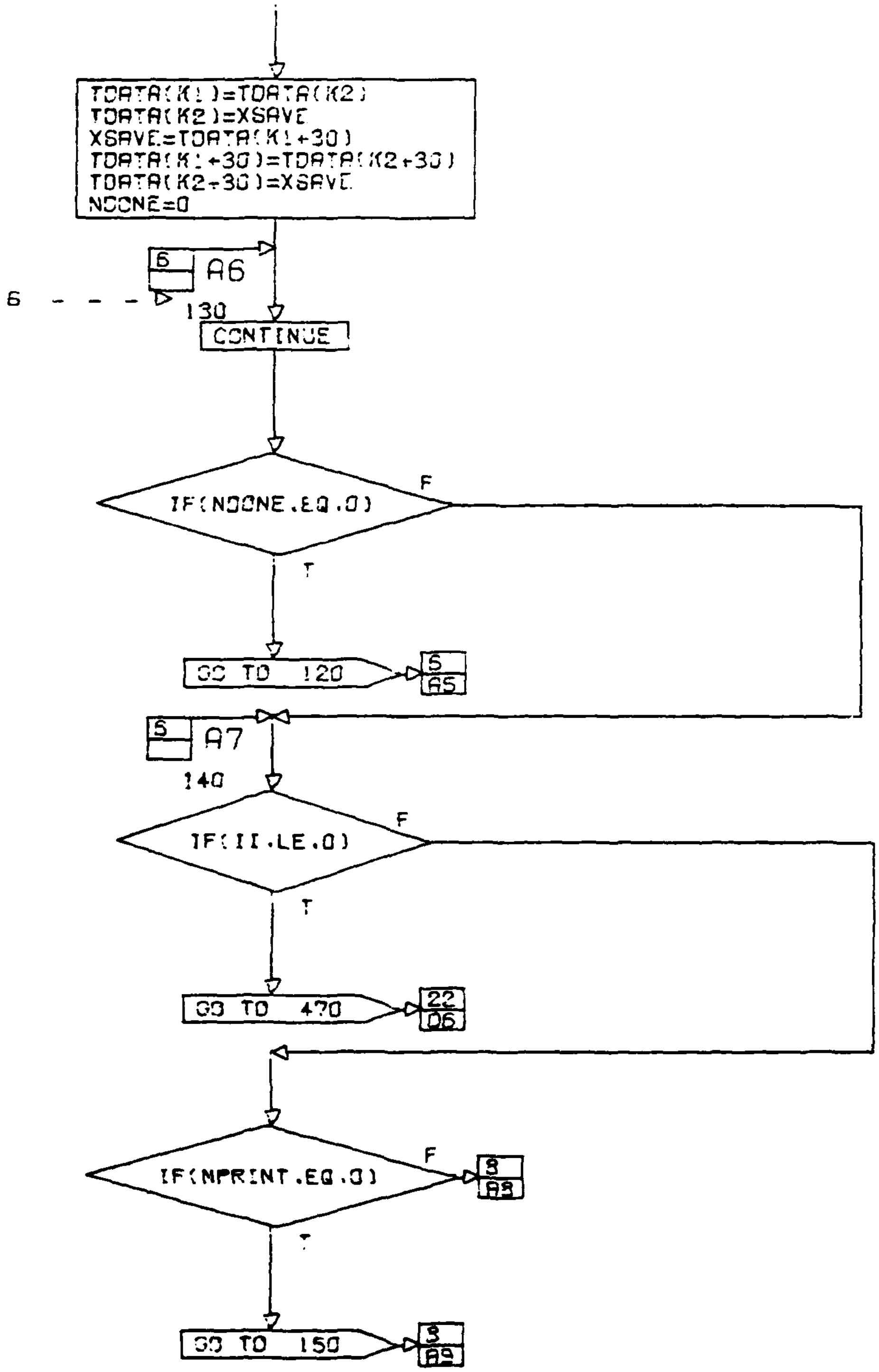
CONT. ON PG 5


IF(LLOC.GT.IARIES)
F
T
TDATA(NEKKAR+30)=LLOC-LEO
4
90
CONTINUE
TDATA(LYRA+29)=LOC-LEO
DO 100 IBALT=MERAK.LOC
6
100
TDATA(IBALT)=0.
LOC=MERAK
NTBL=NTBL-1
GO TO 210
9
B3
2
A4
110
NREM=NMAX-LOC

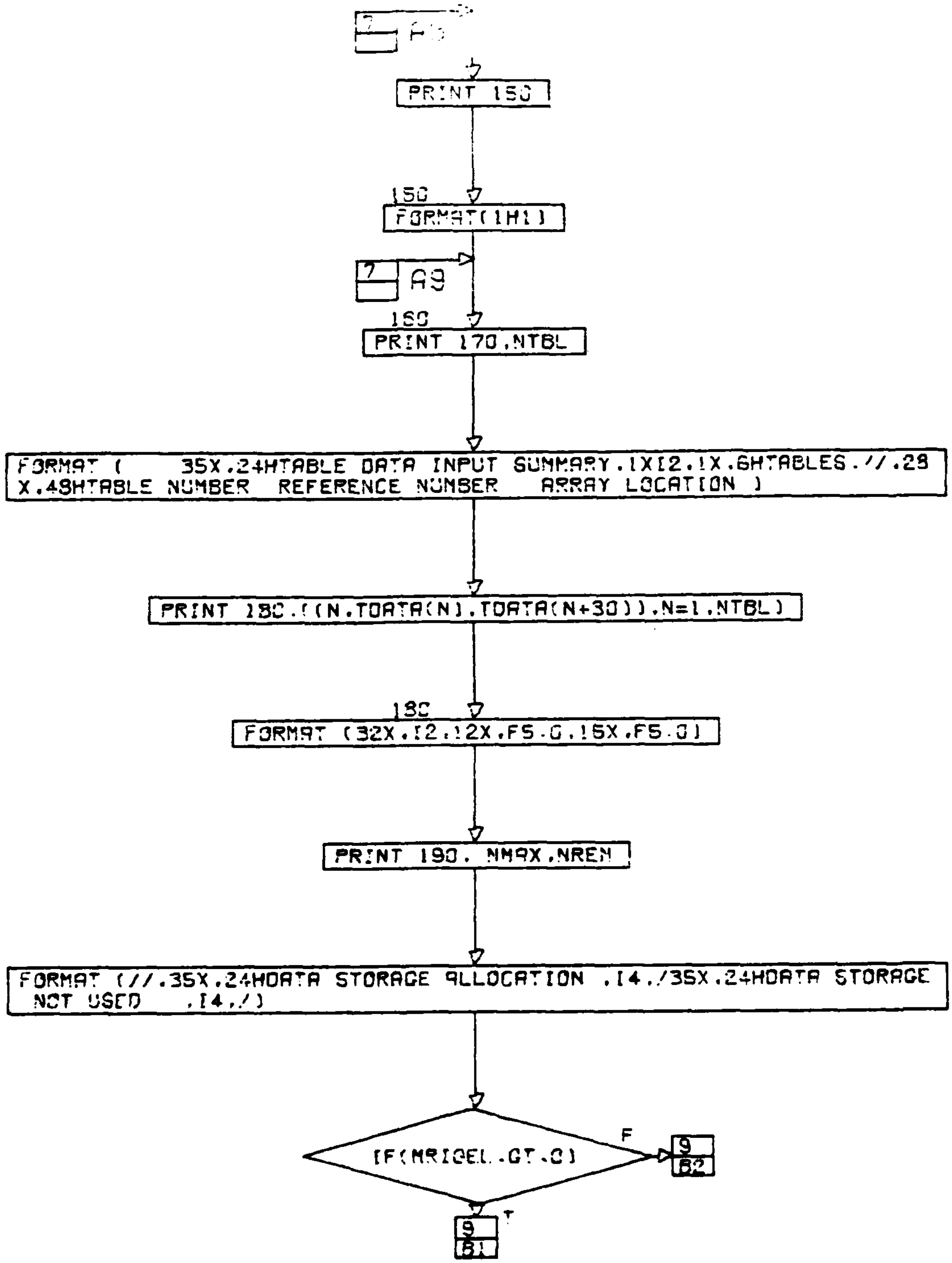
CONT. ON PG 6


IF(NTBL.LE.1)
F
T
GO TO 140
7
97
C*** RE ORDER TABLE REFERENCE NUMBERS
A5
7
120
NDONE=1
DO 130 L=2,NTBL
K1=L-1
K2=L
IF(TDATA(K1).LT.TDATA(K2))
F
T
GO TO 130
7
A6
XSAVE=TDATA(K1)

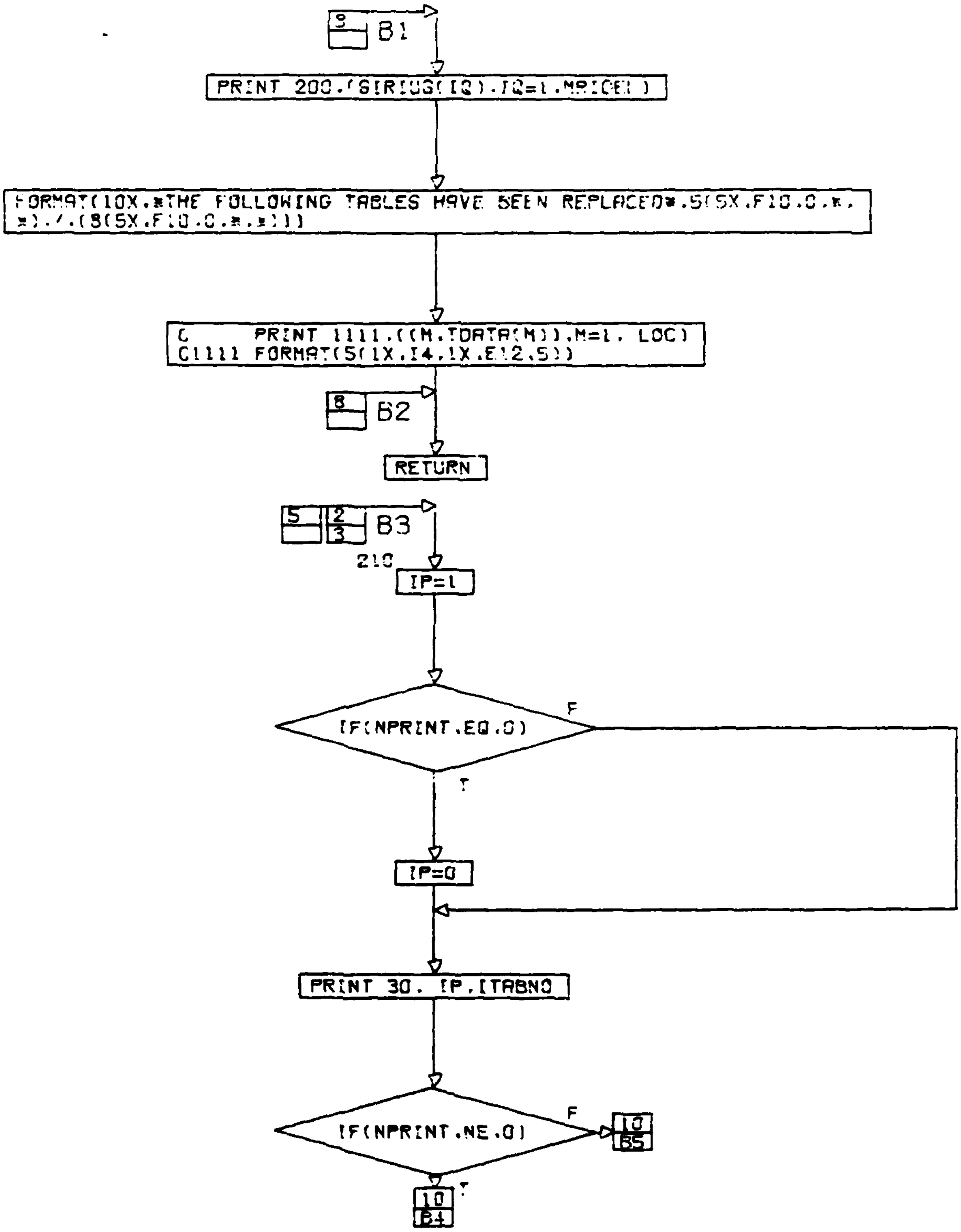
CONT. ON PG 7


TDATA(K1)=TDATA(K2)
TDATA(K2)=XSAVE
XSAVE=TDATA(K1+30)
TDATA(K1+30)=TDATA(K2+30)
TDATA(K2+30)=XSAVE
NDONE=0
6
A6
6
130
CONTINUE
IF(NDONE.EQ.0)
F
T
GO TO 120
6
A5
5
A7
140
IF(II.LE.0)
F
T
GO TO 470
22
D6
IF(NPRINT.EQ.0)
F
8
A8
T
GO TO 150
8
A9

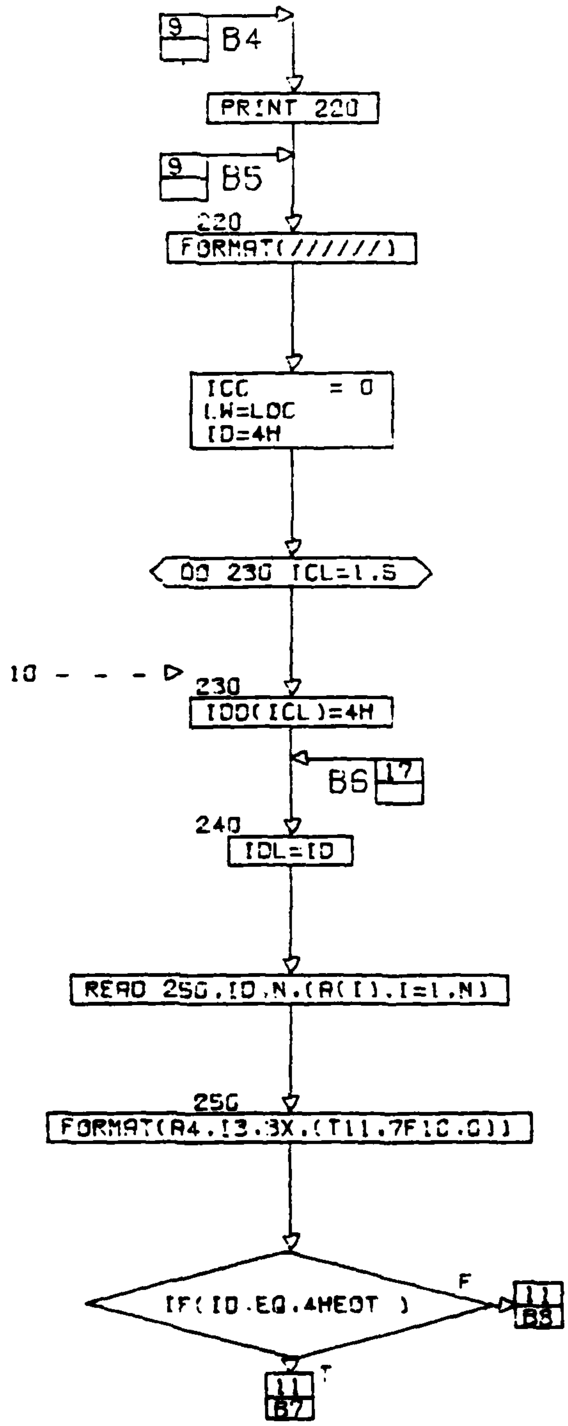
CONT. ON PG 8


7
PRINT 150
150
FORMAT(1H1)
7
A9
160
PRINT 170,NTBL
FORMAT (35X,24HTABLE DATA INPUT SUMMARY,1XI2,1X,6HTABLES,//,28
X,48HTABLE NUMBER REFERENCE NUMBER   ARRAY LOCATION)
PRINT 180,((N,TDATA(N),TDATA(N+30)),N=1,NTBL)
180
FORMAT (32X,I2,12X,F5.0,15X,F5.0)
PRINT 190, NMAX,NREM
FORMAT (//,35X,24HDATA STORAGE ALLOCATION ,I4,/35X,24HDATA STORAGE
NOT USED   ,I4,/)
IF(MRIGEL.GT.0)
F
9
B2
T
9
B1

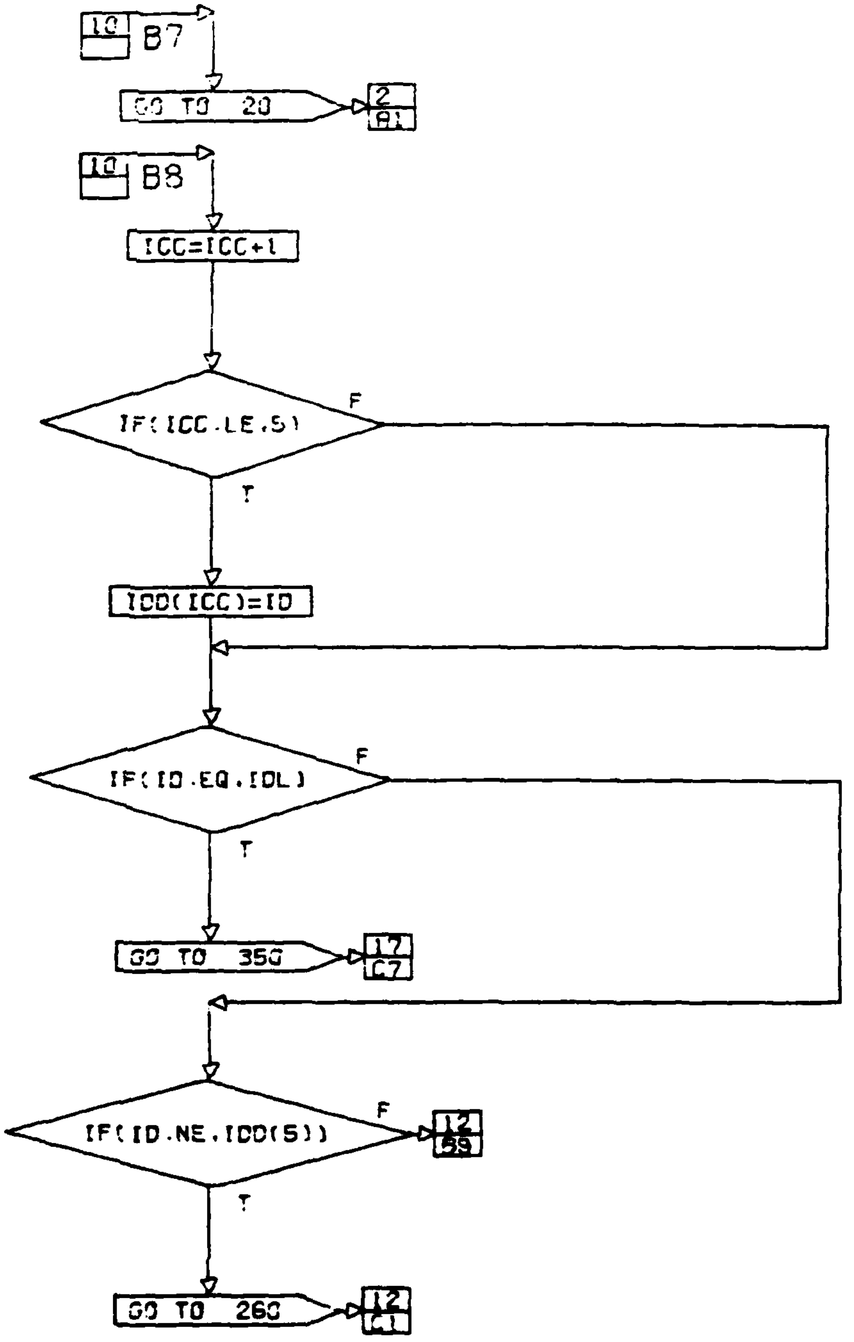
CONT. ON PG 9


9
B1
PRINT 200.(SIRIUS(IQ).IQ=1.MPRICE)
FORMAT(10X.*THE FOLLOWING TABLES HAVE BEEN REPLACED*.5(5X.F10.0.*.
)./.(8(5X.F10.0..*)))
C PRINT 1111.((M.TDATA(M)).M=1. LOC)
C1111 FORMAT(5(1X.I4.1X.E12.5))
8
B2
RETURN
5
2
3
B3
210
IP=1
IF(NPRINT.EQ.0)
F
T
IP=0
PRINT 30. IP.ITABNO
IF(NPRINT.NE.0)
F
10
B5
T
10
B4

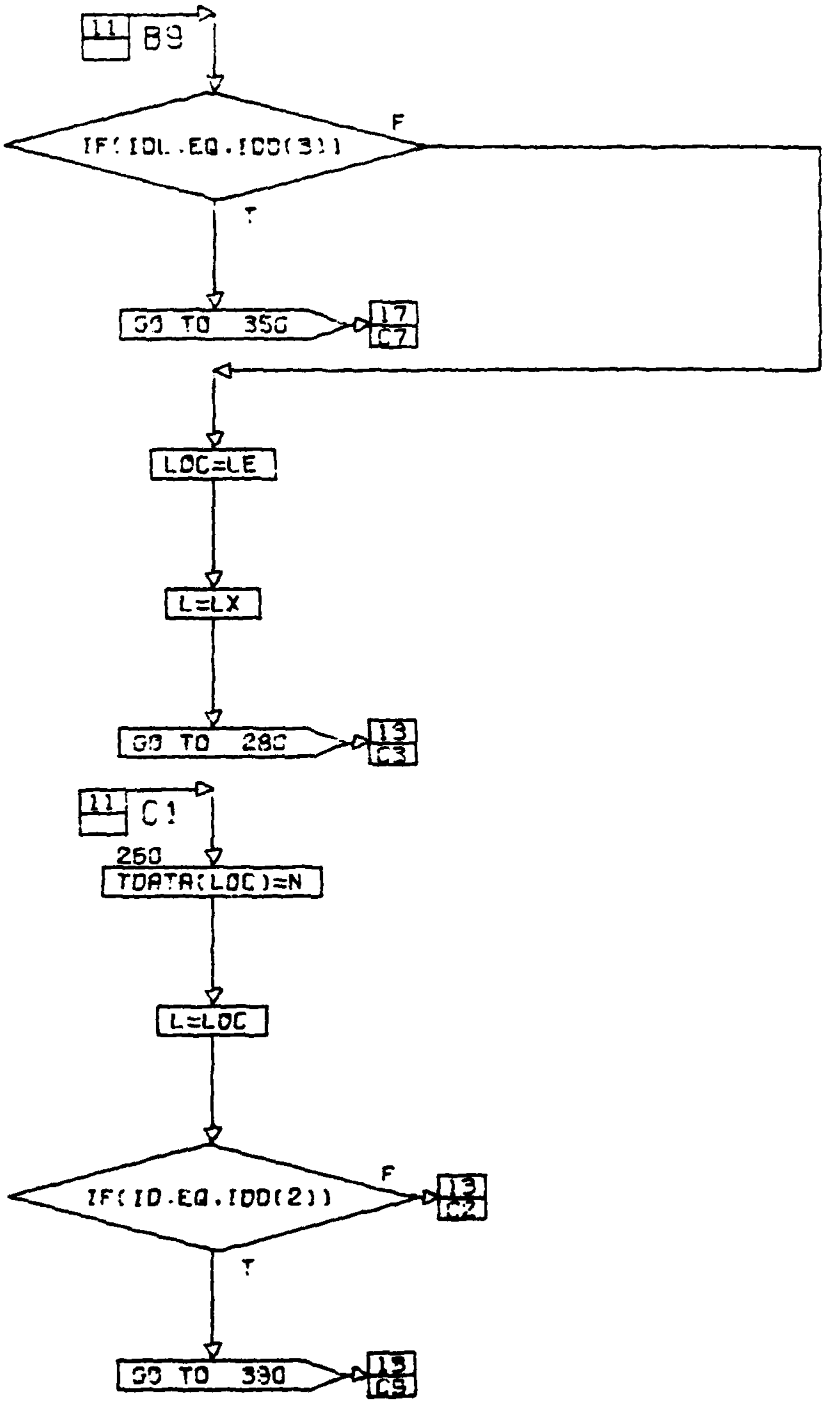
CONT. ON PG 10


9 B4
PRINT 220
9 B5
220
FORMAT(//////)
ICC = 0
LW=LOC
ID=4H
DO 230 ICL=1,5
10
230
IDD(ICL)=4H
B6 17
240
IDL=ID
READ 250,ID,N,(A(I),I=1,N)
250
FORMAT(A4,I3,3X,(T11,7F10.0))
IF(ID.EQ.4HEOT)
F
11 B8
T
11 B7

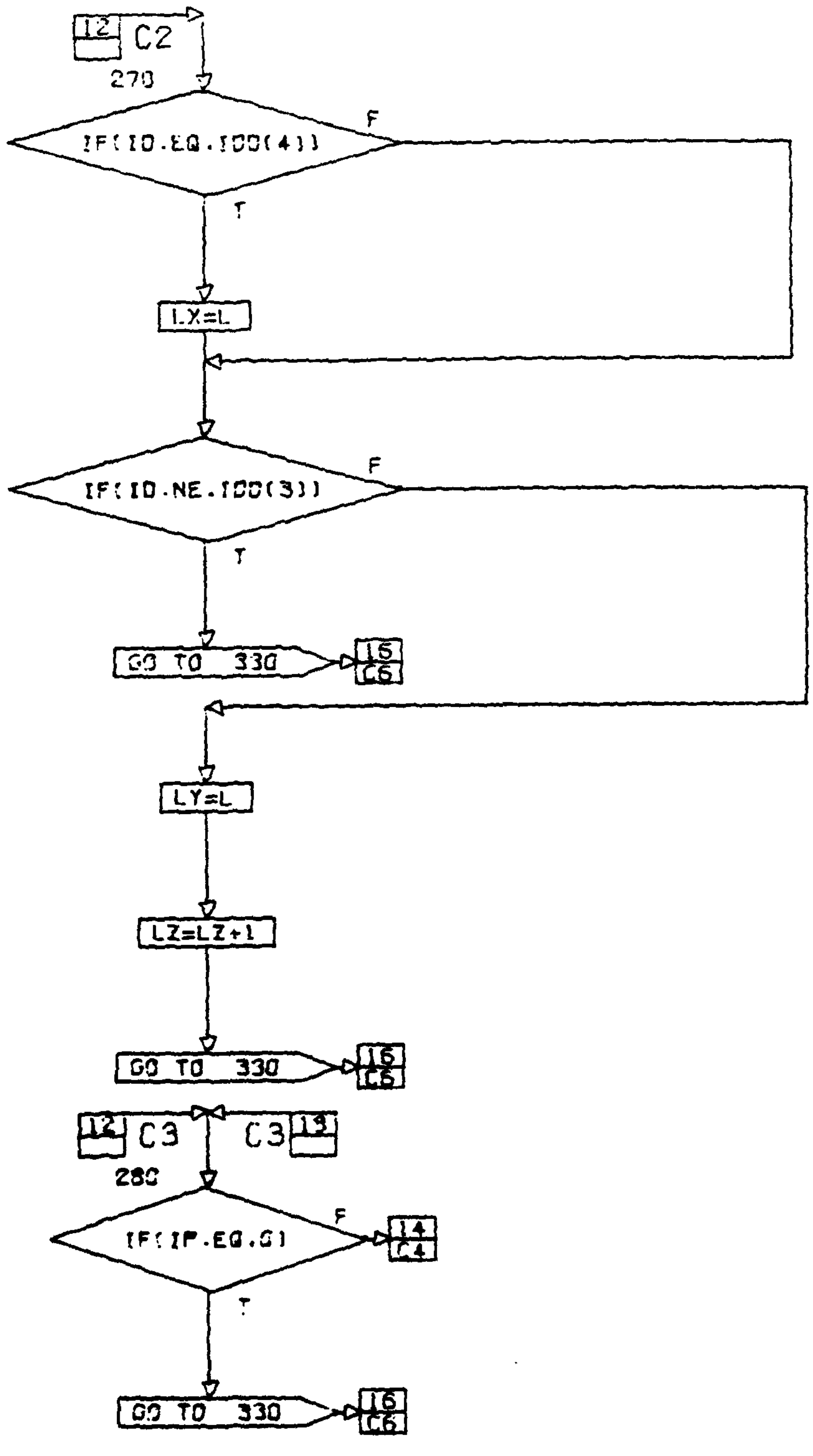
CONT. ON PG 11


10
B7
GO TO 20
2
A1
10
B8
ICC=ICC+1
IF(ICC.LE.5)
F
T
IDD(ICC)=ID
IF(ID.EQ.IDL)
F
T
GO TO 350
17
C7
IF(ID.NE.IDD(5))
F
12
B9
T
GO TO 260
12
C1

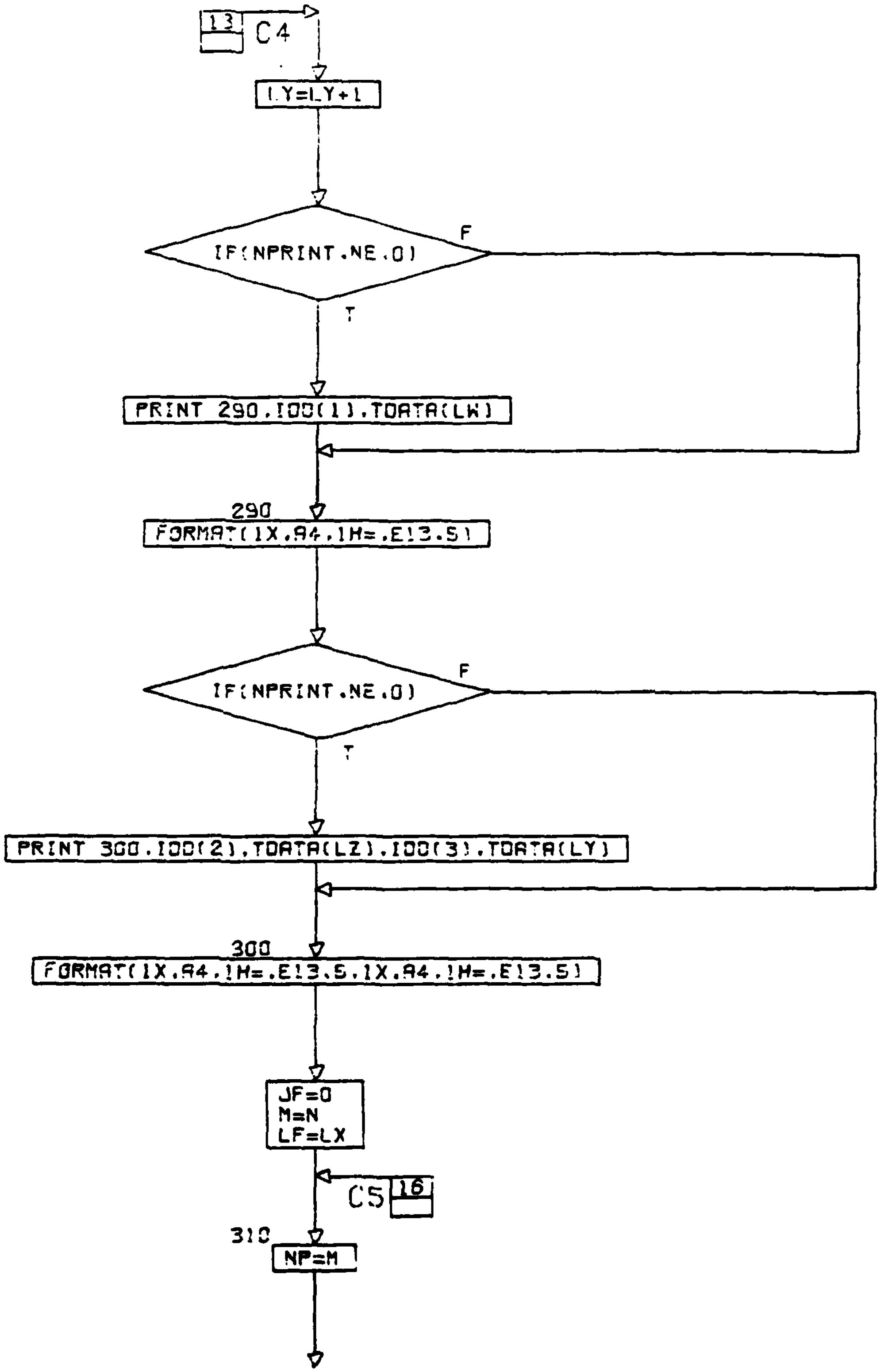
CONT. ON PG 12


11
B9
IF(IDL.EQ.IDD(3))
F
T
GO TO 350
17
C7
LOC=LE
L=LX
GO TO 280
13
C3
11
C1
260
TDATA(LOC)=N
L=LOC
IF(ID.EQ.IDD(2))
F
13
C2
T
GO TO 390
15
C5

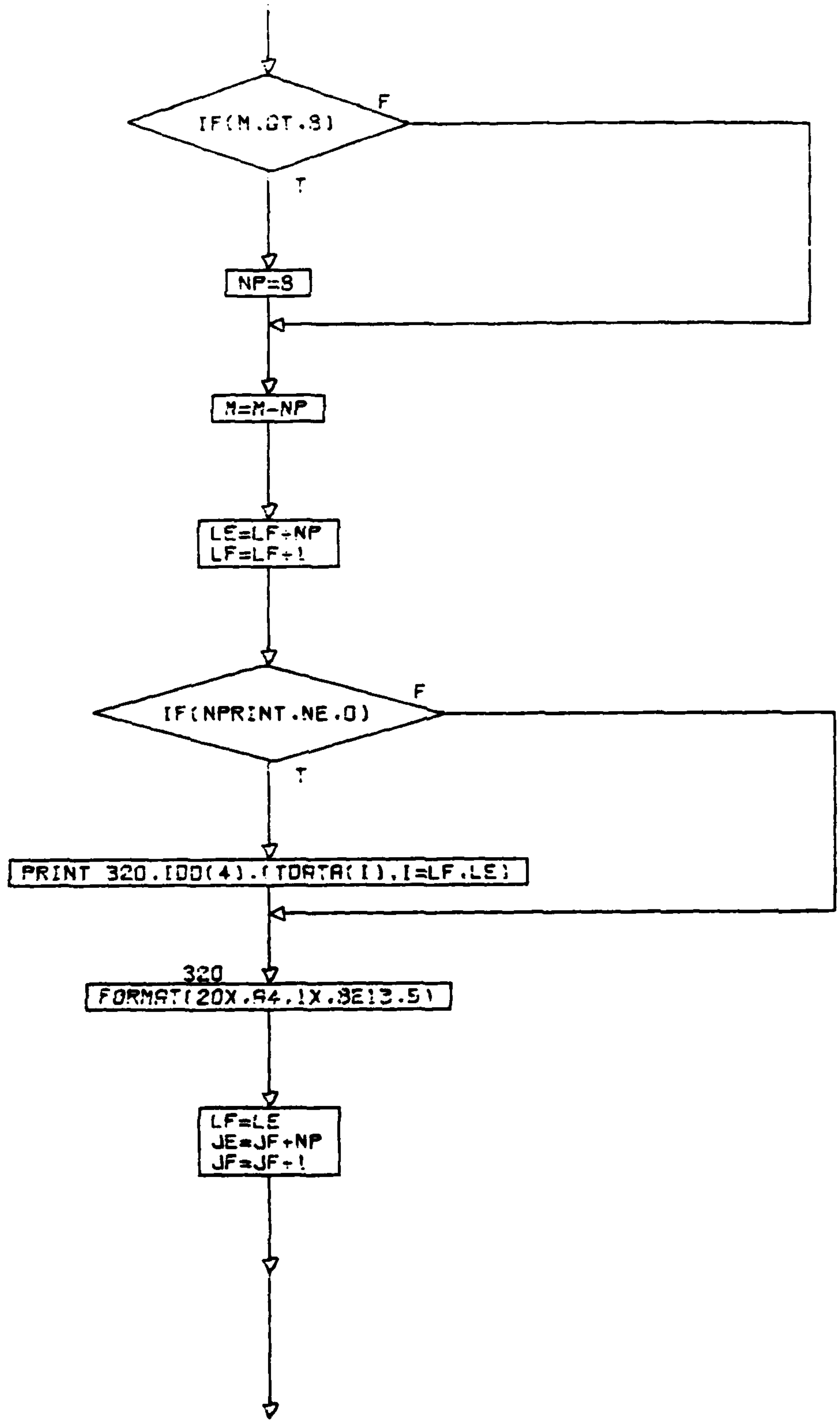
CONT. ON PG 13


12
C2
270
IF(ID.EQ.IDD(4))
F
T
LX=L
IF(ID.NE.IDD(3))
F
T
GO TO 330
15
C6
LY=L
LZ=LZ+1
GO TO 330
16
C6
12
C3
C3
13
280
IF(IP.EQ.0)
F
14
C4
T
GO TO 330
16
C6

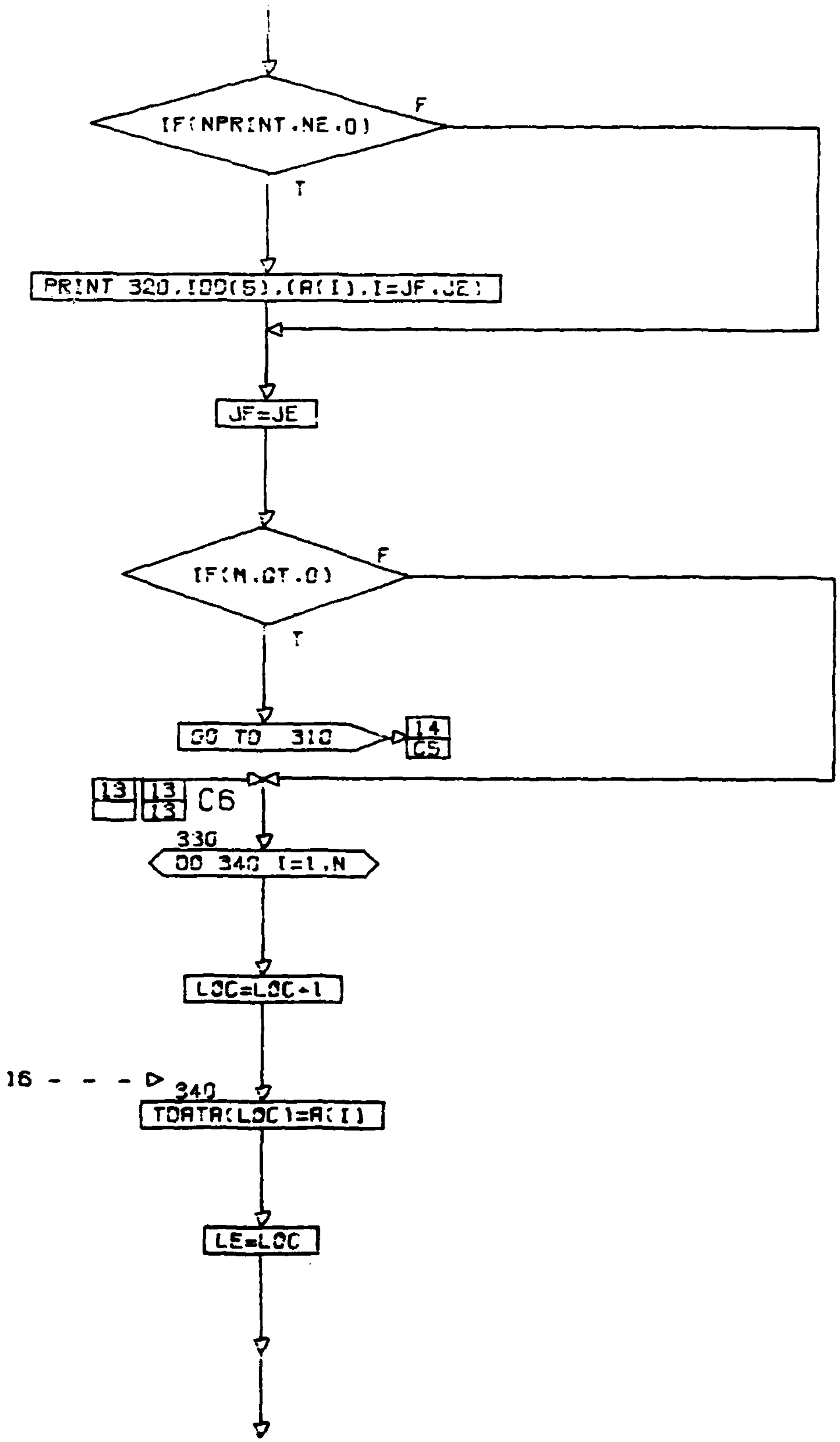
CONT. ON PG 14


13
C4
LY=LY+1
IF(NPRINT.NE.0)
F
T
PRINT 290,IDD(1),TDATA(LW)
290
FORMAT(1X,A4,1H=,E13.5)
IF(NPRINT.NE.0)
F
T
PRINT 300,IDD(2),TDATA(LZ),IDD(3),TDATA(LY)
300
FORMAT(1X,A4,1H=,E13.5,1X,A4,1H=,E13.5)
JF=0
M=N
LF=LX
C5
16
310
NP=M

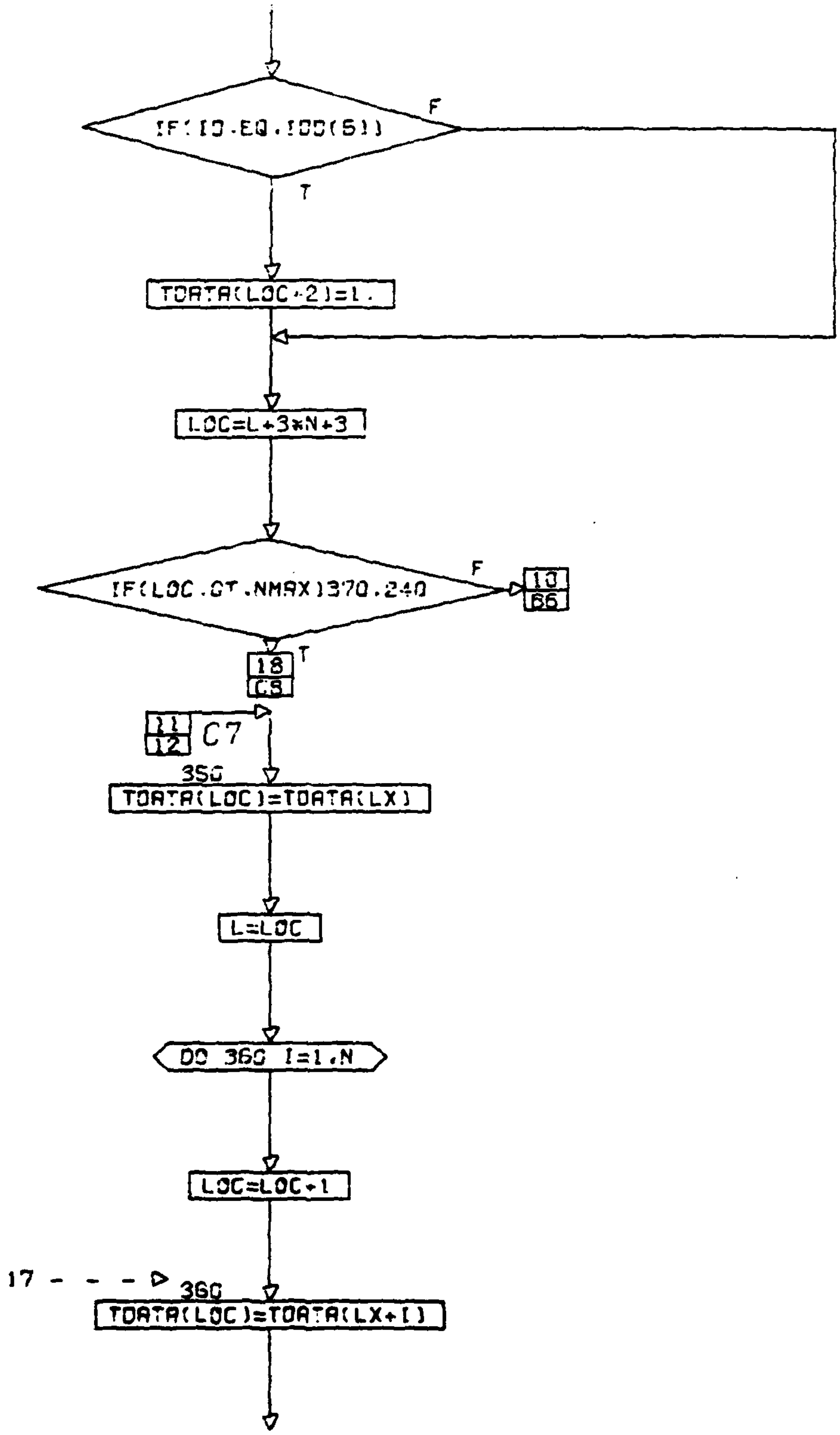
CONT. ON PG 15


IF(M.GT.8)
F
T
NP=8
M=M-NP
LE=LF+NP
LF=LF+1
IF(NPRINT.NE.0)
F
T
PRINT 320,IDD(4),(TDATA(I),I=LF,LE)
320
FORMAT(20X,A4,1X,8E13.5)
LF=LE
JE=JF+NP
JF=JF+1

CONT. ON PG 16

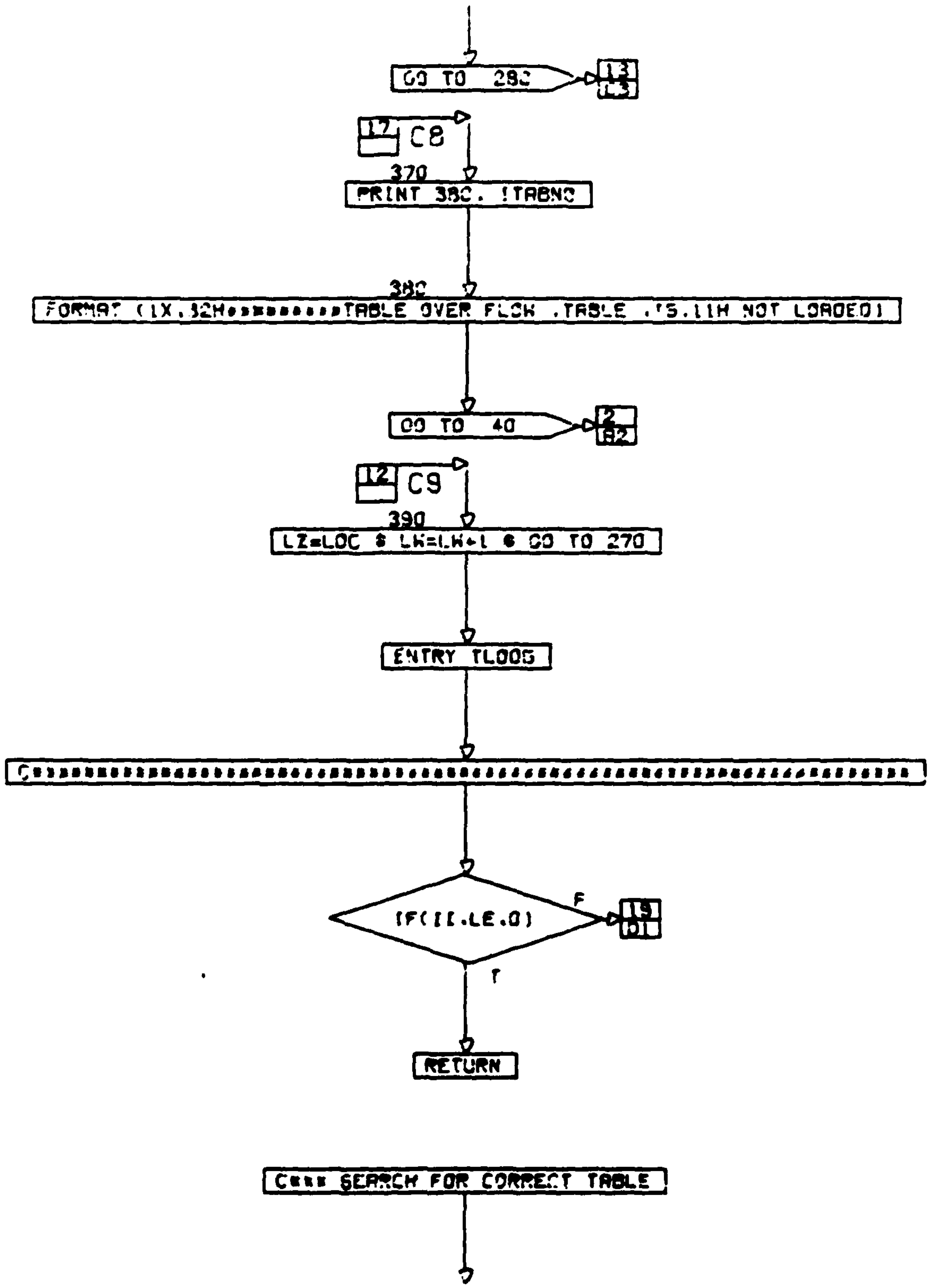

IF(NPRINT.NE.0)
F
T
PRINT 320,IDD(5),(A(I),I=JF,JE)
JF=JE
IF(N.GT.0)
F
T
GO TO 310
14
C5
13
13
13
C6
330
DO 340 I=1,N
LOC=LOC+1
16
340
TDATA(LOC)=A(I)
LE=LOC

CONT. ON PG 17

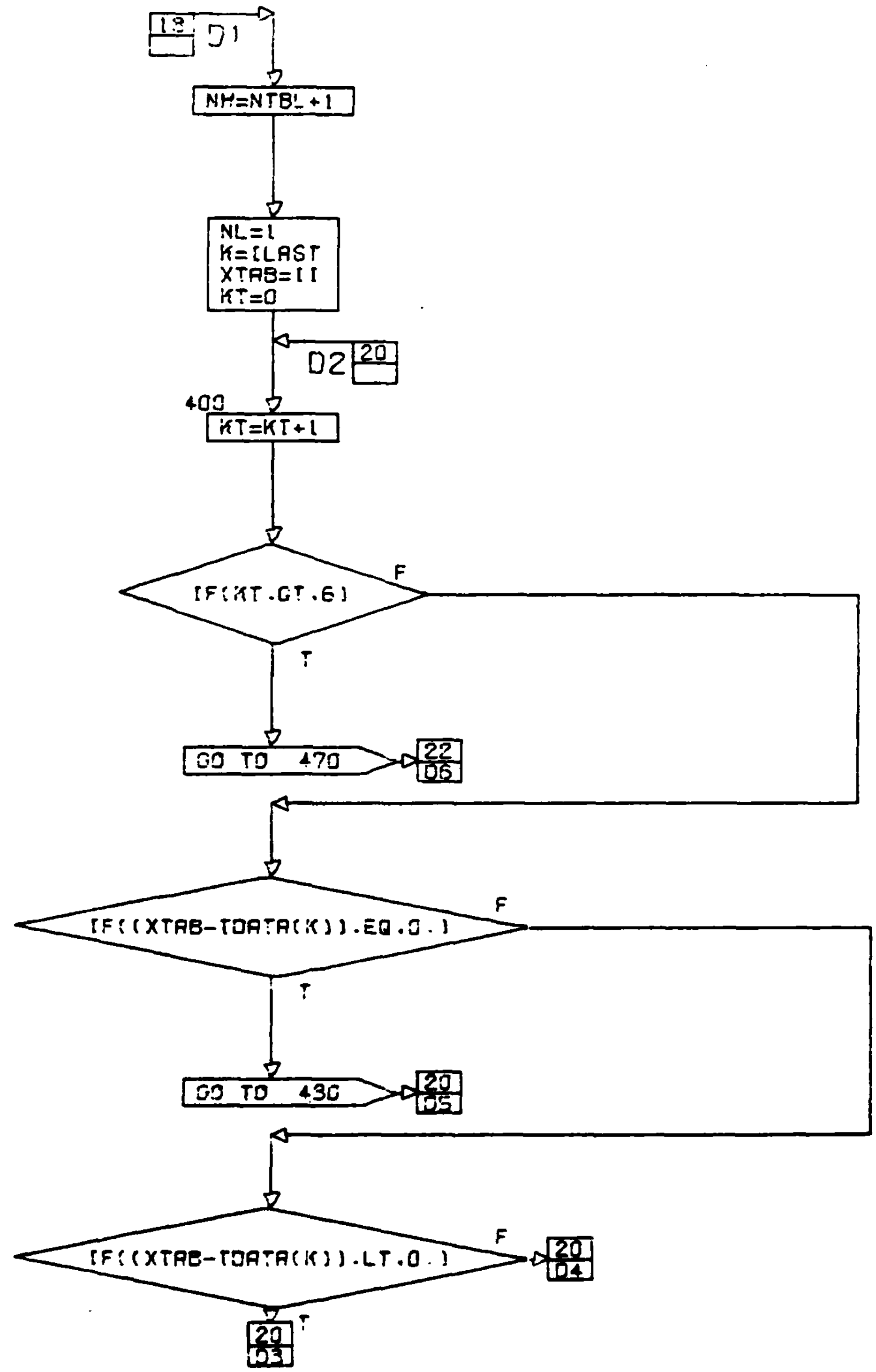


IF(ID.EQ.IDD(5))
F
T
TDATA(LOC+2)=1.
LOC=L+3*N+3
IF(LOC.GT.NMAX)370,240
F
10
B6
T
18
C8
11
12
C7
350
TDATA(LOC)=TDATA(LX)
L=LOC
DO 360 I=1,N
LOC=LOC+1
17
360
TDATA(LOC)=TDATA(LX+I)

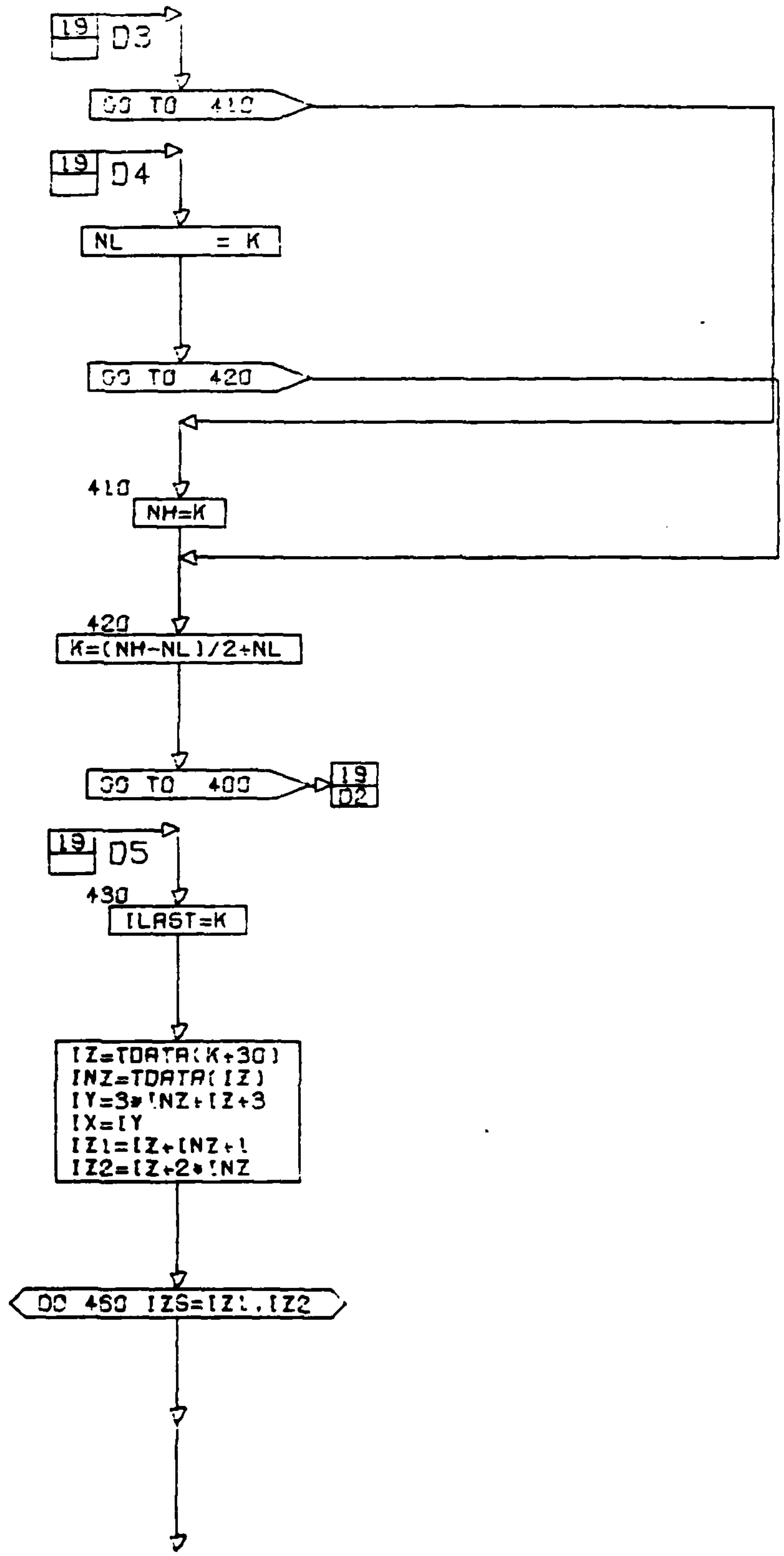
CONT. ON PG 18


GO TO 280
13
L3
17
C8
370
PRINT 380, ITABNO
380
FORMAT (1X,32H********TABLE OVER FLOW ,TABLE ,I5,11H NOT LOADED)
GO TO 40
2
B2
12
C9
390
LZ=LOC $ LW=LW+1 $ GO TO 270
ENTRY TLOOS
C**
IF(II.LE.0)
F
19
D1
T
RETURN
C*** SEARCH FOR CORRECT TABLE

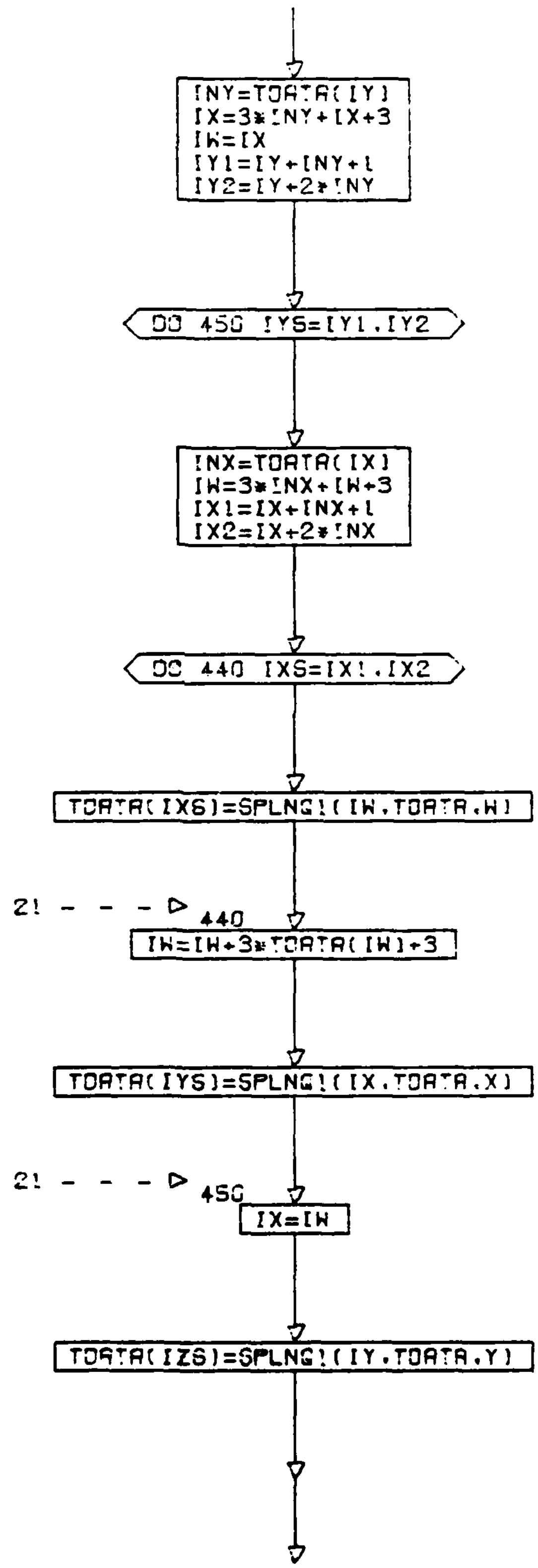
CONT. ON PG 19


19 D1
NH=NTBL+1
NL=1
K=ILAST
XTAB=II
KT=0
D2 20
400
KT=KT+1
IF(KT.GT.6)
F
T
GO TO 470
22
06
IF((XTAB-TDATA(K)).EQ.0.)
F
T
GO TO 430
20
05
IF((XTAB-TDATA(K)).LT.0.)
F
20
04
T
20
03

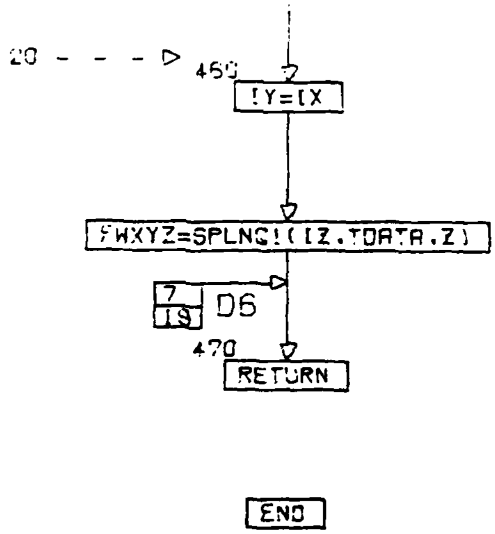
CONT. ON PG 20


19
D3
GO TO 410
19
D4
NL = K
GO TO 420
410
NH=K
420
K=(NH-NL)/2+NL
GO TO 400
19
D2
19
D5
430
ILAST=K
IZ=TDATA(K+30)
INZ=TDATA(IZ)
IY=3*INZ+IZ+3
IX=IY
IZ1=IZ+INZ+1
IZ2=IZ+2*INZ
DO 460 IZS=IZ1,IZ2

CONT. ON PG 21


INY=TDATA(IY)
IX=3*INY+IX+3
IW=IX
IY1=IY+INY+1
IY2=IY+2*INY
DO 450 IYS=IY1,IY2
INX=TDATA(IX)
IW=3*INX+IW+3
IX1=IX+INX+1
IX2=IX+2*INX
DO 440 IXS=IX1,IX2
TDATA(IX6)=SPLNG1(IW,TDATA,W)
21 - - - 440
IW=IW+3*TDATA(IW)+3
TDATA(IYS)=SPLNG1(IX,TDATA,X)
21 - - - 450
IX=IW
TDATA(IZS)=SPLNG1(IY,TDATA,Y)

CONT. ON PG 22



PG 22 FINAL

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