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DYLOFLEX Modifications to FLEXSTAB

(FLEXSTAB Volume II - User's Manual)
(FLEXSTAB Volume III - Programmer's Manual)

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INTRODUCTION

This document describes the required changes made to the SD&SS program of the FLEXSTAB Computer Program System allowing it to be interfaced with the DYLOFLEX Program System. The changes that were made for compatibility with DYLOFLEX were made to the 2.01 FLEXSTAB SD&SS program. The resulting SD&SS program version is compatible with the NASA ARC 1.02.00 FLEXSTAB CPS. Appendix A of this document describes the changes to specific pages in the FLEXSTAB User's Manual (NASA CR-114714). Appendix B describes the changes to specific pages in the FLEXSTAB Programmer's Manual (NASA CR-114715). These pages may be directly incorporated into the aforementioned FLEXSTAB documents giving the DYLOFLEX user complete documentation that is compatible to the DYLOFLEX special version of the SD&SS program.

Additional options.—In addition to the eight basic options of table 9.2-1, there are several more important options. These are included as card sections headed by the following Data Control Cards:

$MATRIX PRINT LIST	$DYNAMIC ANALYSIS
$SDSS MATRIX OUTPUT LIST	$EXTERIOR INFLUENCE DATA
$THRUST DATA	$STRUCTURAL DATA
$GYROSCOPIC DATA	$PRESSURE DATA
$ACTIVE CONTROLS DATA	$AREA RATIO DATA
$PERTURBATION DATA	$SPECIAL SDSS EXECUTION

These options are exercised by including the appropriate card section in the input card deck. A description of each option follows:

$MATRIX PRINT LIST: This option allows the printing of any matrix input to the SD&SS program or internally generated by the SD&SS program. A list of these matrices can be found in appendix B, vol. III. The user should take care when using this option because the matrix printout may require many pages (see sec. 3.6).

$SDSS MATRIX OUTPUT LIST: This option allows the user to select matrices to be stored on output tape SDSSTP *in addition* to those which are automatically stored. A list of matrices can be found in appendix B of volume III.

$THRUST DATA: This option is used whenever thrust is desired. The only case for which it may be omitted is gliding flight. Data included in this card section indicate where and in what direction the thrust vector (or vectors) is acting.

$GYROSCOPIC DATA: Gyroscopic information may be included only if thrust data are input. These data specify the gyroscopic effects of the engines, which may be constant or variable (with respect to thrust), depending upon the basic option used.

$ACTIVE CONTROL DATA: The user must select this option whenever active controls are used. SD&SS will calculate the derivatives due to active controls, print them, and finally store them on tape SDSSTP for subsequent use by the LSA and TH programs. SD&SS will reverse the sign of positive deflection for controls on the plane of symmetry.

$PERTURBATION DATA: When this card section is included, the SD&SS program will calculate the dynamic stability and control derivatives used to form the coefficients in the equations of motion for the $DYNAMIC ANALYSIS option (see below) and the TH program. Additional options can be exercised to calculate control effectivenesses, compressibility corrections for the speed and yaw rate derivatives, and unsteady Thin Body pressures. If the user so desires, provisions are included to replace either steady or unsteady (or both) stability derivatives with wind tunnel or handbook data. This card section should be included if the user is performing a residual-elastic analysis.

$DYNAMIC ANALYSIS: When this option is used, a linear dynamic analysis is performed by integrating the linearized form of the equations of motion. Since the equations are linear, their integrals are composed of exponentials and are generated by solving an eigenvalue problem. This process amounts to finding the roots of the characteristic equation obtained actual configuration geometry can be minimized by introducing a column of scalars that will multiply the panel area array. Thus, the calculated pressures can be made to act on the true configuration area. Note that this option can also be used to scale loads in order to better match wind tunnel data.

$SPECIAL SDSS EXECUTION: When the card section is included, the SD&SS program will calculate the aerodynamic influence coefficient matrix, $\left[A_{p_\Theta} \right]$, and store it onto the output tape SDSSTP.

Additional input. – In addition to the optional card sections mentioned above and the required $STABILITY PROBLEM DATA card section, there are two other card sections which are required for SD&SS execution. These are headed by the Data Control Cards &GENERAL SPECIFICATIONS and $CONTROL SURFACE DATA, or $TRIM CONTROL SURFACE DATA. The input to each is simple, but several minor points are explained in the following paragraphs.

$GENERAL SPECIFICATIONS: Included in the general specifications input on CARD 8 are ALT_{OP}, an altitude option, and $ALPHA_{OP}$, an angle of attack option. When ALT_{OP} is left blank the option is not used and the user must input the atmospheric conditions in which the airplane is flying. When ALT_{OP} = ALTITUDE, the user inputs the altitude, and the program computes the corresponding atmospheric data based on the *1962 U.S. Standard Atmosphere* (ref. 9-1). The user may specify a deviation from standard temperature. The $ALPHA_{OP}$ option may be used to set $\alpha = 0$ for all Slender Bodies off the plane of symmetry. This option was included so that the flow about nacelles that are shielded by a low aspect ratio wing can be more closely approximated. The theory is that the wing completely dominates the flow immediately below it. Therefore, the flow becomes parallel with the lower surface of the wing soon after passing the leading edge. The nacelle is also parallel to the wing lower surface, so it has $\alpha = 0$ with respect to its immediate flow field regardless of the angle of attack of the airplane. This is true only if the nacelle is well aft of the wing leading edge and well inboard of the wing tip.

ON CARD 10, the user has the option of inputting a "derived gust velocity," U_{de}, and a "gust magnification factor," MF (see sec. 5.7.3.3, vol. I). These parameters are used to calculate the load factor and structural loads due to a vertical gust during 1-g level flight. If this option is to be used, the airplane reference motion must be symmetric and stability problem 2 (CONSTANT) should be specified. The program trims the airplane model and then calculates an incremental angle of attack, $\Delta\alpha$, using the input values of U_{de} and MF (see equation 5.7-22, vol. I). Finally, the program automatically reexecutes in the Stability Problem = SPECIFIED mode, using the trim parameters from the previous case with the exception that angle of attack is now taken to be the sum of the trim angle of attack and $\Delta\alpha$.

$CONTROL SURFACE DATA or $TRIM CONTROL SURFACE DATA: This card section is required for every SD&SS run. If the user does not include any control surfaces on his model, he should define one in this section and then define its deflection angle as zero in the $STABILITY PROBLEM card section.

There are three types of control surfaces considered in this card section: elevator (or longitudinal), aileron, and rudder. When an elevator is specified, the program assumes an identical control surface on the opposite side of the plane of symmetry that deflects identically. When an aileron is specified the program assumes an identical control surface on the opposite side of the plane of symmetry that deflects oppositely. The program assumes that a rudder is identical to an aileron except for a sign reversal of positive deflection. Positive control surface deflections are defined according to the standard convention, i.e., elevator and aileron deflections (on the right wing) are positive in the sense of right-handed rotations about the Y_N-axes of the Thin Bodies on which they are defined.

For symmetric reference motion, a longitudinal control device *must* be defined. For coupled reference motion, an aileron and rudder *must also* be defined.

Active and trim control surfaces are not restricted to one body. However, due to theoretical limitations, if there is more than one control surface for a given motion, the surfaces cannot be independent. The relative participation parameter, S, provides the link of dependency. As an example, consider an airplane with two longitudinal control surfaces: a canard and an elevator. Both bodies are defined as one longitudinal control surface. The relative participation is then determined by S. If the canard surface has S = 0.5 and the elevator has S = 1.0, the canard will deflect 0.5° for every degree of deflection for the elevator. With variations of this principle one can define inboard and outboard ailerons, tab surfaces, and geared multisurface rudders.

It should be stated here that the trim control surfaces are assumed to be fixed when computing airplane stability, even though some of these same controls may also be used in the $ACTIVE CONTROL DATA section.

9.2.2 Data Deck Format

The general arrangement of the SD&SS data deck is shown in figure 9.2-1. Figures 9.2-2 through 9.2-15 illustrate portions of the deck in more detail. Table 9.2-3 gives the purpose of each block of input data and indicates whether it is required or optional.

Beginning cards.—The data case begins with the following three cards (see fig. 9.2-1):

Columns	Descriptor	Explanation
		CARD 1 (Format A4,6X,15A4)
1-10 11-70	$CASE FOR STABILITY DERIVATIVES AND STATIC STABILITY PROGRAM	Data Control Card—Identifies start of a data case. The first four columns must contain $CAS. Name of program (optional) or any other label; this is reproduced on the title page of the printout.
		CARD 2 (Format 18A4)
1-72	Case Identification	Case identification; the user is free to input any information he desires. This information is reproduced on every page of the printout.
		CARD 3 (Format 18A4)
1-72	User Identification	User identification; the user is free to input any information he desires. This information is reproduced on the title page of the printout.

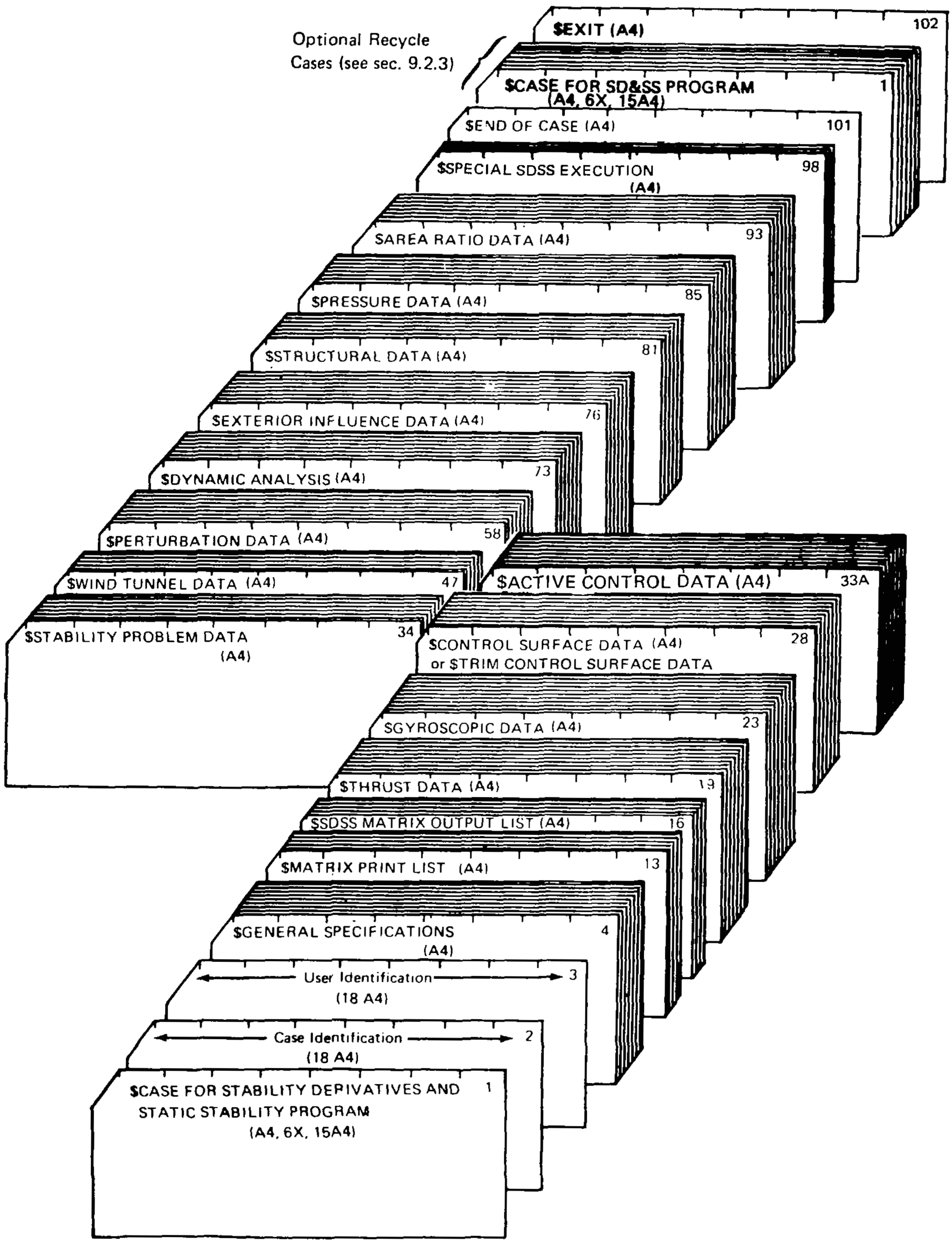


FIGURE 9.2-1.–DATA CARD ARRANGEMENT OF THE SD&SS DATA DECK

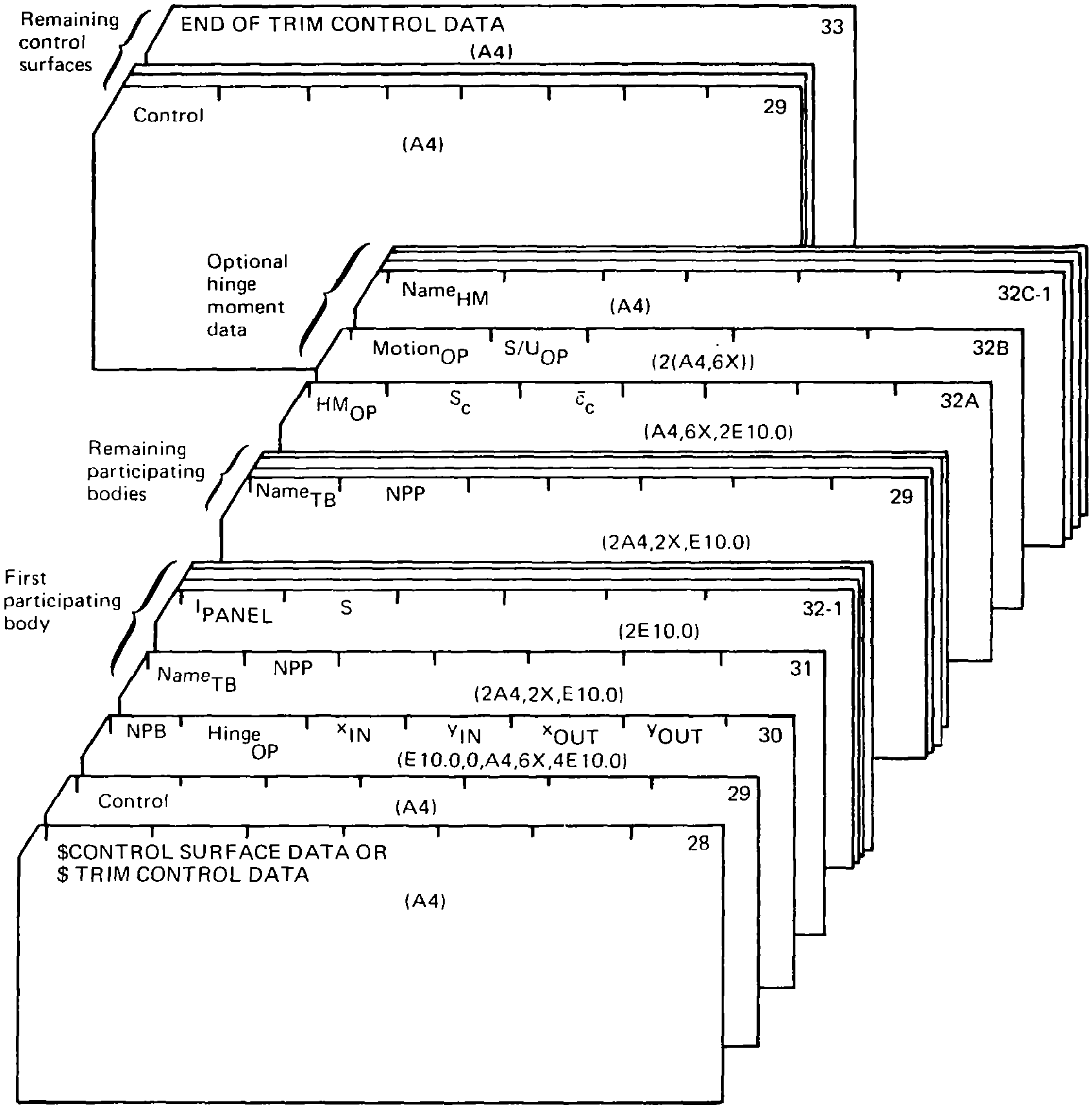


FIGURE 9.2-7—DATA CARD ARRANGEMENT OF CONTROL SURFACE DATA

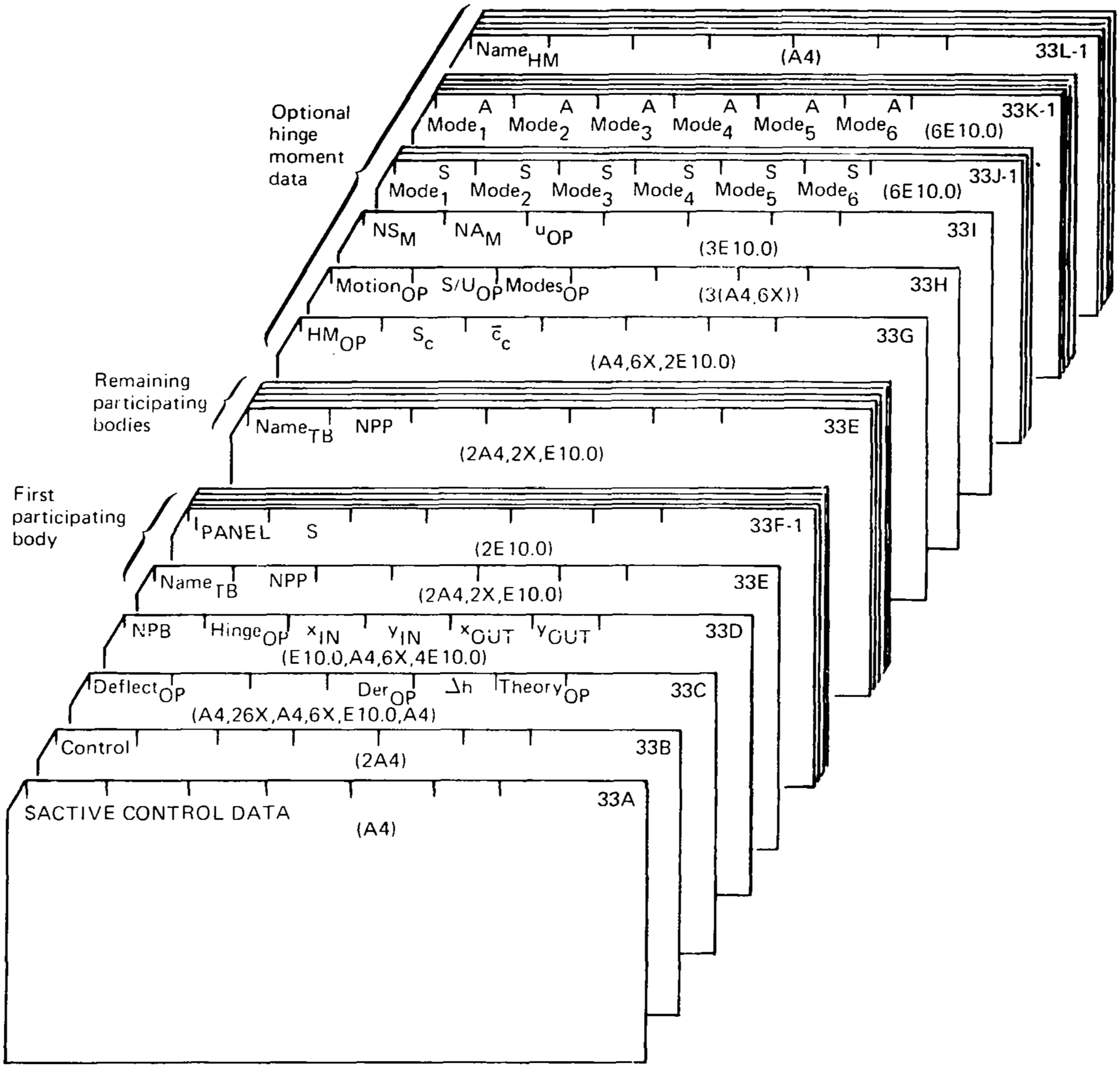


FIGURE 9.2-7a—DATA CARD ARRANGEMENT OF ACTIVE CONTROL DATA

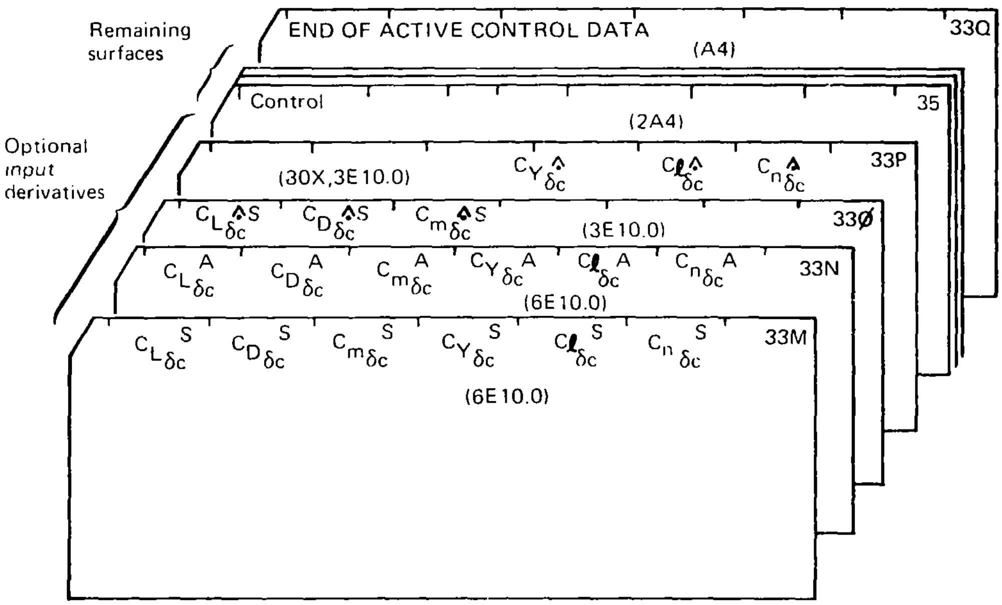


FIGURE 9.2-7a—CONCLUDED

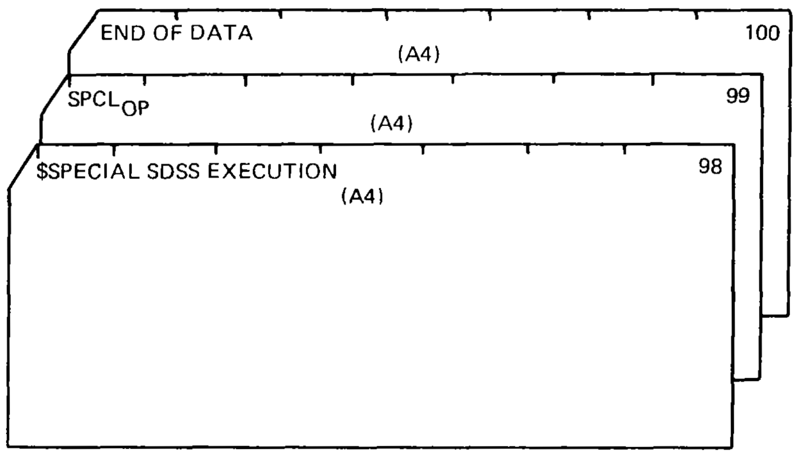


FIGURE 9.2-15A.—DATA CARD ARRANGEMENT OF SPECIAL SDSS EXECUTION DATA

TABLE 9.2-3.—BLOCKS OF DATA FOR THE SD&SS PROGRAM

Data Control Card	Card numbers	Purpose	Required or optional	Relationship to	
				Other blocks of data	Other programs
$CASE FOR SD&SS PROGRAM	1-3	To identify the start of the initial data case	Required	–	–
$GENERAL SPECIFICATIONS	4-12	To specify key input options and flight conditions	Required	–	–
$MATRIX PRINT LIST	13-15	To print any matrix generated or used by SD&SS	Optional	–	–
$SDSS MATRIX OUTPUT LIST	16-18	To store any matrix used in SD&SS on output tape SDSSTP	Optional	–	–
$THRUST DATA	19-22	To specify the direction and location of the thrust vectors	Required[a]	–	Data must be in the same order as in ISIC or ESIC
$GYROSCOPIC DATA	23-27	To specify the gyroscopic effects due to the engines	Optional	Can only be included if $THRUST DATA is included	Can only be included if gyroscopic data were input in ESIC or ISIC
$CONTROL SURFACE DATA OR $ TRIM CONTROL	28-33	To specify which Thin Body panels will act as control surfaces	Required	–	Data depends on GD paneling
$ACTIVE CONTROL SURFACE DATA	33A-33R	To specify which thin body panels will act as active control surfaces	Optional	$PERTURBATION DATA	–
$STABILITY PROBLEM DATA	34-46	To specify the stability problem to be solved and the airplane shape as well as several key output options	Required	–	–
$WIND TUNNEL DATA	47-57	To input user-supplied empirical data to trim the airplane	Optional	–	–

[a]Can be omitted for gliding flight.

TABLE 9.2-3.—Continued

Data Control Card	Card numbers	Purpose	Required or optional	Relationship to	
				Other blocks of data	Other programs
$PERTURBATION DATA	58-72	To generate dynamic stability information for the $DYNAMIC ANALYSIS option and TH	Optional	Must be included to execute the $DYNAMIC ANALYSIS option	Must be included to execute the TH program
$DYNAMIC ANALYSIS	73-75	To calculate the airplane's dynamic stability characteristics based on the linearized equations of motion	Optional	Can only be used if $PERTURBATION DATA is included	–
$EXTERIOR INFLUENCE DATA	76-80	To input exterior downwash matrices	Optional	–	–
$STRUCTURAL DATA	81-84	To input required structural data for rigid cases	Optional	–	Must be included if neither ISIC nor ESIC was executed
$EXTERNAL PRESSURE DATA	85-92	To specify externally generated lifting Thin Body pressures	Optional	–	–
$AREA RATIO DATA	93-97	To alter the effective area of Thin or Interference Body panels	Optional	–	–
$SPECIAL SDSS EXECUTION	98-100	To specify a special SD&SS execution option	Optional	Can be used if $GENERAL SPECIFICATION DATA is included	–
$END OF CASE	101	To signify the end of a data case	Required	–	–
$CASE FOR SD&SS PROGRAM	1-3	To identify the start of a recycle data case (repeated for each recycle case)	Required[a]	–	ALOADS is the only program that can analyze each of the recycle data cases

[a]Required if recycling option is chosen.

TABLE 9.2-3.—Concluded

Data Control Card	Card number	Purpose	Required or optional	Relationship to	
				Other blocks of data	Other programs
$RECYCLE DATA	4-6	To respecify the values of the parameters that are to be changed from the previous case	Required[a]	–	ALOADS is the only program that can analyze each of the recycle data cases
$MATRIX PRINT LIST	7-9	To print matrices used in this recycle case	Optional	–	
$END OF CASE	101	To signify the end of this recycle case	Required[a]	–	
$EXIT	102	To terminate execution	Required		

[a]Required if recycling option is chosen.

Columns	Descriptor	Explanation
		CARD 26 (Format E10.0)
1-10	NTABLE	Must omit if CARD 23 is omitted. Number of entries in angular velocity, ω, versus thrust, T, table (see CARD SET 27). Input CARD 26 and CARD SET 27 *only* if H_{OP} = VARIABLE ($2.0 \leq$ NTABLE ≤ 20.0).
		CARD SET 27 (Format 2E10.0)
1-10 11-20	ω T	Must omit if CARD 23 is omitted. Angular velocity of engines. Thrust of engines. Units / ω / T INCHES / rad/sec / lb IN/FT / rad/sec / lb FEET / rad/sec / lb METERS / rad/sec / newtons There are NTABLE cards in CARD SET 27 with thrust increasing monotonically.

Control surface data. Figure 9.2-7 displays the cards of this section. This card section is *required* for SD&SS execution. The user is advised to read the Usage Guidelines (section 9.2.1) before preparing these data. The sequence CARD 29 through CARD SET 32c is repeated for *each* control surface. The control surfaces must be input in the following order: elevator, aileron, and rudder.

Columns	Descriptor	Explanation
		CARD 28 (Format A4)
1-21	$CONTROL SURFACE DATA or $TRIM CONTROL DATA	Data Control Card—Heads control surface data.
		CARD 29 (Format A4)
1-10	Control Surface	Type of control surface. = ELEVATOR (or LONGITUDINAL): surface is used for longitudinal control. The program assumes that there is an identical surface on the left side of the model with an identical deflection. = AILERON: surface is an aileron. The program assumes that there is an identical surface on the left side, but with opposite deflection. = RUDDER: surface is a rudder on plane of symmetry. A longitudinal surface *must* be specified. If $Motion_{REF}$ = COUPLED REFERENCE MOTION in CARD 5, ailerons and rudder must also be defined.

Columns	Descriptor	Explanation
CARD 30 (Format E10.0,A4,6X,4E10.0)		
1-10	NPB	Number of Thin Bodies participating as part of control surface. The card sequence CARD 28 through CARD SET 29 is repeated for each participating body.
11-20	$Hinge_{OP}$	Hinge option. = SWEEP: incidence vector for control accounts for hinge line sweep. Hinge moments are *not* computed, however the control derivatives are computed. = HINGE: same as SWEEP except hinge moments are computed. = blank: option not exercised (assumes hinge line sweep = 0°).
21-30 31-40 41-50 51-60	x_{IN} y_{IN} x_{OUT} y_{OUT}	Inboard and outboard coordinates of the hinge line in the Local Body Coordinate System. These coordinates are not needed if $Hinge_{OP}$ = blank. Units — $x_{IN}, y_{IN}, x_{OUT}, y_{OUT}$ INCHES — in. IN/FT — in. FEET — ft METERS — m
CARD 31 (Format 2A4,2X,E10.0)		
1-10	$Name_{TB}$	Name of participating body, established by user when GD program was executed.
11-20	NPP	Number of body control points (panels) participating as control surface. There is one card in CARD SET 29 for *each* participating control point.
CARD SET 32 (Format 2E10.0)		
1-10	I_{PANEL}	Number of control point (panel). Thin Body panels are numbered as shown in figure 33. They are also given in the GD printout.
11-20	S	Relative strength of participation by control point (see sec. 12.2-1).

CARD 32A, CARD 32B, and CARD SET 32C are omitted unless the user wishes to compute hinge moments

Columns	Descriptor	Explanation
		CARD 32A (Format A4,6X,2E10.0)
1-10	HM_{OP}	Hinge moment option. = ALL HM: hinge moments due to all available variables (α , β , δc , , etc.) will be computed. = SELECT HM: hinge moments due to variables determined by options on CARD 32B will be computed. = LIST HM: hinge moments due to variables listed by name in CARD SET 32C will be computed
11-20	S_c	Reference area of control surface.
21-30	$\bar{c}_c$	Reference chord of control surface. Units — S_c — $\bar{c}_c$ INCHES — in.^{2} — in. IN/FT — in.^{2} — in. FEET — ft^2 — ft METERS — m^2 — m
		CARD 32B (Format 2(A4,6X))
		This card is input only if HM_{OP} = SELECT HM.
1-10	$Motion_{OP}$	Hinge moment motion option. = SYMMETRIC: hinge moments due to symmetric variables only (α ,Q ,δc^{S}) will be computed. = ANTISYMMETRIC: hinge moments due to antisymmetric variables only (β ,P ,R ,δc^{A}) will be computed. = BOTH: hinge moments due to symmetric and antisymmetric variables will be computed.
11-20	S/U_{OP}	Hinge moment steady/unsteady option. = STEADY: hinge moments due to steady variables only will be computed. = UNSTEADY: hinge moments due to unsteady variables only will be computed. = BOTH: hinge moments due to steady and unsteady variables only will be computed.

Columns	Descriptor	Explanation
CARD SET 32C (Format A4)		
1-10	$Name_{HM}$	This card set is input only if HM_{OP} = LIST HM. Name of hinge moment variable. One name per card. Below is the list of names.

Variable	$Name_{HM}$	Variable	$Name_{HM}$
o	REFERENCE	β	BETA
α	ALPHA	P	P
Q	Q	R	R
δc^S	CS	δc^A	CA
u	U	$\dot{v}$	V-DOT
$\dot{w}$	W-DOT	$\dot{P}$	P-DOT
$\dot{Q}$	Q-DOT	$\dot{R}$	R-DOT
$\dot{\delta c}^S$	CS-DOT	$\dot{\delta c}^A$	CA-DOT

Columns	Descriptor	Explanation
CARD 33 (Format A4)		
1-24	END OF TRIM CONTROL DATA	Terminates trim control data card section.

Active control data.—Figure 79 displays the cards of this section. If there are no active controls, omit this section. The sequence CARD 33B through CARD 33Q is repeated for each contrŏl surface. The user must input the perturbation data section, CARD 58 through CARD 72, when this section is input.

Columns	Descriptor	Explanation
CARD 33A (Format A4)		
1-20	$ACTIVE CONTROL DATA	Data Control Card—Heads active control data.
CARD 33B (Format 2A4)		
1-8	Control	Must omit if CARD 34 is omitted. Name of control. Is on the plane of symmetry, the program will reverse the sign of positive deflection.

Columns	Descriptor	Explanation
CARD 33C (Format A4,26X,A4,6X,E10.0,A4)		
		Must omit if CARD 33A is omitted.
1-30	$Deflect_{OP}$	Control surface deflection option. = SYMMETRIC: surface is symmetrically deflected. = ANTISYMMETRIC: surface is antisymmetrically deflected. = BOTH: surface is treated as a symmetrically deflected surface and as an antisymmetrically deflected surface.
31-40	Der_{OP}	Option for user to input derivatives. = STEADY: steady aerodynamic derivatives are input on CARDS 33M and 33N. = UNSTEADY: unsteady aerodynamic derivatives are input on CARDS 33O and 33P = BOTH: steady and unsteady aerodynamic derivatives are input on CARDS 33M, 33N, 33O, and 33P. = blank: option not exercised.
41-50	Δh	$(X_{cg} - X_{REF})$/chord; where X_{REF} is the external moment reference point.
51-60	$Theory_{OP}$	Option for user to input controls which are not amenable to linearized small perturbation potential flow theory. = YES or blank: theory amenable (CARDS 33D and 33E, CARD SET 33F must be input). = NO: theory not amenable (CARDS 33D and 33E, CARD SET 33F, and hinge moment data are *not* input but the user must input derivatives, i.e., Der_{OP} = STEADY, UNSTEADY, or BOTH).

Columns	Descriptor	Explanation
		CARD 33D (Format E10.0,A4,6X,4E10.0)
		Must omit if CARD 33A is omitted.
1-10	NPB	Number of Thin Bodies participating as part of control surface. The card sequence CARD 33E and CARD SET 33F is repeated for each participating body.
11-20	$Hinge_{OP}$	Hinge option. = SWEEP: incidence vector for control accounts for hinge line sweep. Hinge moments are *not* computed, however the control derivatives are computed. = HINGE: same as SWEEP except hinge moments are computed. = blank: option not exercised. CARD 33G through CARD SET 33L are omitted.
21-30 31-40 41-50 51-60	x_{IN} y_{IN} x_{OUT} y_{OUT}	Inboard and outboard coordinates of the hinge line in the Local Body Coordinate System. These coordinates are not needed if $Hinge_{OP}$=blank. Units — $x_{IN}, y_{IN}, x_{OUT}, y_{OUT}$ INCHES — in. IN/FT — in. FEET — ft METERS — m
		CARD 33E (Format 2A4,2X,E10.0)
		Must omit if CARD 33A is omitted.
1-10	$Name_{TB}$	Name of participating body, established by user when GD program was executed.
11-20	NPP	Number of body control points (panels) participating as control surface. There is one card in CARD SET 33F for *each* participating control point.
		CARD 33F (Format 2E10.0)
		Must omit if CARD 33A is omitted.
1-10	I_{PANEL}	Number of control point (panel). Thin Body panels are numbered as shown in figure 4.2-18.
11-20	S	Relative strength of participation by control point.

CARD 33G through CARD SET 33L are omitted when $Hinge_{OP}$= blank.

Columns	Descriptor	Explanation
		CARD 33G (Format A4,6X,2E10.0)
		Must omit if CARD 33A is omitted
1-10	HM_{OP}	Hinge moment option. = ALL HM: hinge moments due to all available variables (α, β, δc, etc.) will be computed. = SELECT HM: hinge moments due to variables determined by options on CARD 33H will be computed. = LIST HM: hinge moments due to variables listed by name in CARD SET 33L will be computed.
11-20	S_c	Reference area of control surface.
21-30	$\bar{c}_c$	Reference chord of control surface.

Units	S_c	$\bar{c}_c$
INCHES	$in.^2$	in.
IN/FT	$in.^2$	in.
FEET	ft^2	ft
METERS	m^2	m

Columns	Descriptor	Explanation
		CARD 33H (Format 3(A4,6X))
		This card is input only if HM_{OP} = SELECT HM.
1-10	$Motion_{OP}$	Hinge moment motion option. = SYMMETRIC: hinge moments due to symmetric variables only (α, Q, δc^S) will be computed. = ANTISYMMETRIC: hinge moments due to antisymmetric variables only (β, P, R, δc^A) will be computed. = BOTH: hinge moments due to symmetric and antisymmetric variables will be computed. This is the default option.
11-20	S/U_{OP}	Hinge moment steady/unsteady option. = STEADY: hinge moments due to steady variables only will be computed. = UNSTEADY: hinge moments due to unsteady variables only will be computed. = BOTH: hinge moments due to steady and unsteady variables only will be computed. This is the default option.

Columns	Descriptor	Explanation
		CARD 33H (Format 3(A4,6X)) Continued
21-30	$Modes_{OP}$	Dynamic modes option. = NO MODES or blank: hinge moments due to modes are not computed. This is the default option. CARD 33I and CARD SETS 33J and 33K are omitted. = ALL MODES: hinge moments due to all modes and all elastic rate derivatives are computed. CARD 33I and CARD SETS 33J and 33K are omitted. = SOME MODES: hinge moments due to modes specified on CARD 33I and CARD SETS 33J and 33K calculated.

The following card sequence (CARD 33I, CARD SETS 33J and 33K) are omitted unless $Modes_{OP}$ = SOME MODES on CARD 33H.

Columns	Descriptor	Explanation
		CARD 33I (Format 3E10.0)
1-10	NS_M	Number of symmetric modes selected for hinge moment calculations. The modes are listed on CARD SET 33J. $0 \leq NS_M \leq 20$ (omit CARD SET 33J if $NS_M = 0$).
11-20	NA_M	Number of antisymmetric modes selected for hinge moment calculations. The modes are listed on CARD SET 33K. $0 \leq NA_M \leq 20$ (omit CARD SET 33K if $NA_M = 0$).
21-30	u_{OP}	Generalized coordinate option = 0: u_1, $\dot{u}_1$, and $\ddot{u}_1$ coordinates are calculated. = 1: u_1 coordinates only. = 2: $\dot{u}_1$ coordinates only. = 3: $\ddot{u}_1$ coordinates only. = 4: u_1 and $\dot{u}_1$ coordinates only. = 5: u_1 and $\ddot{u}_1$ coordinates only. = 6: $\dot{u}_1$ and $\ddot{u}_1$ coordinates only.

Columns	Descriptor	Explanation
		CARD SET 33J (Format 6E10.0)
1-10	$Mode_1^S$	List of symmetric modes selected for hinge moment calculations. Six modes per card.
11-20	$Modes_2^S$	
21-30	$Mode_3^S$	
31-40	$Mode_4^S$	
41-50	$Mode_5^S$	
51-60	$Mode_6^S$	
		CARD SET 33K (Format 6E10.0)
1-10	$Mode_1^A$	List of antisymmetric modes selected for hinge moment calculations. Six modes per card.
11-20	$Mode_2^A$	
21-30	$Mode_3^A$	
31-40	$Mode_4^A$	
41-50	$Mode_5^A$	
51-60	$Mode_6^A$	
		CARD SET 33L (Format A4)
		This card set is input only if HM_{OP} = LIST HM.
1-10	$Name_{HM}$	Name of hinge moment variable. One name per card. Below is the list of names.

Variable	$Name_{HM}$	Variable	$Name_{HM}$
o	REFERENCE	β	BETA
α	ALPHA	P	P
Q	Q	R	R
δc^S	CS	δc^A	CA
u	U	$\dot{v}$	V-DOT
$\dot{w}$	W-DOT	$\dot{P}$	P-DOT
$\dot{Q}$	Q-DOT	$\dot{R}$	R-DOT
$\dot{\delta} c^S$	CS-DOT	$\dot{\delta} c^A$	CA-DOT

Columns	Descriptor	Explanation
CARD 33M (Format 6E10.0)		
1-10	$C_{L_{\delta c}}{}^{S}$	Symmetric steady control derivatives. Input only if $Deflect_{OP}$ = SYMMETRIC or BOTH and Der_{OP} = STEADY or BOTH (see CARD 36). Units are 1/deg.
11-20	$C_{D_{\delta c}}{}^{S}$	
21-30	$C_{m_{\delta c}}{}^{S}$	
31-40	$C_{Y_{\delta c}}{}^{S}$	
41-50	$C_{\ell_{\delta c}}{}^{S}$	
51-60	$C_{n_{\delta c}}{}^{S}$	
CARD 33N (Format 6E10.0)		
1-10	$C_{L_{\delta c}}{}^{A}$	Antisymmetric steady control derivatives. Input only if $Deflect_{OP}$ = ANTISYMMETRIC or BOTH and Der_{OP} = STEADY or BOTH (see CARD 36). Units are 1/deg.
11-20	$C_{D_{\delta c}}{}^{A}$	
21-30	$C_{m_{\delta c}}{}^{A}$	
31-40	$C_{Y_{\delta c}}{}^{A}$	
41-50	$C_{\ell_{\delta c}}{}^{A}$	
51-60	$C_{n_{\delta c}}{}^{A}$	
CARD 33O (Format 3E10.0)		
1-10	$C_{L_{\hat{\delta} c}}{}^{S}$	Symmetric unsteady control derivatives. Input only if $Deflect_{OP}$ = SYMMETRIC or BOTH and Der_{OP} = UNSTEADY or BOTH (see CARD 36). Units are 1/rad. For example, $C_{L_{\hat{\delta} c}}{}^{S}$ can be expressed as $\dfrac{\partial C_L{}^{S}}{\partial\left(\dfrac{\dot{\delta}_c \bar{c}}{2U_1}\right)}$
11-20	$C_{D_{\hat{\delta} c}}{}^{S}$	
21-30	$C_{m_{\hat{\delta} c}}{}^{S}$	

Columns	Descriptor	Explanation
CARD 33P (Format 30X, 3D10.0)		
31-40	$C_{Y_{\hat{\delta}_c}}^{A}$ $C_{\ell_{\hat{\delta}_c}}^{A}$ $C_{n_{\hat{\delta}_c}}^{A}$	Antisymmetric unsteady control derivatives. Input only if Deflect_{OP} = ANTISYMMETRIC or BOTH and Der_{OP} = UNSTEADY or BOTH (see CARD 36). Units are 1/rad. For example $C_{Y_{\hat{\delta}_c}}^{A}$ can be expressed as $\dfrac{\partial C_Y{}^A}{\partial\left(\dfrac{\delta c\ b}{2U_1}\right)}$
CARD 33Q (Format A4)		
1-26	END OF ACTIVE CONTROL DATA	Terminates active control data card section.

Stability problem data. -Cards of this section explain the basic stability problem to be solved. The user is urged to read section 9.2.1 thoroughly before preparing these cards. Figure 9.2-8 illustrates the card sequence. This card section is required for SD&SS execution.

Columns	Descriptor	Explanation
CARD 34 (Format A4)		
1-23	$STABILITY PROBLEM DATA	Data Control Card—Heads stability problem data.
CARD 35 (Format A4)		
1-9	Problem	Stability problem option. = CONSTANT: stability problem 1—trim solution with constant coefficients. = ITERATION: stability problem 2—iterative trim solution. Wind tunnel or handbook data are input. = SPECIFIED: stability problem 3—user specifies trim condition of the model. (α_1, θ_1, δe_1, β_1, δa_1, δr_1; see CARD 42).

Columns	Descriptor	Explanation
		CARD 59 (Continued)
31-40	Blanks	
41-50	$Loads_{OP}$	Perturbation loads option. = LOADS: *Loads are calculated and stored on tape SDSSTP for the SLOADS program.*[a] = blanks: loads are not calculated.
51-60	$Print_{PERT}$	Perturbation print option. = PRINT: all perturbation stability matrices calculated for the TH program are printed. = blanks: not printed.
		CARD 60 (Format A4, 6X, E10.0)
1-10	$Steady_{OP}$	Must omit if CARD 58 is omitted. Steady perturbation derivative option. = STEADY: the user elects to replace *all* FLEXSTAB-calculated steady perturbation derivatives by inputting wind tunnel or handbook data on CARDS 61-66. = blanks: derivatives are not input.
11-20	Δh	$(X_{CG} - X_{REF})/\bar{c}$; *the distance, as a fraction of reference chord,* from the model's center of gravity to the reference point used by the steady perturbation derivatives. X_{CG} and X_{REF} are measured in the Reference Axis System. The reference chord, $\bar{c}$, was input in CARD 12. Input only if $Steady_{OP}$ = STEADY. Note: This card must be included, even if both fields are blank.

CARDS 61-66 are omitted if $Steady_{OP}$ is blank in CARD 60. They contain the user-supplied steady perturbation derivatives, which are in standard nondimensional form (see sec. 5.6.2, vol. I). Note that all steady derivatives must be input; fields left blank are interpreted as zeros.

[a]The usage guidelines of the SLOADS program, section 17.2.1, should be consulted before using the perturbation loads option.

Columns	Descriptor	Explanation
		CARD SET 95 (Format 6E10.0)
1-10 11-20 21-30 31-40 41-50 51-60	PN_1 PN_2 PN_3 PN_4 PN_5 PN_6	Must omit if CARD 93 is omitted. Omit this card set if IP_{OP} = ALL in CARD 94. Panel numbers (found in GD printout). They must be ordered to agree with area ratio factors input on the next card set. There are six (6) panel numbers per card.
		CARD SET 96 (Format 6E10.0)
1-10 11-20 21-30 31-40 41-50 51-60	AF_1 AF_2 AF_3 AF_4 AF_5 AF_6	Must omit if CARD 93 is omitted. The area ratio factors that are applied on each panel above. The order of these area ratio factors must agree with the ordering of the panels (as specified in CARD SET 95, or the GD program if IP_{OP} = ALL in CARD 94). Note: $A_{modified} = A_{\substack{geometry \\ definition}} * AF_i$
		CARD 97 (Format A4)
1-11	END OF DATA	Must omit if CARD 93 is omitted. Terminates the area ratio data.

Special SDSS execution.–This card set, in addition to the General Specifications card set, gives the user the capability to specify limited SD&SS executions (see section 9.2.1). Figure 9.2- illustrates the data card arrangement.

Columns	Descriptor	Explanation
		CARD 98 (Format A4)
1-24	$SPECIAL SDSS EXECUTION	Omit of special execution is not desired. Data Control Card – Heads special SD&SS execution data.
		CARD 99 (Format A4)
		Must omit if CARD 98 is omitted.
1-4	$SPCL_{OP}$	Special SD&SS option = AERODYNAMIC: Calculate and store on the SDSSTP data tape the aerodynamic influence coefficient matrices. NOTE: $GENERAL SPECIFICATIONS DATA set must be included in the data deck. In particular the following variables must be specified. $Motion_{REF}$, $Speed_{OP}$ GD Tape, and AIC Tape

Columns	Descriptor	Explanation
		CARD 100 (Format A4)
1-11	END OF DATA	Must omit if CARD 98 is omitted Terminates the special SD&SS execution data

Concluding cards.—CARD 101 concludes the data case and CARD 102 terminates program execution.

Columns	Descriptor	Explanation
		CARD 101 (Format A4)
1-12	$END OF CASE	Data Control Card – Identifies end of data case.
		CARD 102 (Format A4)
1-5	$EXIT	Data Control Card – Terminates program execution.

A.11 STABILITY DATA TAPE (SDSSTP)

SDSSTP is a binary tape composed of many logical files. In general, these files consist of:

- A master catalog of the contents of SDSSTP. This catalog is always the first file on the tape.
- Miscellaneous data required by the TH, SLOADS, and ALOADS programs. These data are stored in one file and consist of information such as moments of inertia, center of gravity location, number and size of the stability derivative matrices, etc.
- Slender Body and Thin Body lifting pressure data. These data are stored in one logical file.
- The $\lceil k_I \rfloor$ and $\lceil m_I \rfloor$ structural matrices. These matrices (if they exist) are copied from SICTP3 onto SDSSTP.
- Stability derivative matrices.
- Displacement and camber slope matrices.
- Elastic axis load matrices (optional).
- Gust matrices (optional).
- Any user-specified matrices. An option in the SD&SS program allows the user to specify matrices to be stored on SDSSTP in addition to those which are normally saved.[a]

Each matrix is stored as one logical file. Tables A.11-1 and A.11-1a gives a complete list of the matrices that are *automatically* saved (depending on options) on SDSSTP.

Only the formats of the first file (master catalog), the file containing the miscellaneous data, and the pressure data file will be described. The remaining files on SDSSTP contain matrices and, as such, conform to the Standard FLEXSTAB Matrix Format explained in appendix A.1.

The first file on SDSSTP is the master catalog. It is composed of several data records. There are two types of data records in this catalog: Matrix Records and Terminal Records. A Matrix Record contains information pertaining to the data stored in one particular file of SDSSTP. Thus, for each file on SDSSTP (not counting the master catalog) there is a corresponding Matrix Record in the master catalog. A Terminal Record is used to signify the end of the catalog. The formats of these two data records are shown in tables A.11-2 and A.11-3.

[a]Any matrix generated internally by SD&SS or input to SD&SS via AICTAP or SICTP3 may be specified for storage on SDSSTP. See appendix B-1 for a complete list of matrices.

TABLE A.11-1.a.—SDSSTP MATRICES

FLEXSTAB name	Engineering symbol
(CONTRL)–A	$\begin{bmatrix} C_{Y_{\delta_{a_{\text{rigid}}}}} & C_{Y_{\delta_{a_{\text{elastic incr}}}}} & C_{Y_{\delta_{r_{\text{rigid}}}}} & C_{Y_{\delta_{r_{\text{elastic incr}}}}} & C_{Y_{\delta_{c_{i_{\text{rigid}}}}}} & C_{Y_{\delta_{c_{i_{\text{elastic incr}}}}}} \\ C_{\ell_{\delta_{a_{\text{rigid}}}}} & C_{\ell_{\delta_{a_{\text{elastic incr}}}}} & C_{\ell_{\delta_{r_{\text{rigid}}}}} & C_{\ell_{\delta_{r_{\text{elastic incr}}}}} & C_{\ell_{\delta_{c_{i_{\text{rigid}}}}}} & C_{\ell_{\delta_{c_{i_{\text{elastic incr}}}}}} \\ C_{n_{\delta_{a_{\text{rigid}}}}} & C_{n_{\delta_{a_{\text{elastic incr}}}}} & C_{n_{\delta_{r_{\text{rigid}}}}} & C_{n_{\delta_{r_{\text{elastic incr}}}}} & C_{n_{\delta_{c_{i_{\text{rigid}}}}}} & C_{n_{\delta_{c_{i_{\text{elastic incr}}}}}} \end{bmatrix}$ where i ranges over the number of antisymmetric active control surfaces
(CONTRL)–S	$\begin{bmatrix} C_{L_{\delta_{e_{\text{rigid}}}}} & C_{L_{\delta_{e_{\text{elastic incr}}}}} & C_{L_{\delta_{c_{i_{\text{rigid}}}}}} & C_{L_{\delta_{c_{i_{\text{elastic incr}}}}}} \\ C_{D_{\delta_{e_{\text{rigid}}}}} & C_{D_{\delta_{e_{\text{elastic incr}}}}} & C_{D_{\delta_{c_{i_{\text{rigid}}}}}} & C_{D_{\delta_{c_{i_{\text{elastic incr}}}}}} \\ C_{m_{\delta_{e_{\text{rigid}}}}} & C_{m_{\delta_{e_{\text{elastic incr}}}}} & C_{m_{\delta_{c_{i_{\text{rigid}}}}}} & C_{m_{\delta_{c_{i_{\text{elastic incr}}}}}} \end{bmatrix}$ where i ranges over the number of symmetric active controls
(CSNAMES)A	$\begin{bmatrix} \text{AILERON} & \text{RUDDER} & AC_{\text{name}_i} \cdots AC_{\text{name}_n} \end{bmatrix}$ where i ranges over the number of antisymmetric active controls
(CSNAMES)S	$\begin{bmatrix} \text{ELEVATOR} & AC_{\text{name}_i} \cdots AC_{\text{name}_n} \end{bmatrix}$ where i ranges over the number of symmetric active controls

TABLE A.11-1a.—CONCLUDED

FLEXSTAB name	Engineering symbol
(STATIC)–S	$\begin{bmatrix} C_{L_{1_{rigid}}} & C_{L_{1_{\substack{elastic\\incr}}}} & C_{L_{\hat{U}_{rigid}}} & C_{L_{\hat{U}_{\substack{elastic\\incr}}}} & C_{L_{\alpha_{rigid}}} & C_{L_{\alpha_{\substack{elastic\\incr}}}} & C_{L_{\hat{q}_{rigid}}} & C_{L_{\hat{q}_{\substack{elastic\\incr}}}} \\ 0 & 0 & C_{D_{\hat{U}_{rigid}}} & C_{D_{\hat{U}_{\substack{elastic\\incr}}}} & C_{D_{\alpha_{rigid}}} & C_{D_{\alpha_{\substack{elastic\\incr.}}}} & C_{D_{q_{rigid}}} & C_{D_{\hat{q}_{\substack{elastic\\incr}}}} \\ 0 & 0 & C_{m_{\hat{U}_{rigid}}} & C_{m_{\hat{U}_{\substack{elastic\\incr}}}} & C_{m_{\alpha_{rigid}}} & C_{m_{\alpha_{\substack{elastic\\incr.}}}} & C_{m_{\hat{q}_{rigid}}} & C_{m_{\hat{q}_{\substack{elastic\\incr}}}} \end{bmatrix}$
(STATIC)–A	$\begin{bmatrix} C_{Y_{\beta_{rigid}}} & C_{Y_{\beta_{\substack{elastic\\incr}}}} & C_{Y_{\hat{p}_{rigid}}} & C_{Y_{\hat{p}_{\substack{elastic\\incr}}}} & C_{Y_{\hat{r}_{rigid}}} & C_{Y_{\hat{r}_{\substack{elastic\\incr}}}} \\ C_{\ell_{\beta_{rigid}}} & C_{\ell_{\beta_{\substack{elastic\\incr}}}} & C_{\ell_{\hat{p}_{rigid}}} & C_{\ell_{\hat{p}_{\substack{elastic\\incr}}}} & C_{\ell_{\hat{r}_{rigid}}} & C_{\ell_{\hat{r}_{\substack{elastic\\incr}}}} \\ C_{n_{\beta_{rigid}}} & C_{n_{\beta_{\substack{elastic\\incr}}}} & C_{n_{\hat{p}_{rigid}}} & C_{n_{\hat{p}_{\substack{elastic\\incr}}}} & C_{n_{\hat{r}_{rigid}}} & C_{n_{\hat{r}_{\substack{elastic\\incr}}}} \end{bmatrix}$

APPENDIX B

DYLOFLEX MOD
TO
FLEXSTAB PROGRAMMER'S MANUAL (VOL. III)

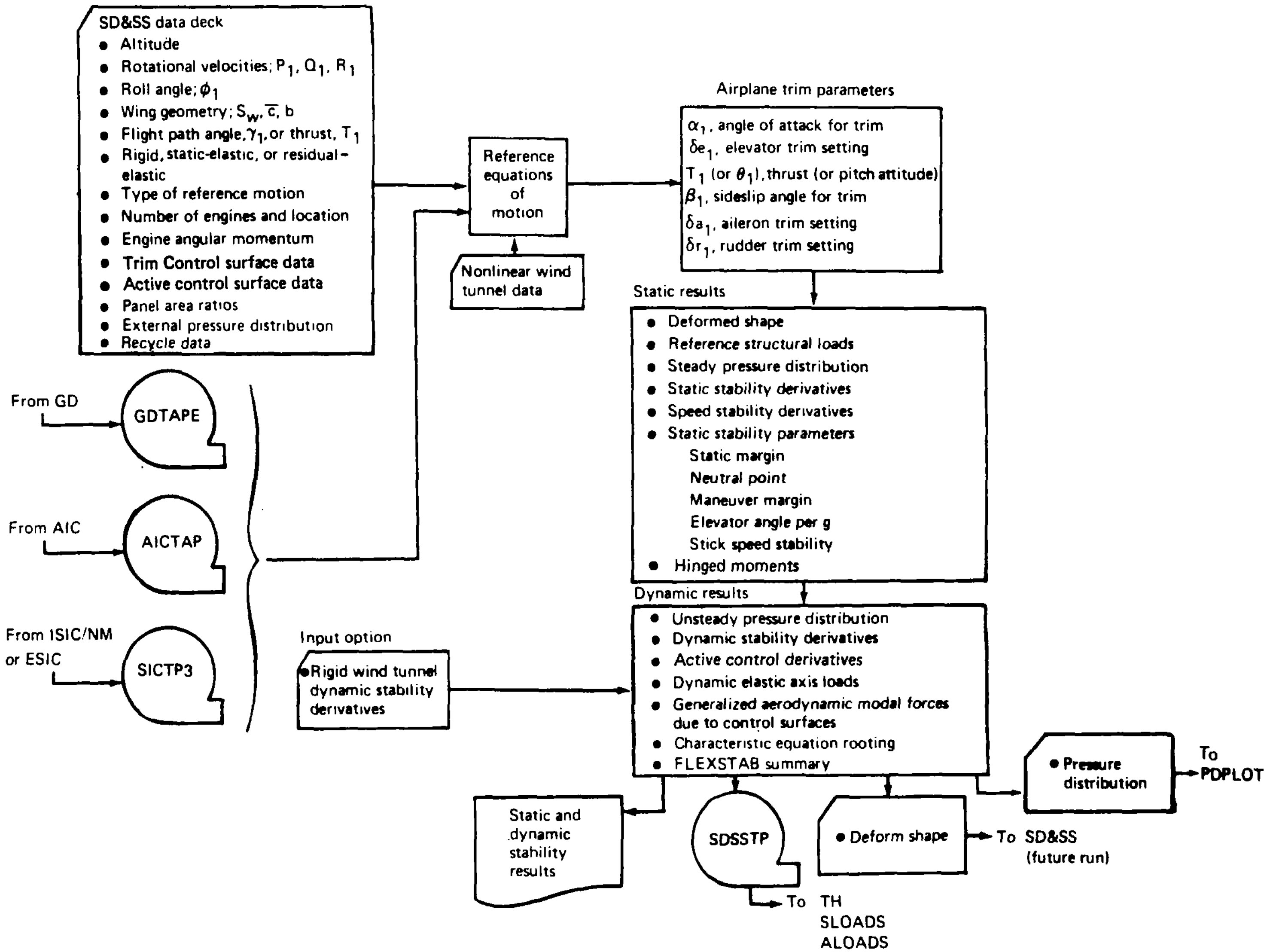


FIGURE 9.0-1.—SCHEMATIC OF SD&SS PROGRAM

9.1 OVERLAY STRUCTURE

Figure 9.1-1 illustrates the functional operation of each overlay. Figure 9.1-2 illustrates the overlay/subprogram structural arrangement.

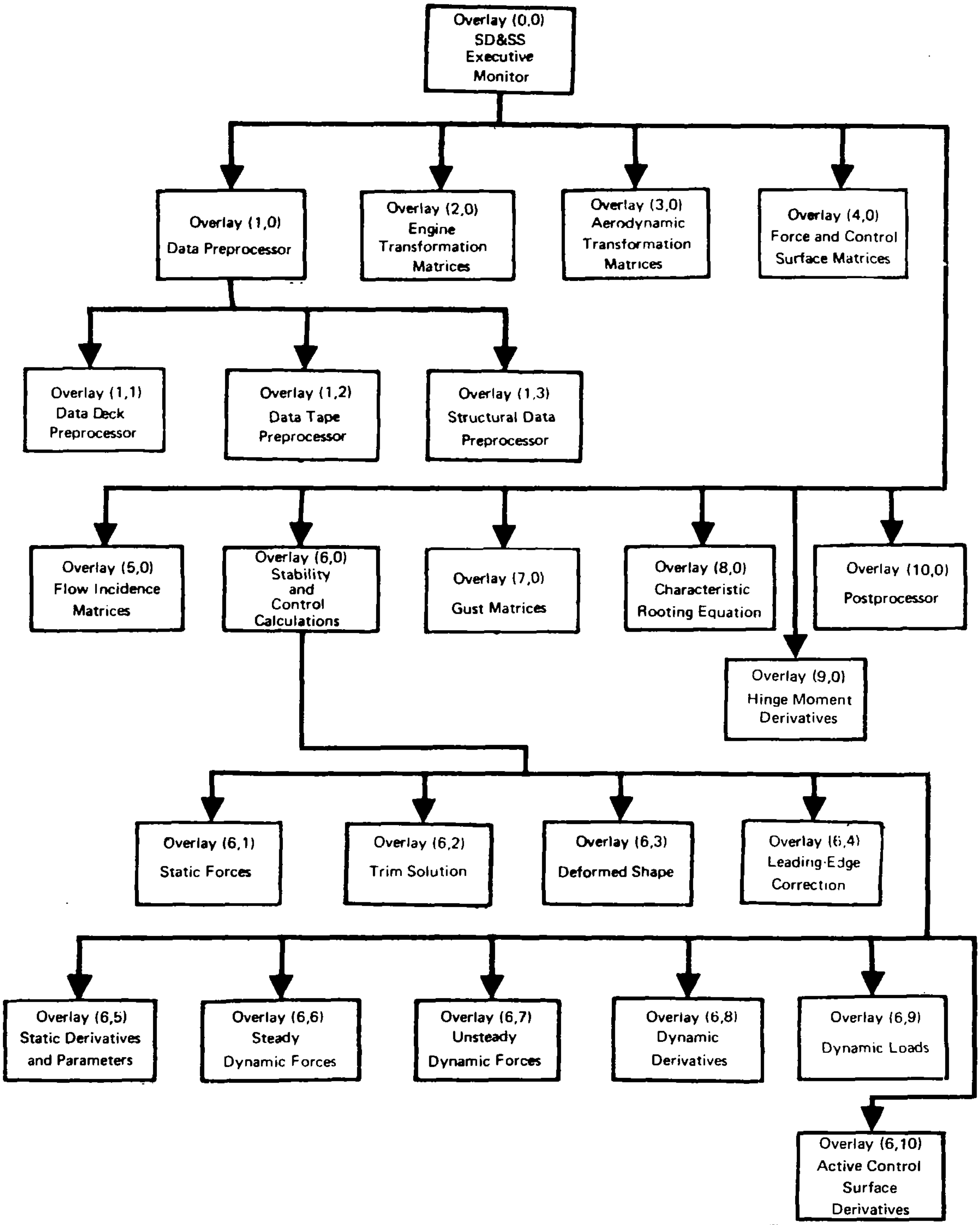


FIGURE 9.1-1.—SD&SS OVERLAY FUNCTIONAL LAYOUT

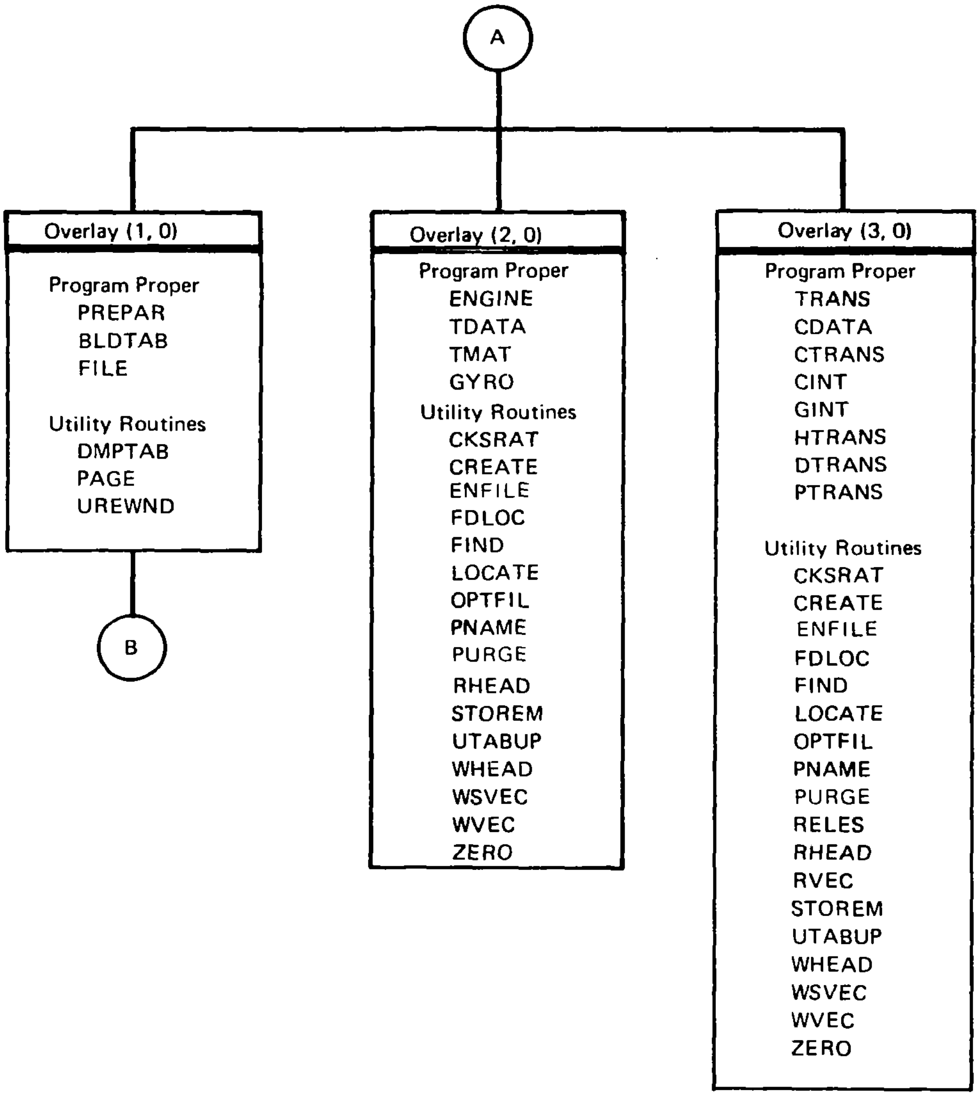


FIGURE 9.1-2.—CONTINUED

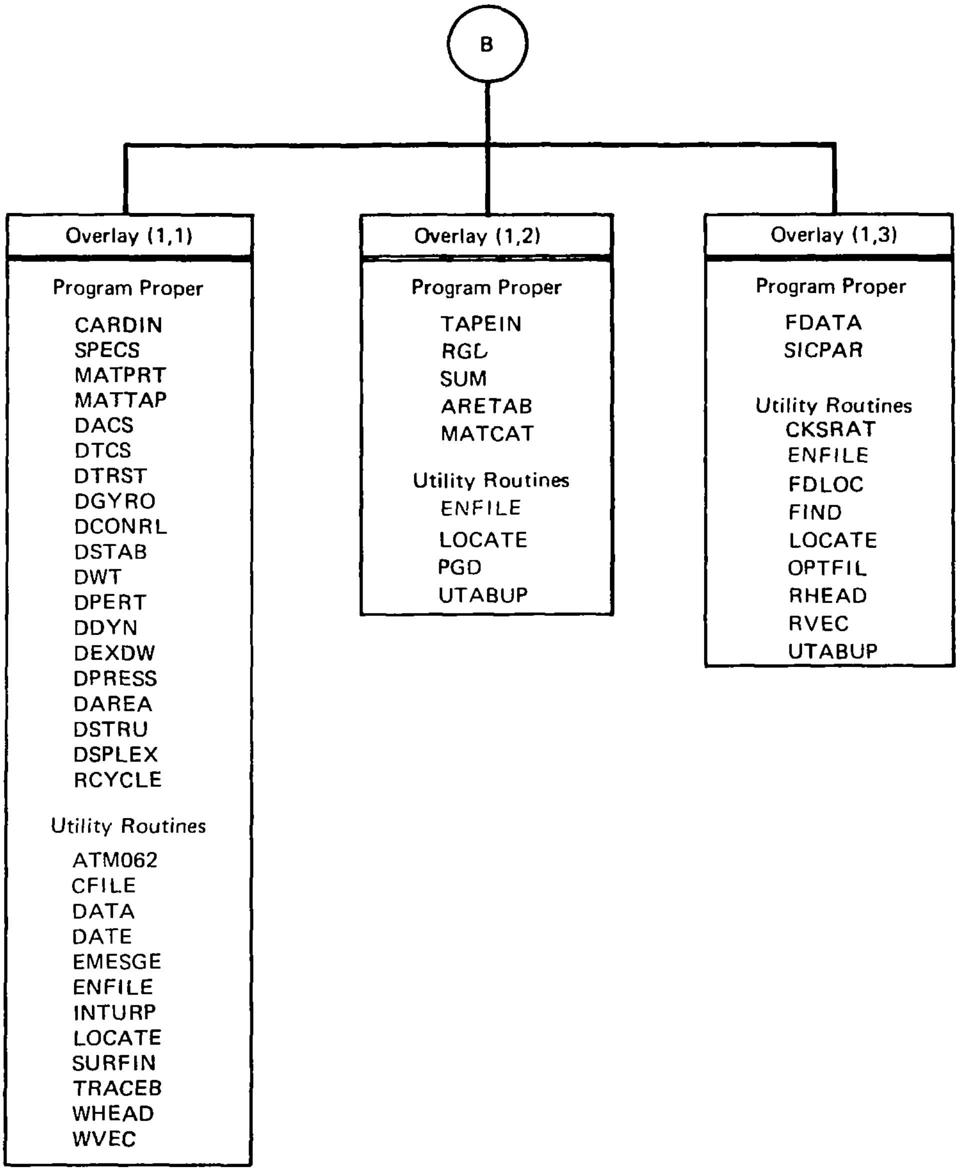


FIGURE 9.1-2.—CONTINUED

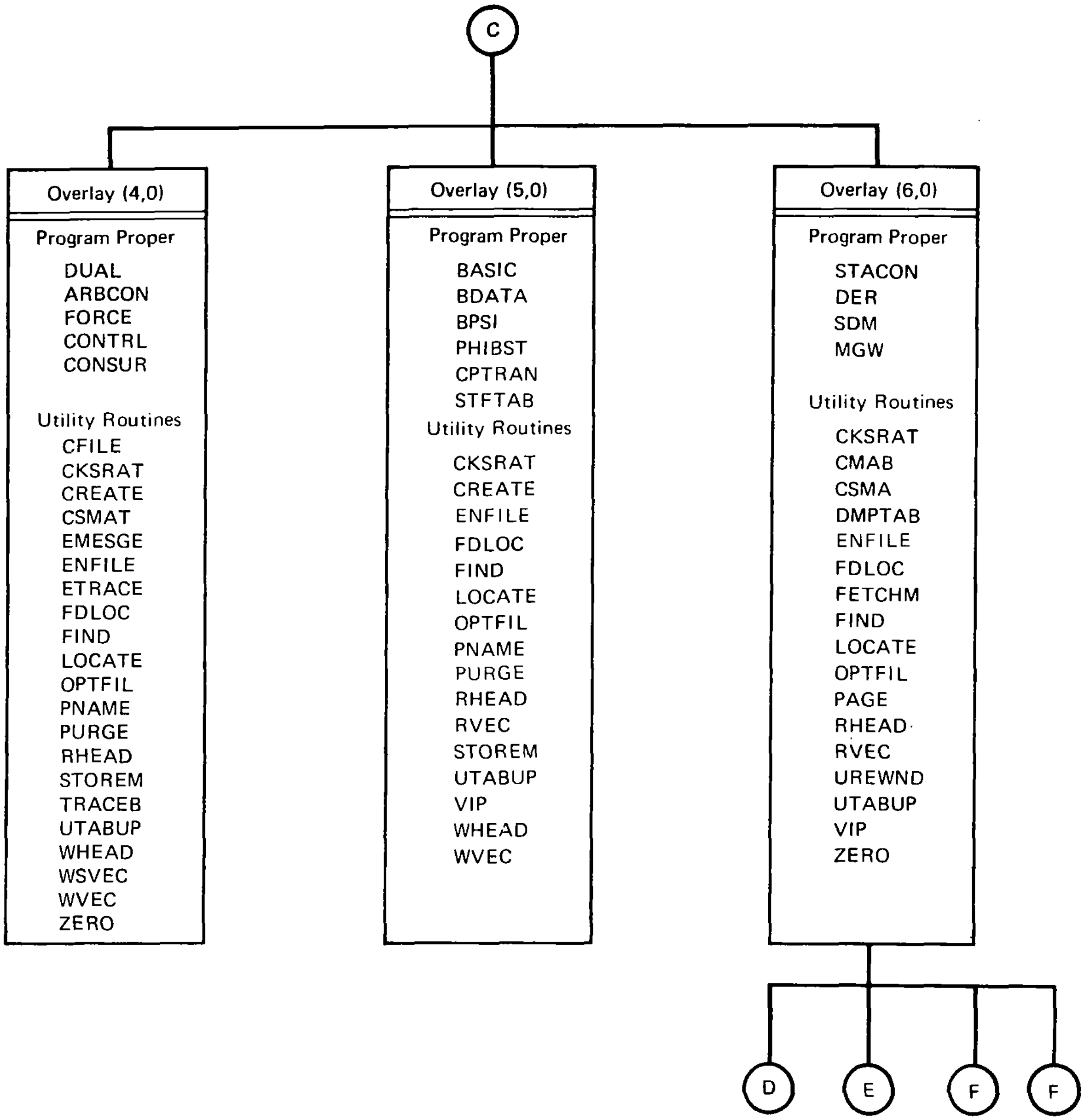


FIGURE 9.1-2.–CONTINUED

D

Overlay (6,1)

Program Proper

DONE
RAIC
DS
DA

Utility Routines

AUTOSV
BCKSUB
COPYM
CREATE
MINVER
MOP
NEEDS
PNAME
PURGE
RECVEC
REDUCE
RELES
STDIN
STDOUT
TAAB
TAINV
TEMAB
TINVER
TMAB
TMABT
TMATB
TPRINT
TRNFER
TSAB
TSATB
TSIA
TSMA
TTRANS
VLIN
WHEAD
WVEC
ZAPPAZ

Overlay (6,2)

Program Proper

TRIM
TMDATA
TS
TA
FS
FA
FT
TRIMCC
TRIMIT
WTDATA
WTDER
F2F3
TMPRT
FTOTAL

Utility Routines

AUTOSV
BCKSUB
CAAB
CINVER
COPYM
CPRINT
CREATE
CSAB
LINEIN
MINVER
MOP
NEEDS
PNAME
PURGE
RECVEC
REDUCE
RELES
STDIN
STDOUT
STOREM
SURFIN
TAAB
TAINV
TEMAB
TINVER
TMAB
TMABT
TMATB
TPRINT
TRNFER
TSAB
TSATB
TSIA
TSMA
TTRANS
VLIN
WHEAD
WVEC
ZAPPAZ

Overlay (6,3)

Program Proper

SHAPE
SMAT
DFP
SD
SDLIST
PRES
SBPRES
TBPRES
LOADS

Utility Routines

AUTOSV
BCKSUB
COPYM
CREATE
MINVER
MOP
NEEDS
PNAME
PURGE
RECVEC
REDUCE
RELES
STDIN
STDOUT
STOREM
TAAB
TAINV
TEMAB
TINVER
TMAB
TMABT
TMATB
TPRINT
TRNFER
TSAB
TSATB
TSIA
TSMA
TTRANS
VLIN
WHEAD
WVEC
ZAPPAZ

FIGURE 9.1-2.—CONTINUED

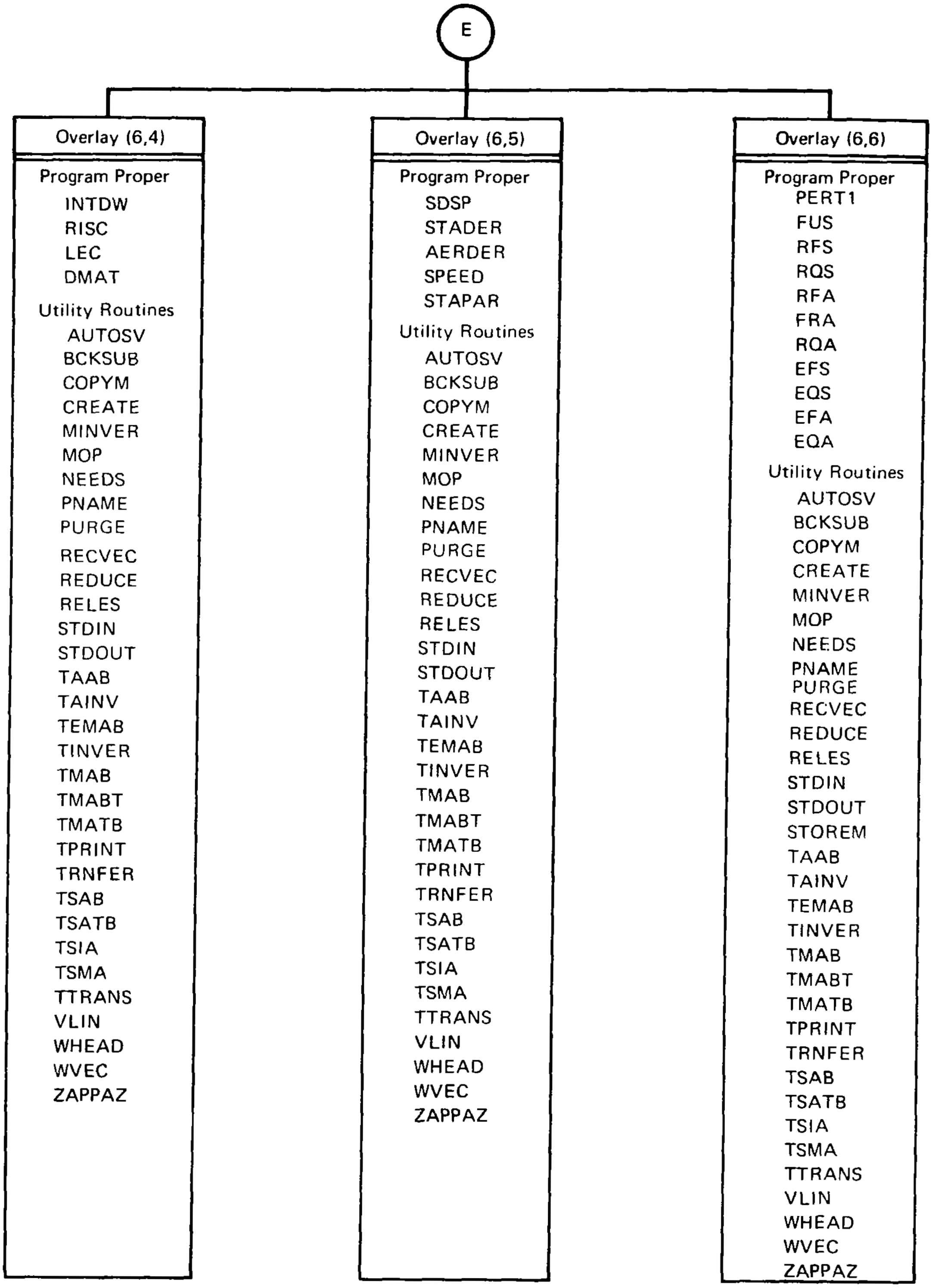


FIGURE 9.1-2.—CONTINUED

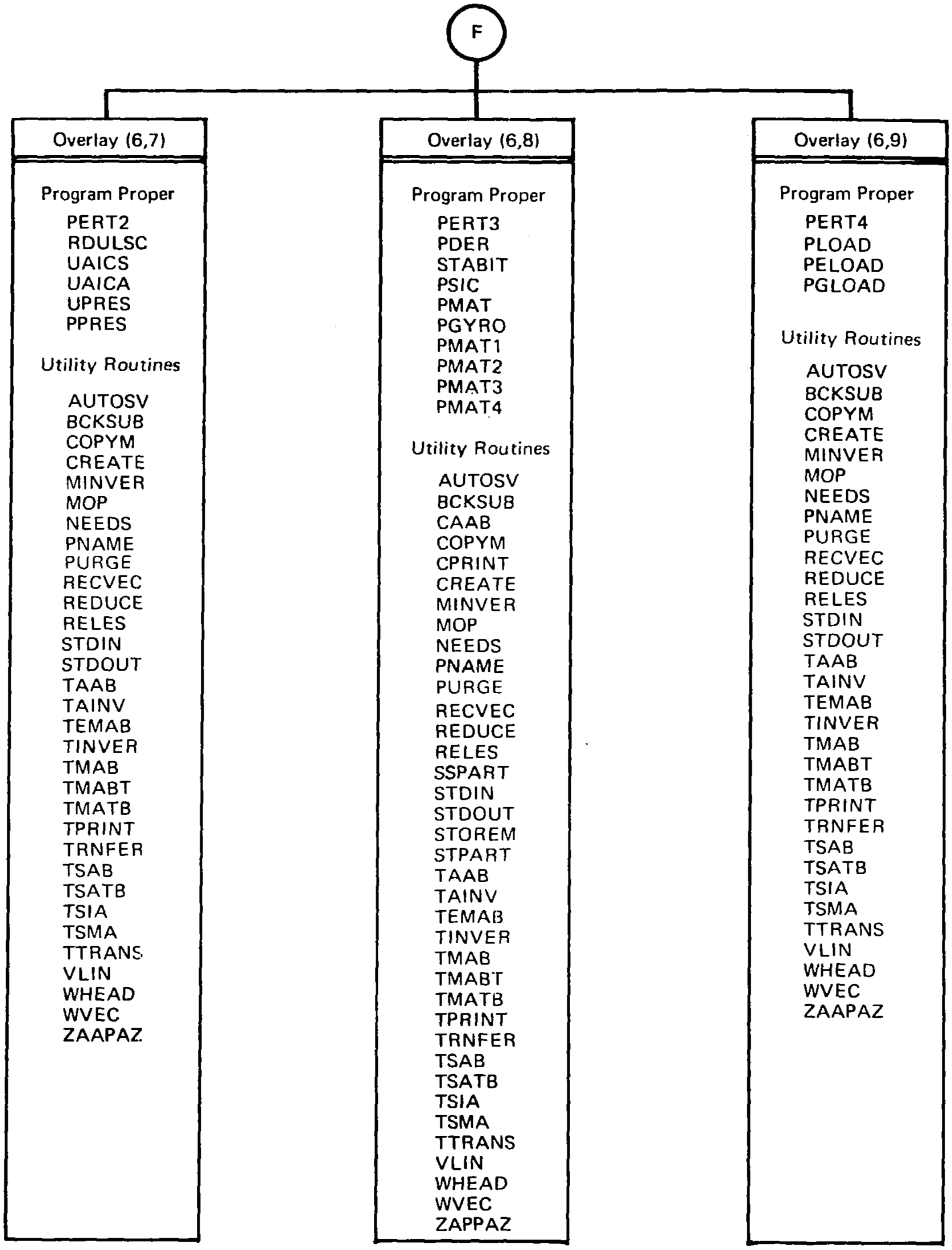


FIGURE 9.1-2.–CONTINUED

F

Overlay (6,10)

Program Proper

PACS
FDS
QDS
FODS
PCSDER
A8A9

ULIB Routines

AUTOSV
BCKSUB
CALVEC
CFILE
CKSRAT
CMAB
COPYM
CPRINT
CREATE
CSMA
CSMAT
DER
DMPTAB
FDLOC
FETCHM
FIND
LOCATE
MINVER
MOP
NEEDS
OPTFIL
PNAME
RECVEC
REDUCE
RELES
RHEAD
RVEC
SDM

Overlay (6,10)

UL1B Routines (continued)

SSPART
STDIN
STDOUT
STOREM
STPART
TAAB
TAINV
TEMAB
TINVER
TMAB
TMABT
TMATB
TPRINT
TRNFER
TSAB
TSATB
TSIA
TSMA
TTRANS
UTABUP
VLIN
WHEAD
WVEC
ZAPPAZ
ZERO

FIGURE 9.1-2.–(CONTINUED)

G

Overlay (7,0)

Program Proper

GUST
PGUST

Utility Routines

AUTOSV
BCKSUB
CKSRAT
COPYM
CREATE
ENFILE
FIND
LOCATE
MINVER
MOP
NEEDS
OPTFIL
PAGE
PNAME
PURGE
RECVEC
REDUCE
RELES
RHEAD
RVEC
STDIN
STDOUT
TAAB
TAINV
TEMAB
TINVER
TMAB
TMABT
TMATB
TPRINT
TRNFER
TSAB
TSATB
TSIA
TSMA
TTRANS
UTABUP
VIP
VLIN
WHEAD
WVEC
ZAPPAZ

Overlay (8,0)

Program Proper

CER
DIGEST
HMAT
LONG1
LAT1
COUP1
LONG2
LAT2
COUP2
CMFIND
DMINIT
DMFIND
DMADD
DMDEL
SEC
EIGENC
GENEIG
EIGENP
HESQR
SCALE
REALVE
COMPVE
CERPRT
AMPHAS

Utility Routines

CINVER
CKSRAT
CMAB
COPY
CSHELL
ENFILE
FDLOC
FIND
FSHELL
LOCATE
OPTFIL
PAGE
RHEAD
RVEC
UTABUP
VIP
WHEAD
WVEC

Overlay (9,0)

Program Proper

HM
HMCAL
HMRIG
HMELAS
HMNM

Utility Routines

AUTOSV
BCKSUB
CKSRAT
CMAB
COPYM
CREATE
CSMAT
CTMAB
DFMES
EMESGE
FDLOC
FETCHM
FIND
LOCATE
MINVER
MOP
NEEDS
OPTFIL
PNAME
RECVEC
REDUCE
RELES
RHEAD
RVEC
STDIN
STDOUT
STOREM
TAAB
TAINV
TEMAB
TINVER
TMAB
TMABT
TMATB
TPRINT
TRACEB
TRNFER
TSAB
TSATB
TSIA
TSMA
TTRANS
UTABUP
VLIN
WHEAD
WVEC
ZAPPAZ
ZERO

Overlay (10,0)

Program Proper

POST
PDATA
MSIZES
SDTAPE
SUMARY

Utility Routines

CKSRAT
COPY
CREATE
DATE
DMPTAB
ENFILE
FIND
LOCATE
OPTFIL
PAGE
PURGE
RHEAD
RVEC
TPRINT
UTABUP
WHEAD
WVEC

FIGURE 9.1-2.–CONCLUDED

TABLE 9.2-1.—DESCRIPTIONS OF SD&SS SUBPROGRAMS

Subprogram name	Flow-chart	Over-lay	Type		Purpose	Interrelationship	
			Prog[a]	Work[b]		Calls	Called by
AERDER	9.3-48	(6,5)	S	C	To compute the total aerodynamic forces and moments	CMAB DER PAGE	SDSP
AMPHAS	—	(8,0)	S	C	To compute the amplitude and phase relationships between two vectors defined by their real and imaginary components	—	CERPRT
ARBCON		(4,0)	S	C	To compute the active control surface matrices	CONSUR FDLOC	DUAL
ARETAB	—	(1,2)	S	C	Creates the table of bodies that are to have modified panel areas	LOCATE UTABUP	RGD
A8A9	9.3-84e	(6,10)	S	C	To output the force matrices due to active controls.	CPRINT CREATE SSPART STOREM STPART ZERO	PACS
BASIC	9.3-19	(5,0)	MP	M	To monitor the creation of the flow incidence matrices	BDATA BPSI CPTRAN PHIBST	MONITR
BDATA	9.3-19	(5,0)	S	C	To prepare the geometric data for the flow incidence matrices	FDLOC	BASIC
BLDTAB	9.3-3	(1,0)	S	C	To place information about previously created matrices into the automatic matrix management tables. This information includes for each matrix: a) Name of the matrix b) Identification number c) I/O unit containing the matrix d) File position	FILE UREWND	PREPAR

a. Identifies the type of subprogram: MP = main program, S = subroutine, and F = function
b. Identifies the type of work performed: C = computation, I/O = input/output, M = monitor, and U = utility

TABLE 9.2-1.–CONTINUED

Subprogram name	Flow-chart	Over-lay	Type		Purpose	Interrelationship	
			Prog[a]	Work[b]		Calls	Called by
BLDTAB (cont.)					In addition, this routine 1) builds tables of information on the status of I/O units used for storage of permanent and intermediate matrices, and 2) records the status of I/O units used for storage of scratch matrices		
BPSI	9.3-19	(5,0)	S	C	To create the flow incidence matrices $\{\psi_C^S\}$, $\{\psi_\alpha^S\}$, $\{\psi_Q^S\}$, $\{\psi_\beta^A\}$, $\{\psi_P^A\}$, $\{\psi_R^A\}$, and the displacement matrix $\{\dot{d}_{IN}^S\}$	FDLOC STOREM	BASIC
CARDIN	9.3-4	(1,1)	MP	M	To monitor the processing of all input card data	DACS DAREA DATA DDYN DEXDW DGYRO DPERT DPRESS DSTAB DSTRU DTRST DTCS DSPLEX DWT INTURP MATPRT MATTAP PAGE RCYCLE SPECS	PREPAR
CDATA	9.3-11	(3,0)	S	C	To prepare the geometric data for the aerodynamic transformation matrices	CREATE FDLOC WHEAD WVEC	TRANS

a. Identifies the type of subprogram: MP = main program, S = subroutine, and F = function
b. Identifies the type of work performed: C = computation, I/O = input/output, M = monitor, and U = utility

TABLE 9.2-1.–CONTINUED

Subprogram name	Flow-chart	Over-lay	Type		Purpose	Interrelationship	
			Prog[a]	Work[b]		Calls	Called by
CER	9.3-87	(8,0)	MP	M	To control the execution of the characteristic equation rooting module	CERPRT DIGEST EIGENC HMAT PAGE	MONITR
CERPRT	9.3-87	(8,0)	S	I/O	To print the final results of the CER module	AMPHAS CSHELL FSHELL PAGE VIP	CER
CINT	9.3-12	(3,0)	S	C	To create the Interference Body matrix [INT] and merge it into the camber transformation matrices $[T_{FP}]$	ENFILE GINT RHEAD RVEC WHEAD WVEC ZERO	CTRANS
CMFIND	—	(8,0)	S	C	To locate the logical file of a requested dynamic stability matrix	—	COUP1 COUP2 LAT1 LAT2 LONG1 LONG2
COMPVE	9.3-86	(8,0)	S	C	To recover eigenvectors	—	EIGENP
CONSUR	9.3-18	(4,0)	S	C	To create a control surface incidence matrix	STOREM ZERO	ARBCON CONTRL

a. Identifies the type of subprogram: MP = main program, S = subroutine, and F = function
b. Identifies the type of work performed: C = computation, I/O = input/output, M = monitor, and U = utility

TABLE 9.2-1.—CONTINUED

Subprogram name	Flow-chart	Over-lay	Type		Purpose	Interrelationship	
			Prog[a]	Work[b]		Calls	Called by
DA	9.3-24	(6,1)	S	C	To compute the antisymmetric rigid and static elastic stability matrices	MOP RELES	DONE
DACS	9.3-4	(1,1)	S	I/O	To process active control surface data	PAGE DCONRL	CARDIN
DAREA	9.3-4	(1,1)	S	I/O	To process the area ratio data	ENFILE PAGE	CARDIN
DCONRL	9.3-4	(1,1)	S	I/O	To process control input data common to trim and active controls	EMESGE PAGE	DACS DTCS
DDYN	9.3-4	(1,1)	S	I/O	To process the dynamic analysis data	PAGE	CARDIN
DER	9.3-50	(6,0)	S	C	To calculate the $[DER^S]$ and $[DER^A]$ matrices	—	AERDER CONDER SPEED STABIT STADER
DEXDW	9.3-4	(1,1)	S	I/O	To process the exterior downwash matrices (input on data cards)	PAGE WHEAD WVEC	CARDIN
DFP	9.3-39	(6,3)	S	C	To compute the pressure force matrices in the airplane shape module	MOP RCCAL RELES	SHAPE
DGYRO	9.3-4	(1,1)	S	I/O	To process the gyroscopic card input data	PAGE	CARDIN

a. Identifies the type of subprogram: MP = main program, S = subroutine, and F = function
b. Identifies the type of work performed: C = computation, I/O = input/output, M = monitor, and U = utility

TABLE 9.2-1.–CONTINUED

Subprogram name	Flow-chart	Overlay	Type		Purpose	Interrelationship	
			Prog[a]	Work[b]		Calls	Called by
DONE	9.3-21	(6,1)	MP	M	To monitor the rigid and static elastic stability matrix calculations	DA DS RAIC STATUS	STACON
DPERT	9.3-4	(1,1)	S	I/O	To process the perturbation (dynamic) stability card input data	PAGE	CARDIN
DPRESS	9.3-4	(1,1)	S	I/O	To process the external pressure distribution data	ENFILE PAGE	CARDIN
DS	9.3-23	(6,1)	S	C	To compute the symmetric rigid and static elastic stability matrices	MOP RELES STATUS	DONE
DSPLEX	9.3-4	(1,1)	S	I/O	To process the special SDSS execution data	PAGE	CARDIN
DSTAB	9.3-4	(1,1)	S	I/O	To process the stability card input data	PAGE	CARDIN
DSTRU	9.3-4	(1,1)	S	I/O	To process the structural data	PAGE	CARDIN
DTRANS	9.3-15	(3,0)	S	C	To create the integrated downwash transformation matrices $[TRANS_{ID}{}^{S}]$ and $[TRANS_{ID}{}^{A}]$	CREATE FDLOC PNAME RVEC WHEAD WSVEC WVEC ZERO	TRANS
DTCS	9.3-4	(1,1)	S	I/O	To process trim control data	CFILE DCONRL EMESGE PAGE	CARDIN
DTRST	9.3-4	(1,1)	S	I/O	To process the thrust vector card input data	PAGE	CARDIN
DUAL	9.3-16	(4,0)	MP	M	To monitor the creation of the aerodynamic force transformation matrices and the control surface transformation matrices	CONTRL FORCE	MONITR
DWT	9.3-4	(1,1)	S	I/O	To process the wind tunnel card input data	PAGE SURFIN	CARDIN
EFA	9.3-61	(6,6)	S	C	To compute the antisymmetric elastic aerodynamic perturbation forces	FETCHM MOP PNAME RELES	PERT1

a. Identifies the type of subprogram: MP = main program, S = subroutine, and F = function
b. Identifies the type of work performed: C = computation, I/O = input/output, M = monitor, and U = utility

TABLE 9.2-1.–CONTINUED

Subprogram name	Flow-chart	Over-lay	Type		Purpose	Interrelationship	
			Prog[a]	Work[b]		Calls	Called by
EFS	9.3-59	(6,6)	S	C	To compute the symmetric elastic aerodynamic perturbation forces	FETCHM MOP PNAME RELES	PERT1
EIGENC	——	(8,0)	S	M	To communicate with the eigenvector routine GENEIG	GENEIG	CER
EIGENP	9.3-86	(8,0)	S	C	To root the characteristic matrix, $[H_1]$	COMPVE HESQR REALVE SCALE	GENEIG
ENGINE	9.3-7	(2,0)	MP	M	To monitor the creation of the thrust and gyroscopic transformation matrices	GYRO TDATA TMAT	MONITR
EQA	9.3-62	(6,6)	S	C	To compute the antisymmetric elastic normal modes aerodynamic perturbation forces	MOP RELES	PERT1
EQS	9.3-60	(6,6)	S	C	To compute the symmetric elastic normal modes aerodynamic perturbation forces	MOP RELES	PERT1
FA	9.3-30	(6,2)	S	C	To compute the antisymmetric stability forces	FETCHM FDLOC RVEC VIP VIPA ZERO	TRIM
FDATA	9.3-6	(1,3)	S	I/O	To retrieve important airplane structural data from SICTP3	SICPAR	PREPAR
FDS	9.3-84a	(6,10)	S	C	To calculate the forces due to active controls	CALVEC ZERO	PACS
FILE	9.3-3	(1,0)	S	C	To determine the I/O unit containing the requested matrix and the most efficient method to access it	——	BLDTAB

a. Identifies the type of subprogram: MP = main program, S = subroutine, and F = function
b. Identifies the type of work performed: C = computation, I/O = input/output, M = monitor, and U = utility

TABLE 9.2-1.–CONTINUED

Subprogram name	Flow-chart	Over-lay	Type		Purpose	Interrelationship	
			Prog[a]	Work[b]		Calls	Called by
FOOLRM	—	(0,0)	S	I/O	To force the CDC Record Manager to load its utilities in the (0,0) overlay	—	—
FODS	9.3-84c	(6,10)	S	C	To include empirical forces due to active controls	CMAB FDLOC SDM ZERO	PACS
FORCE	9.3-13	(4,0)	S	C	To create the aerodynamic force transformation matrices $[T_{TF}^{S}]$, $[T_{TF}^{A}]$, $[T_{fT}^{S}]$, and $[T_{fT}^{A}]$	CREATE FDLOC PNAME WHEAD WSVEC	DUAL
FRA	—	(6,6)	S	C	To add speed term to the yaw rate derivatives	FETCHM MOP RELES STOREM ZERO	RFA
FS	9.3-29	(6,2)	S	C	To compute the symmetric static stability forces	FETCHM FDLOC PAGE RVEC VIP VIPA ZERO	TRIM
FT	9.3-31	(6,2)	S	C	To 1) add thickness effects to stability forces, 2) compute stability forces due to thrust, 3) compute stability forces due to gyroscopic effects, and 4) add wind tunnel data when available	FETCHM MGW MOP RELES STOREM	TRIM
FTOTAL	9.3-36	(6,2)	S	C	To calculate the total external and the total aerodynmaic forces acting on the airplane	CMAB	TRIMCC TRIMIT

a. Identifies the type of subprogram: MP = main program, S = subroutine, and F = function
b. Identifies the type of work performed: C = computation, I/O = input/output, M = monitor, and U = utility

TABLE 9.2-1.–CONTINUED

Subprogram name	Flow-chart	Over-lay	Type		Purpose	Interrelationship	
			Prog[a]	Work[b]		Calls	Called by
FUS	9.3-54	(6,6)	S	C	To compute the symmetric rigid aerodynamic perturbation speed forces	FETCHM MOP PNAME RELES	PERT1
F2F3	9.3-35	(6,2)	S	C	To calculate the elastic increment trim matrices $\{F_2\}$ and $\{F_3\}$	——	TRIMCC TRIMIT
GENEIG	——	(8,0)	S	M	To communicate with the eigenvector routine EIGENP	EIGENP	EIGENC
GINT	——	(3,0)	S	C	To generate the transformation matrix that transforms interference panel forces to line singularities	WHEAD WVEC ZERO	CINT
GUST	9.3-85	(7,0)	MP	M	To monitor the creation of the aerodynamic gust matrices	PAGE PGUST	MONITR
GYRO	9.3-9	(2,0)	S	C	To create the gyroscopic transformation matrices $\left[G^{SS} \vdots G^{SA}\right]$, $\left[G^{AS} \vdots G^{AA}\right]$, $\left[\frac{\partial G^{SS}}{\partial \omega} \vdots \frac{\partial G^{SA}}{\partial \omega}\right]$, $\left[\frac{\partial G^{AS}}{\partial \omega} \vdots \frac{\partial G^{AA}}{\partial \omega}\right]$, $\left[\bar{G}^{S}\right]$, $\left[\bar{G}^{A}\right]$, $\left[\frac{\partial \bar{G}^{S}}{\partial \omega}\right]$, and $\left[\frac{\partial \bar{G}^{A}}{\partial \omega}\right]$	FDLOC STOREM ZERO	ENGINE
HESQR	9.3-94	(8,0)	S	C	To perform a Hessenberg reduction on the scaled characteristic matrix, $[H_1]$, and then compute the eigenvalues	——	EIGENP

a. Identifies the type of subprogram: MP = main program, S = subroutine, and F = function
b. Identifies the type of work performed: C = computation, I/O = input/output, M = monitor, and U = utility

TABLE 9.2-1.—CONTINUED

Subprogram name	Flow-chart	Over-lay	Type		Purpose	Interrelationship	
			Prog[a]	Work[b]		Calls	Called by
HM	9.3-94a	(9,0)	MP	M	To monitor calculation of the hinge moments	DFMES ETRACE HMCAL PAGE STATUS	MONITR
HMAT	9.3-87	(8,0)	S	M	To monitor the computation of the characteristic matrix, H_1	COUP1 COUP2 DMINIT LAT1 LAT2 LONG1 LONG2	CER
HMCAL	9.3-94b	(9,0)	S	C	To calculate the hinge moments for trim and active controls	CSMAT CTMAB EMESGE ETRACE FDLOC HMELAS HMNM HMRIG PAGE RVEC ZERO	HM
HMELAS	9.3-94d	(9,0)	S	C	To calculate the elastic increment to the hinge moments	EMESGE ETRACE FETCHM MOP RELES VIP VIPA	HMCAL
HMNM	9.3-94e	(9,0)	S	C	To calculate the hinge moments due to modal forces	CMAB EMESGE ETRACE FETCHM	HMCAL

a. Identifies the type of subprogram: MP = main program, S = subroutine, and F = function
b. Identifies the type of work performed: C = computation, I/O = input/output, M = monitor, and U = utility

TABLE 9.2-1.—CONTINUED

Subprogram name	Flow-chart	Over-lay	Type		Purpose	Interrelationship	
			Prog[a]	Work[b]		Calls	Called by
HMRIG	9.3-94c	(9,0)	S	C	To calculate rigid body hinge moments	CTMAB EMESGE ETRACE FETCHM STOREM VIP VIPA	HMCAL
HTRANS	9.3-14	(3,0)	S	C	To create the thickness transformation matrices [$TRANS_t$] and [AT]	CREATE FDLOC PNAME RVEC WHEAD WSVEC WVEC	TRANS
INITAL	9.3-1	(0,0)	S	C	To initialize key program variables such as options, flight parameters (ρ, P_1, R_1, Q_1, ϕ, etc.), matrix sizes, etc.	INTAL1 INTAL2 INTAL3	SDSS
INTAL1	9.3-1	(0,0)	S	C	To initialize key program variables	—	INITAL
INTAL2	9.3-1	(0,0)	S	C	To initialize key program variables	—	INITAL
INTAL3	9.3-1	(0,0)	S	C	To initialize key program variables	—	INITAL
INTDW	9.3-44	(6,4)	MP	M	To monitor the integrated downwash matrix module	DMAT RISC	STACON
IOUNTS	9.3-1	(0.0)	S	C	To assign the I/O unit numbers and to initialize matrix file position indicators	—	SDSS
LAT1	9.3-89	(8,0)	S	C	To develop the characteristic matrix, [H_1], for a static-elastic model in antisymmetric motion	CINVER CMAB CMFIND DMADD RHEAD RVEC SEC	HMAT

a. Identifies the type of subprogram: MP = main program, S = subroutine, and F = function
b. Identifies the type of work performed: C = computation, I/O = input/output, M = monitor, and U = utility

TABLE 9.2-1.–CONTINUED

Subprogram name	Flow-chart	Over-lay	Type		Purpose	Interrelationship	
			Prog[a]	Work[b]		Calls	Called by
MATCAT	9.3-5	(1,2)	S	I/O	To process the aerodynamic and structural matrix catalogs (first file on AICTAP and SICTP3 magnetic tapes	ENFILE PAGE	TAPEIN
MATPRT	9.3-4	(1,1)	S	I/O	To process the matrix print list of the card input data	PAGE	CARDIN
MATTAP	9.3-4	(1,1)	S	I/O	To process the list of matrices to be put onto SDSSTP in addition to standard matrices	PAGE	CARDIN
MGW	9.3-32	(6,0)	S	C	To calculate the $\{M^{G^S}\}$ and $\{M^{G^A}\}$ matrices	CMAB CSMA FETCHM	FT SMAT
MONITR	9.3-2	(0,0)	S	M	To monitor problem execution by directing the data case to the appropriate modules	BASIC CER DUAL ENGINE GUST HM POST PREPAR STACON STATUS TRANS	SDSS
MSIZES	9.3-95	(7,0)	S	I/O C	To print information concerning the matrix sizes used in the SD&SS program	PAGE	POST

a. Identifies the type of subprogram: MP = main program, S = subroutine, and F = function
b. Identifies the type of work performed: C = computation, I/O = input/output, M = monitor, and U = utility

TABLE 9.2-1.–CONTINUED

Subprogram name	Flow-chart	Over-lay	Type		Purpose	Interrelationship	
			Prog[a]	Work[b]		Calls	Called by
PACS	9.3-84	(6,10)	MP	M	To monitor execution of the active controls module	A8A9 FDS FODS PCSDER QDS	STACON
PCSDER	9.3-84d	(6,10)	S	I/O	To print the derivatives due to active controls	AUTOSV CMAB DER PAGE STOREM	PACS
PDATA	9.3-95	(9,0)	S	I/O	To collect and output (on magnetic tape) data required by the TH program	CREATE LOCATE PAGE	POST
PDER	9.3-69	(6,8)	S	C I/O	To compute and print the dynamic stability derivatives	AUTOSV CPRINT FDLOC PAGE SDM STABIT ZERO	PERT3
PELOAD	9.3-82	(6,9)	S	C I/O	To compute the elastic increment dynamic structural load matrices for SLOADS program	MOP PAGE RELES	PERT4

a. Identifies the type of subprogram: MP = main program, S = subroutine, and F = function
b. Identifies the type of work performed: C = computation, I/O = input/output, M = monitor, and U = utility

TABLE 9.2-1.–CONTINUED

Subprogram name	Flow-chart	Over-lay	Type		Purpose	Interrelationship	
			Prog[a]	Work[b]		Calls	Called by
PREPAR	9.3-3	(1,0)	MP	M	To monitor the processing of all incoming data (cards and magnetic tape)	BLDTAB CARDIN DMPTAB FDATA TAPEIN UREWND	MONITR
PRES	9.3-53	(6,3)	S	M	To monitor the steady pressure distribution calculations	CREATE LOCATE PAGE SBPRES TBPRES	SHAPE
PSIC	9.3-71	(6,8)	S	I/O	To output $[k_1^{S,A}]$ and $[m_1^{S,A}]$ matrices needed for TH on the SDSSTP	FETCHM STOREM	PERT3
PTRANS	9.3-13	(3,0)	S	C	To create the pressure distribution transformation matrix $[T_{\Delta P}]$	STOREM	TRANS
QDS	9.3-84b	(6,10)	S	C	To compute the generalized aerodynamic forces due to active controls	CALVEC ZERO	PACS
RAIC	9.3-22	(6,1)	S	C	To reduce the steady AIC matrices $[LSC^S]$, $\left[\frac{\partial LSC^S}{\partial M}\right]$, and $[LSC^A]$	CREATE FDLOC PNAME RVEC WHEAD WVEC	DONE
RCCAL	—	(0,0)	S	U	To check a block of logic and determine if computations are necessary during a recycle case	—	DFP SMAT STACON TRIM

a. Identifies the type of subprogram: MP = main program, S = subroutine, and F = function
b. Identifies the type of work performed: C = computation, I/O = input/output, M = monitor, and U = utility

TABLE 9.2-1.–CONTINUED

Subprogram name	Flow-chart	Over-lay	Type		Purpose	Interrelationship	
			Prog[a]	Work[b]		Calls	Called by
SMAT	9.3-38	(6,3)	S	C	To compute the intial symmetric and antisymmetric shape matrices	MGW MOP PURGE RCCAL RELES STOREM	SHAPE
SPECS	9.3-4	(1,1)	S	I/O	To process the general problem specifications of the card input data	ATMO62 ENFILE LOCATE PAGE	CARDIN
SPEED	9.3-51	(6,5)	S	I/O C	To compute and print the speed derivatives	CMAB DER FETCHM MOP PAGE RELES	SDSP
STABIT	9.3-70	(6,8)	S	C	To transform the dynamic (perturbation) stability forces to derivatives	DER ZERO	PDER
STACON	9.3-20	(6,0)	MP	M	To monitor the stability and control module	DMPTAB DONE INTDW PAGE PERT1 PERT2 PERT3 PERT4 PACS RCCAL SDSP SHAPE STATUS TRIM UREWND ZERO	MONITR

a. Identifies the type of subprogram: MP = main program, S = subroutine, and F = function
b. Identifies the type of work performed: C = computation, I/O = input/output, M = monitor, and U = utility

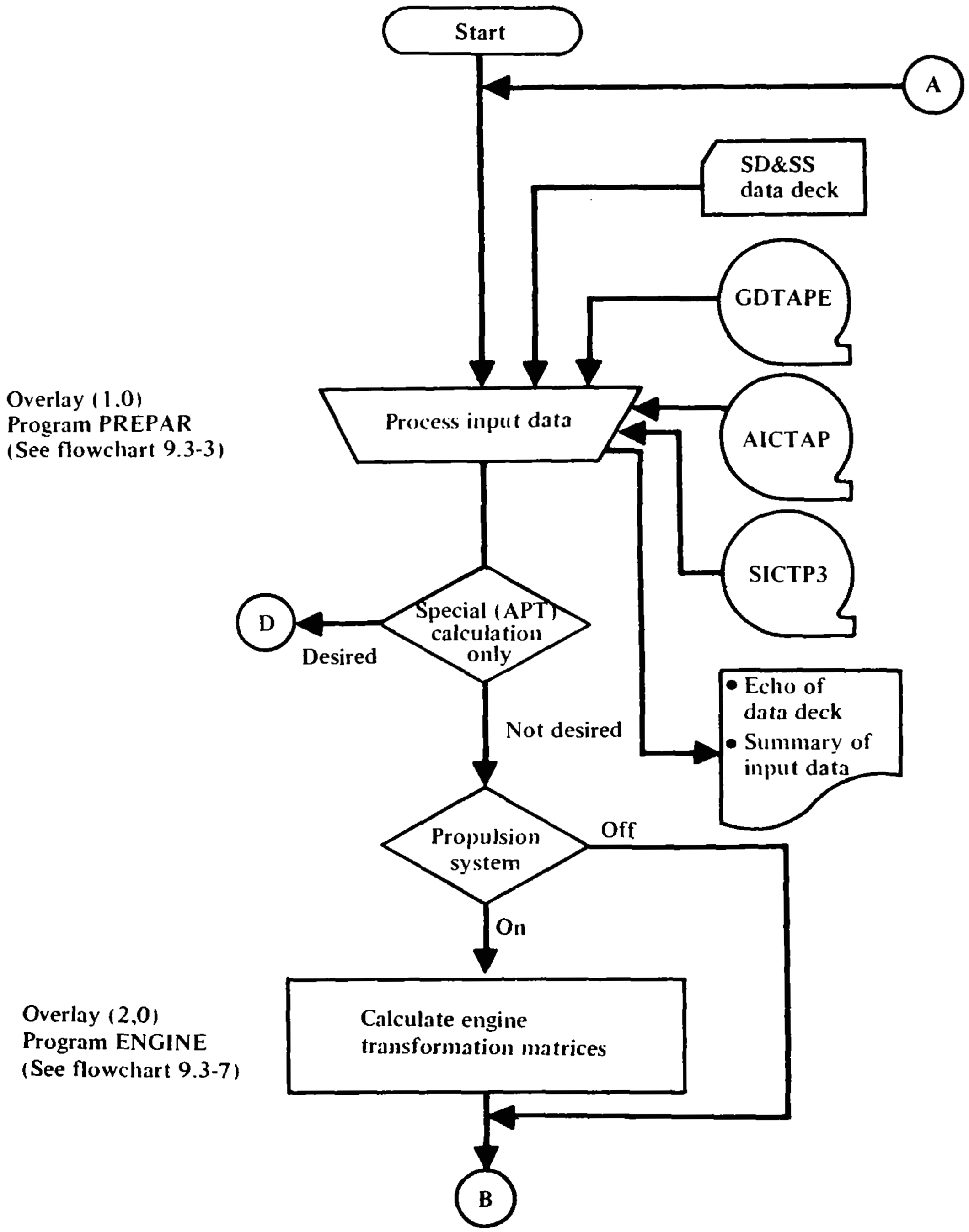
TABLE 9.2-1–CONTINUED

Subprogram name	Flow-chart	Over-lay	Type		Purpose	Interrelationship	
			Prog[a]	Work[b]		Calls	Called by
STADER	9.3-49	(6,5)	S	I/O C	To compute and print the static stability derivatives	AUTOSV CMAB DER FETCHM FDLOC PAGE RVEC VIP	SDSP
STAPAR	9.3-52	(6,5)	S	I/O C	To compute and print the stability parameters (static margin, neutral point, etc.)	PAGE	SDSP
STFTAB	—	(5,0)	S	C	To compute $\{\Delta CP_o\}$, $\{\Delta CP_\alpha\}$, $\{\Delta CP_\beta\}$ arrays with the input data	—	CPTRAN
SUM	—	(1,2)	S	U	To sum the elements of an array	—	RGD
SUMARY	9.3-95	(9,0)	C	I/O	To print a summary of data for the present cycle	DATE	POST
TA	9.3-28	(6,2)	S	C	To compute antisymmetric trim matrices	CREATE FDLOC MOP PNAME RELES RVEC WHEAD WVEC	TRIM
TAPEIN	9.3-5	(1,2)	MP	M	To monitor the processing of the input magnetic tape data	MATCAT PGD RGD	PREPAR
TBPRES	9.3-53	(6,3)	S	I/O C	To compute, print, and punch the steady pressure distributions on Thin Bodies	FDLOC FETCHM PAGE ZERO	PRES
TDATA	9.3-8	(2,0)	S	C	To prepare the thrust vector data	FDLOC	ENGINE

a. Identifies the type of subprogram: MP = main program, S = subroutine, and F = function

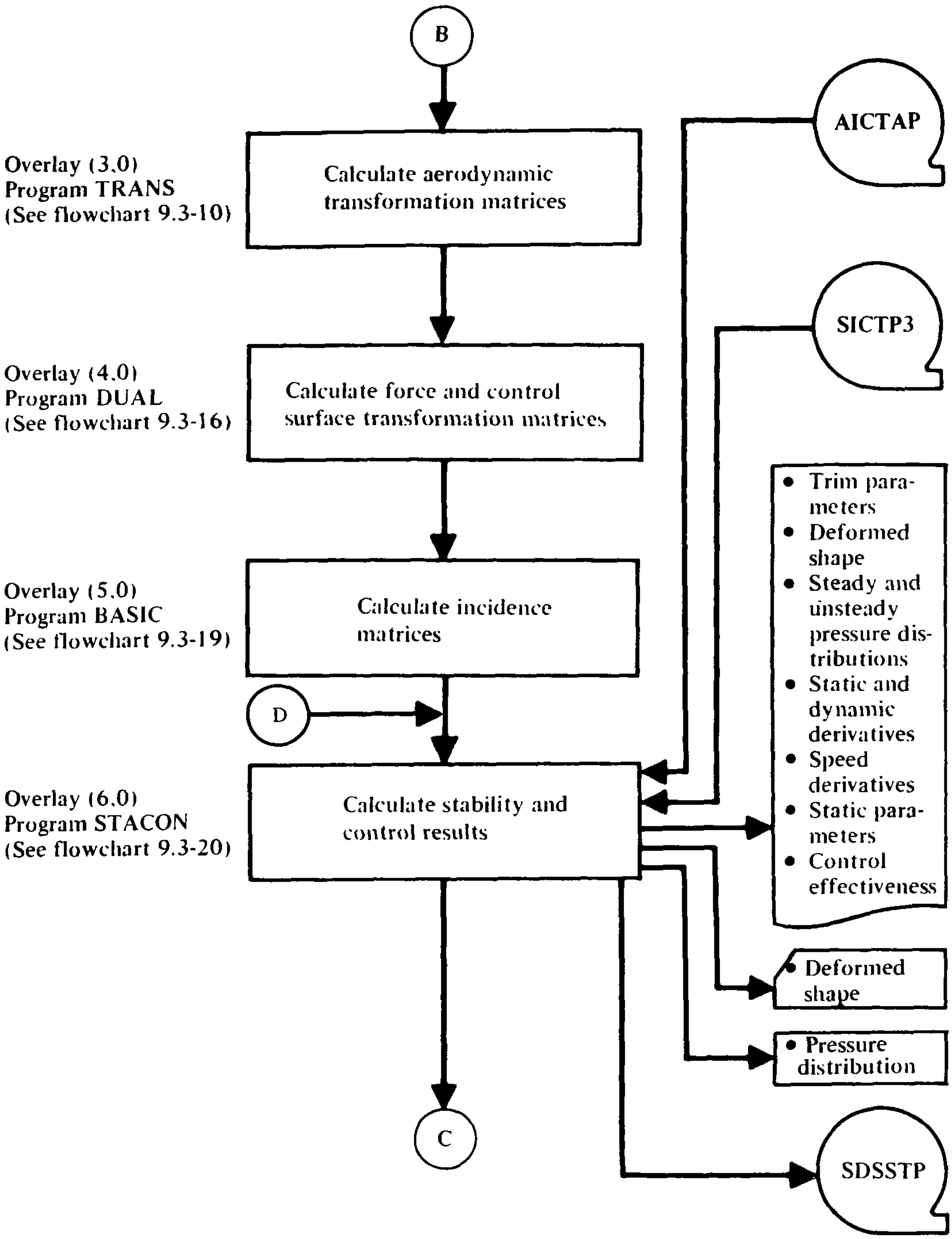
b. Identifies the type of work performed: C = computation, I/O = input/output, M = monitor, and U = utility

Subroutine MONITR

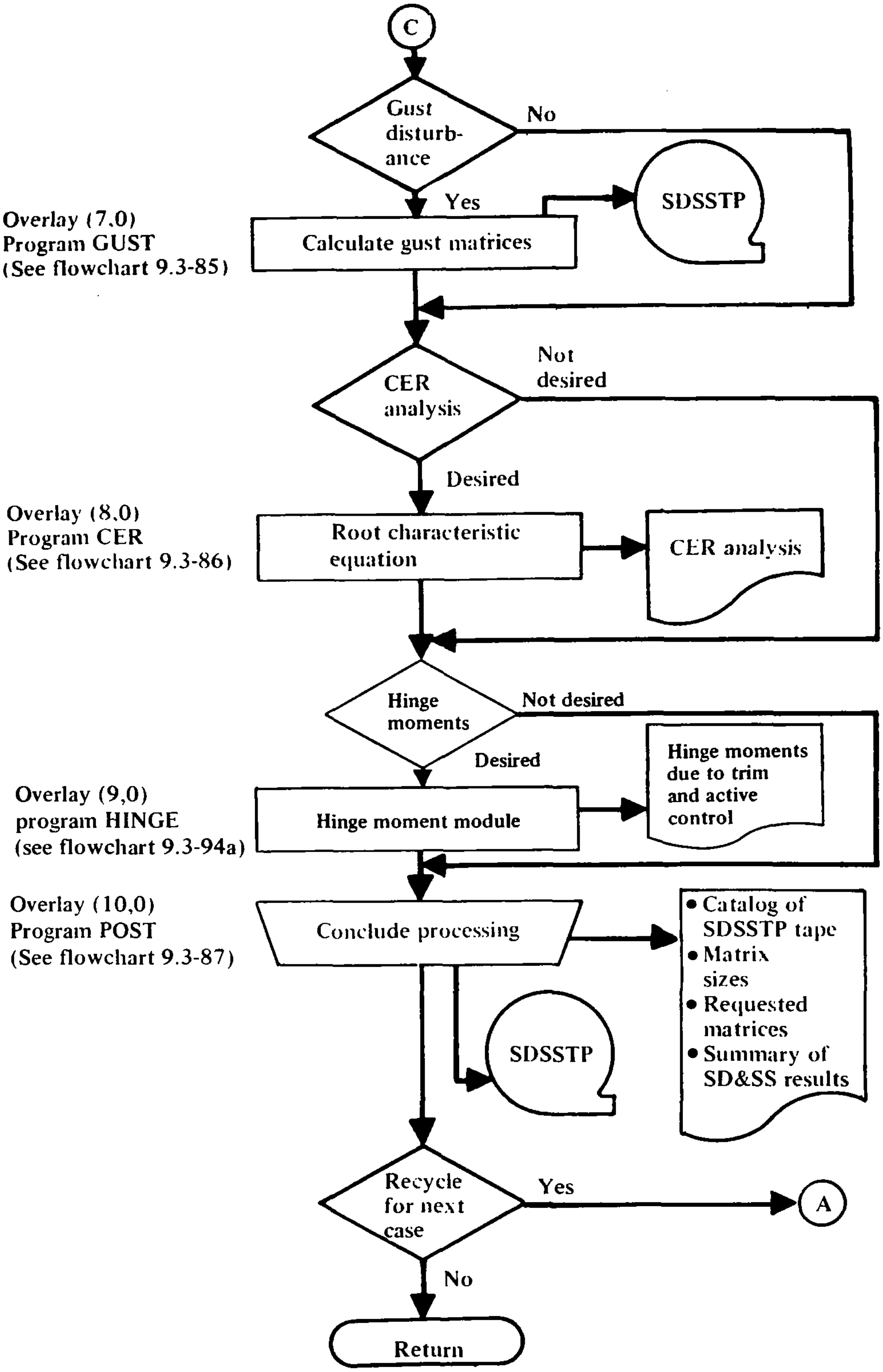


FLOWCHART 9.3-2.– SD&SS CONTROL ROUTINE

MONITR (Cont.)

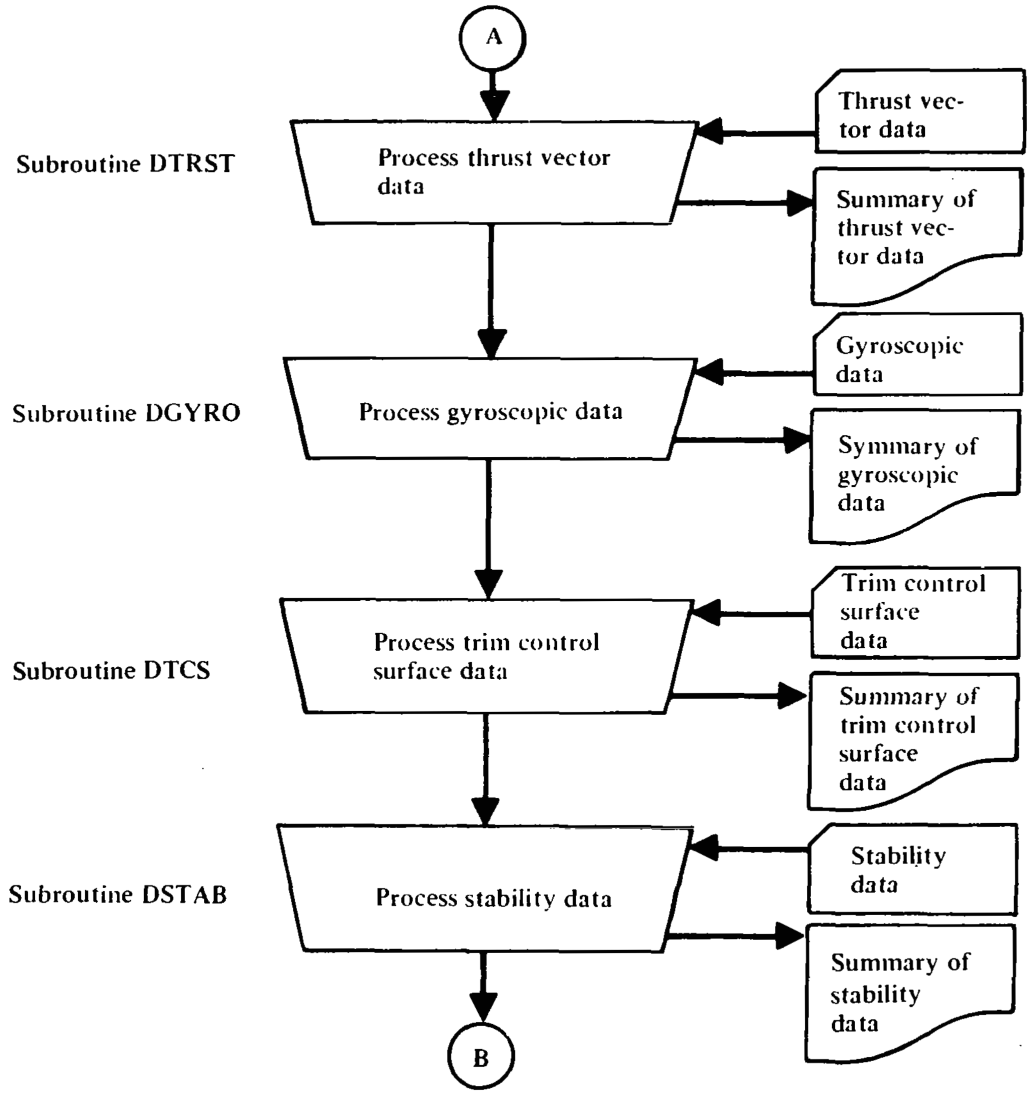


FLOWCHART 9.3-2.—CONTINUED



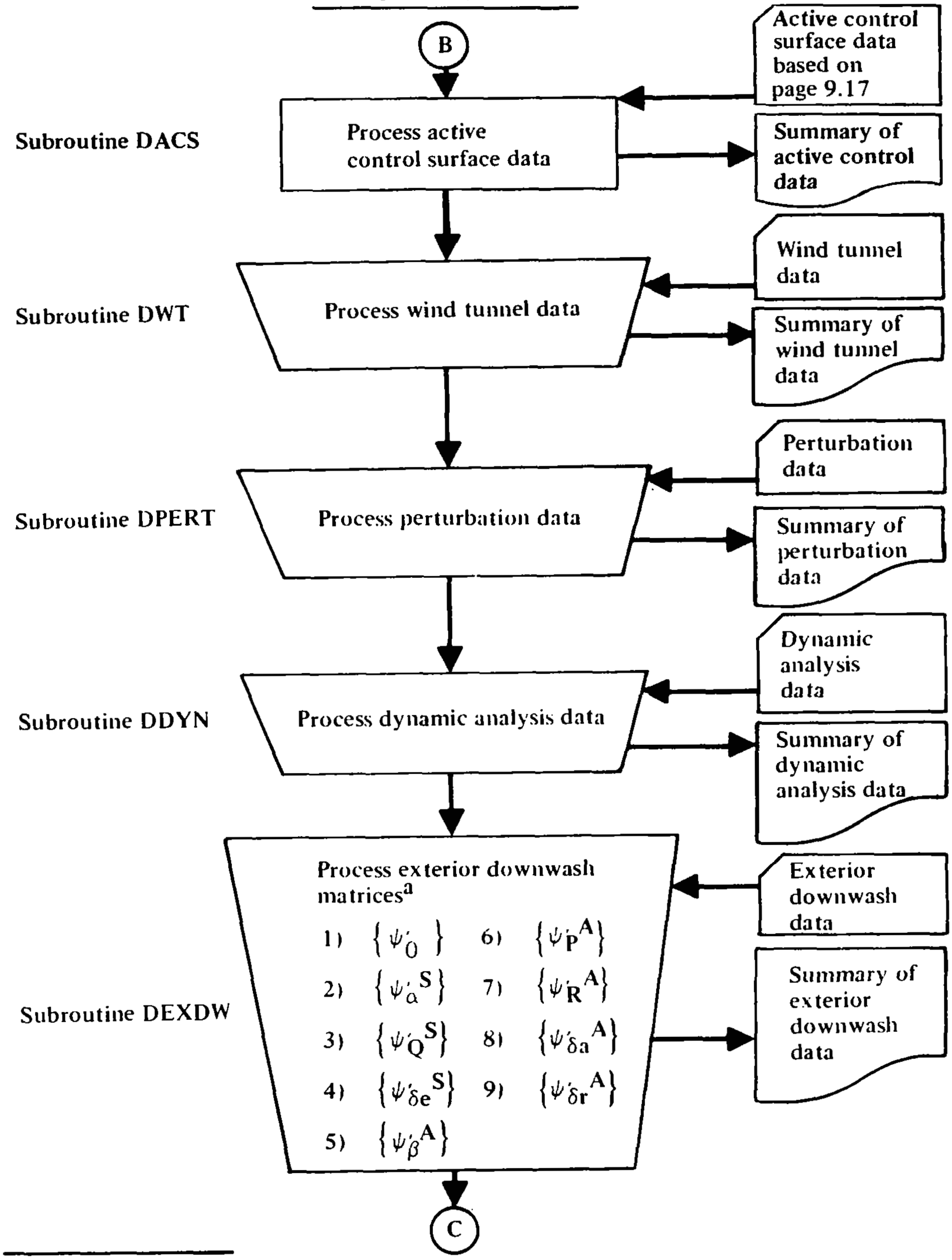
FLOWCHART 9.3-2.—CONCLUDED

CARDIN (Cont.)



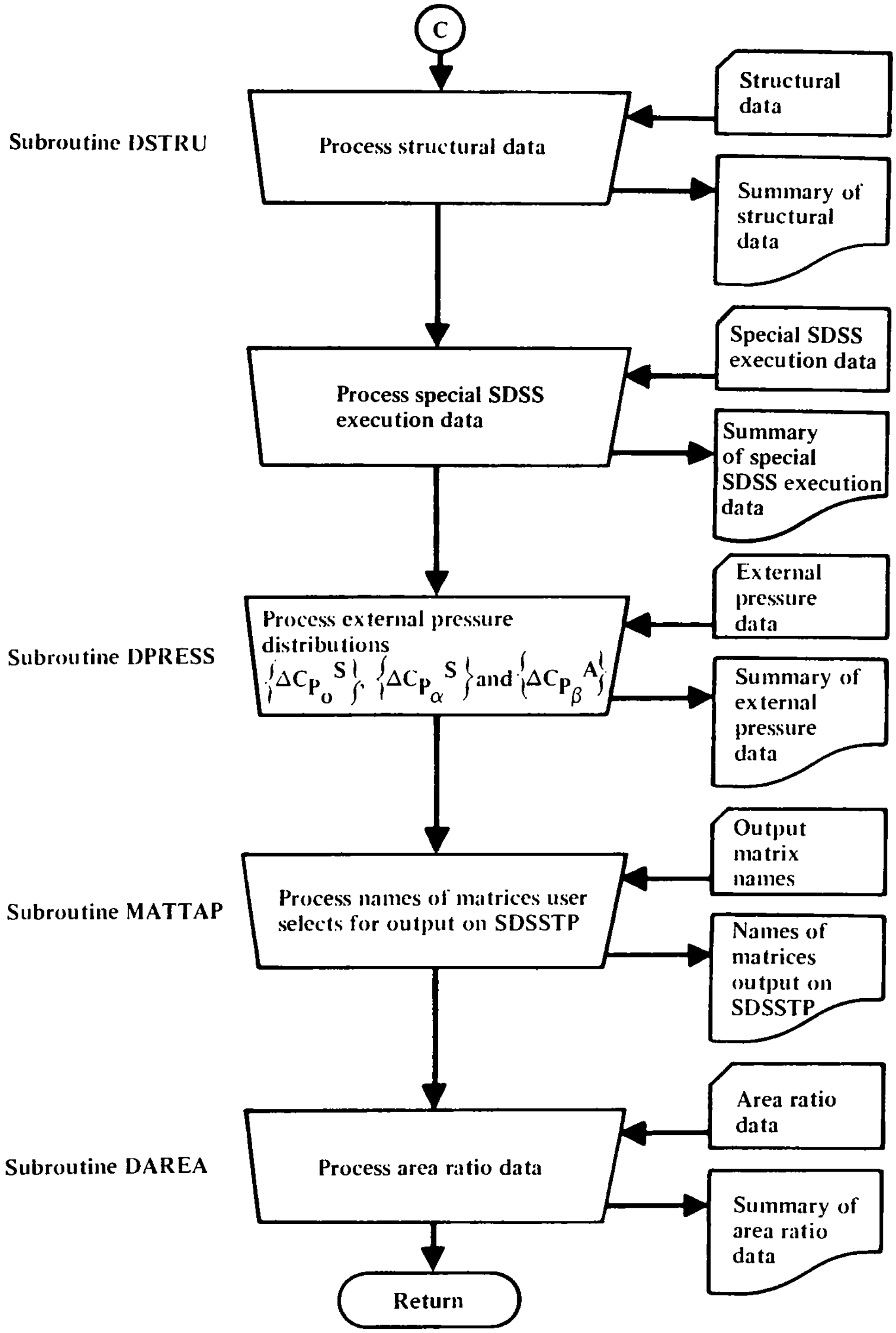
FLOWCHART 9.3-4.—CONTINUED

CARDIN (Cont.)

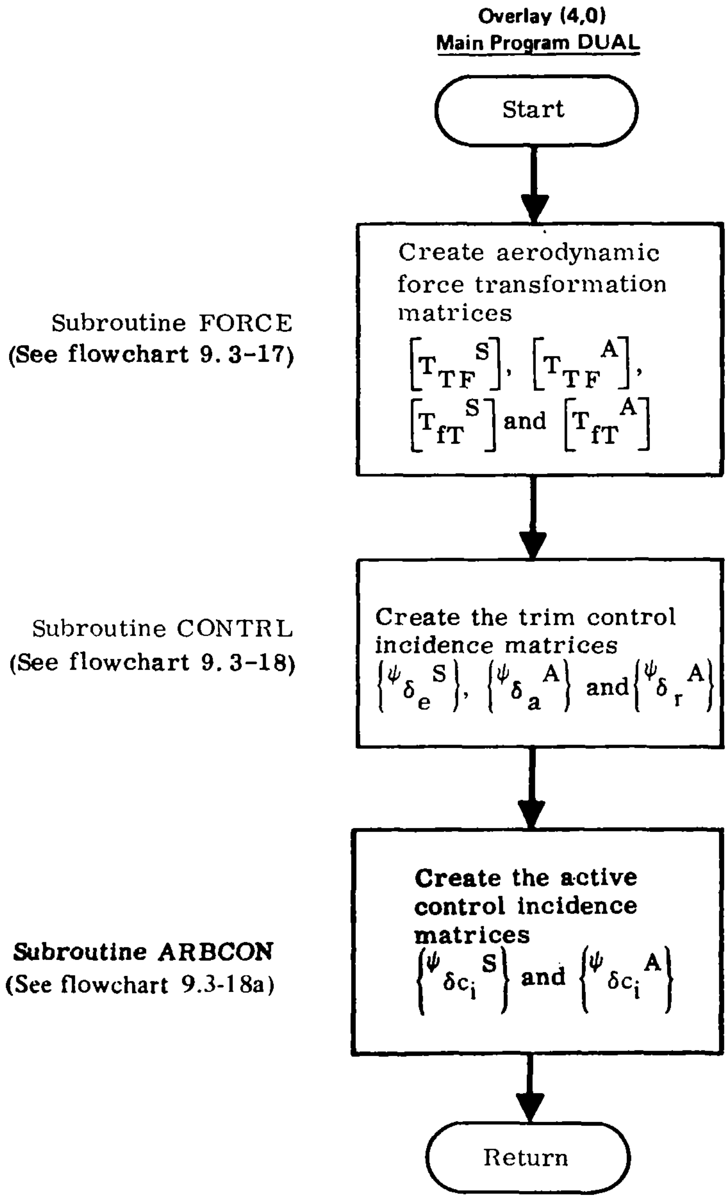


[a]The exterior downwash matrices $\{\psi'_i\}$ described in section 3.4.14 of volume I, are incorporated into the equations of volume I by replacing the matrix products $[A_{P0}]$ $\{\psi_i\}$ by the sum of the matrix products $[A_{P0}]$ $\{\psi_i\}$ + $[LSC]$ $\{\psi'_i\}$ where $\{\psi_i\}$ is any one of the column matrices appearing in equation (3.5-45) of volume I.

FLOWCHART 9.3-4.—CONTINUED

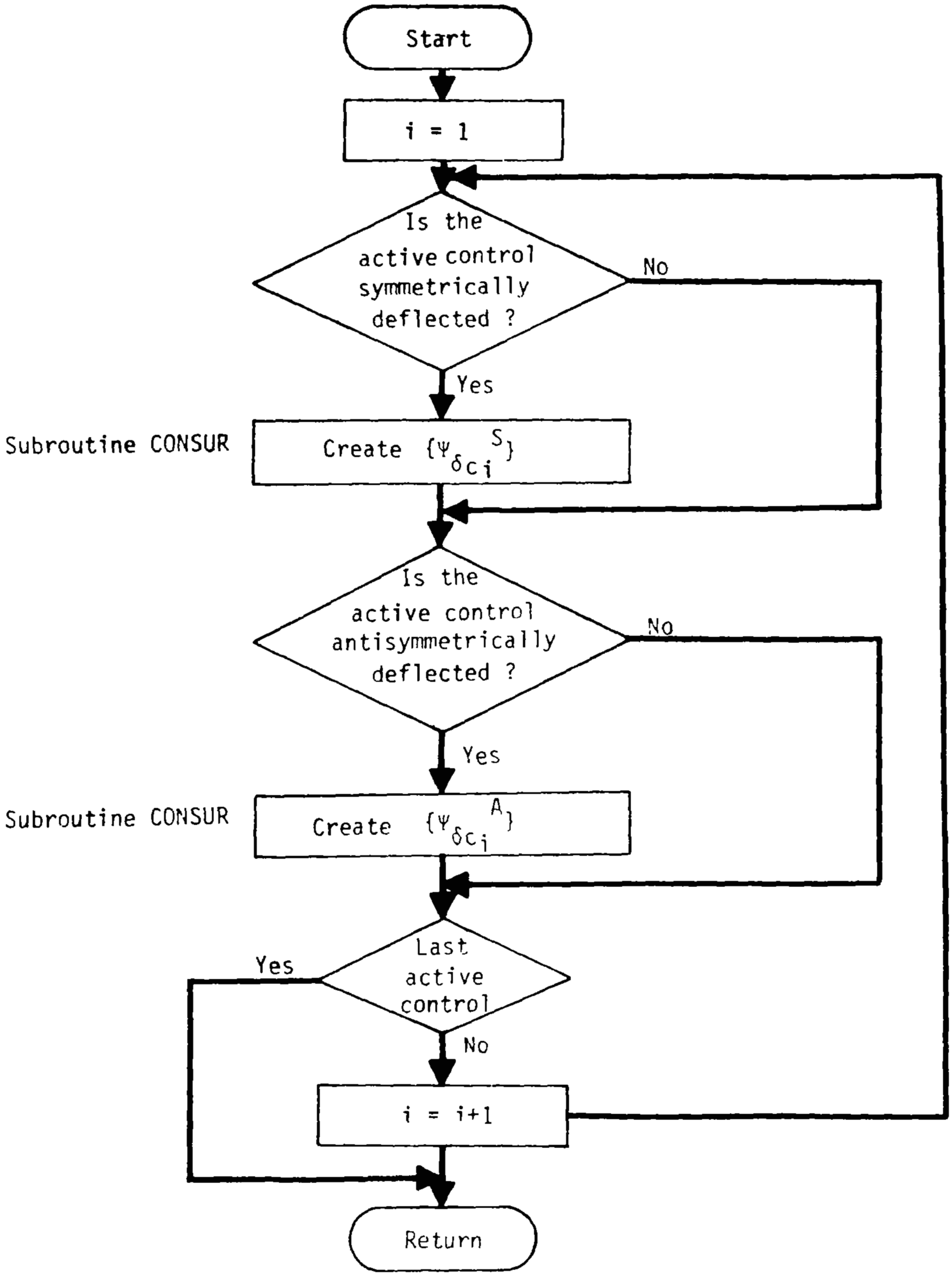


FLOWCHART 9.3-4.–CONCLUDED

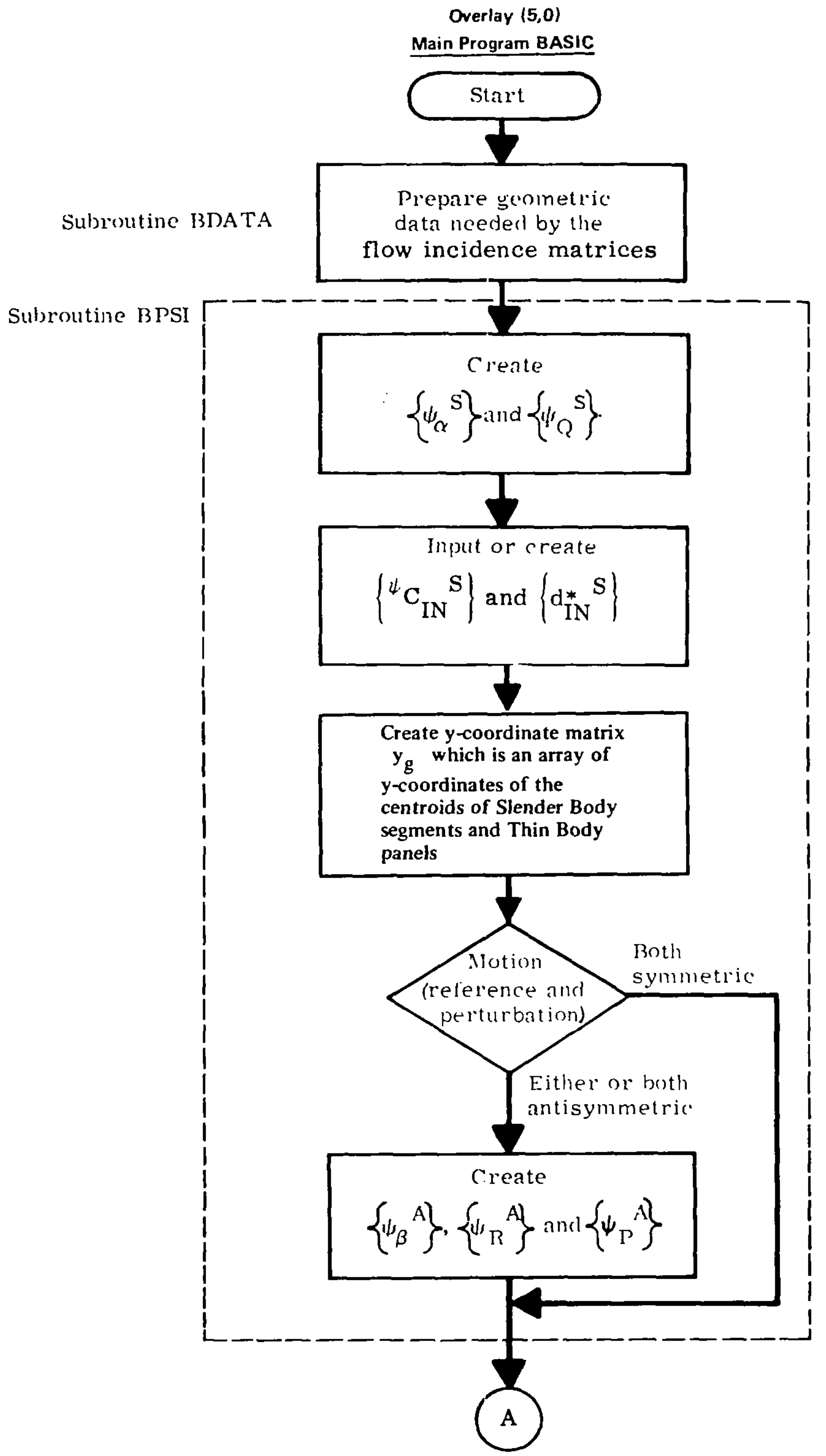


FLOWCHART 9.3-16.—FORCE AND CONTROL SURFACE MATRICES

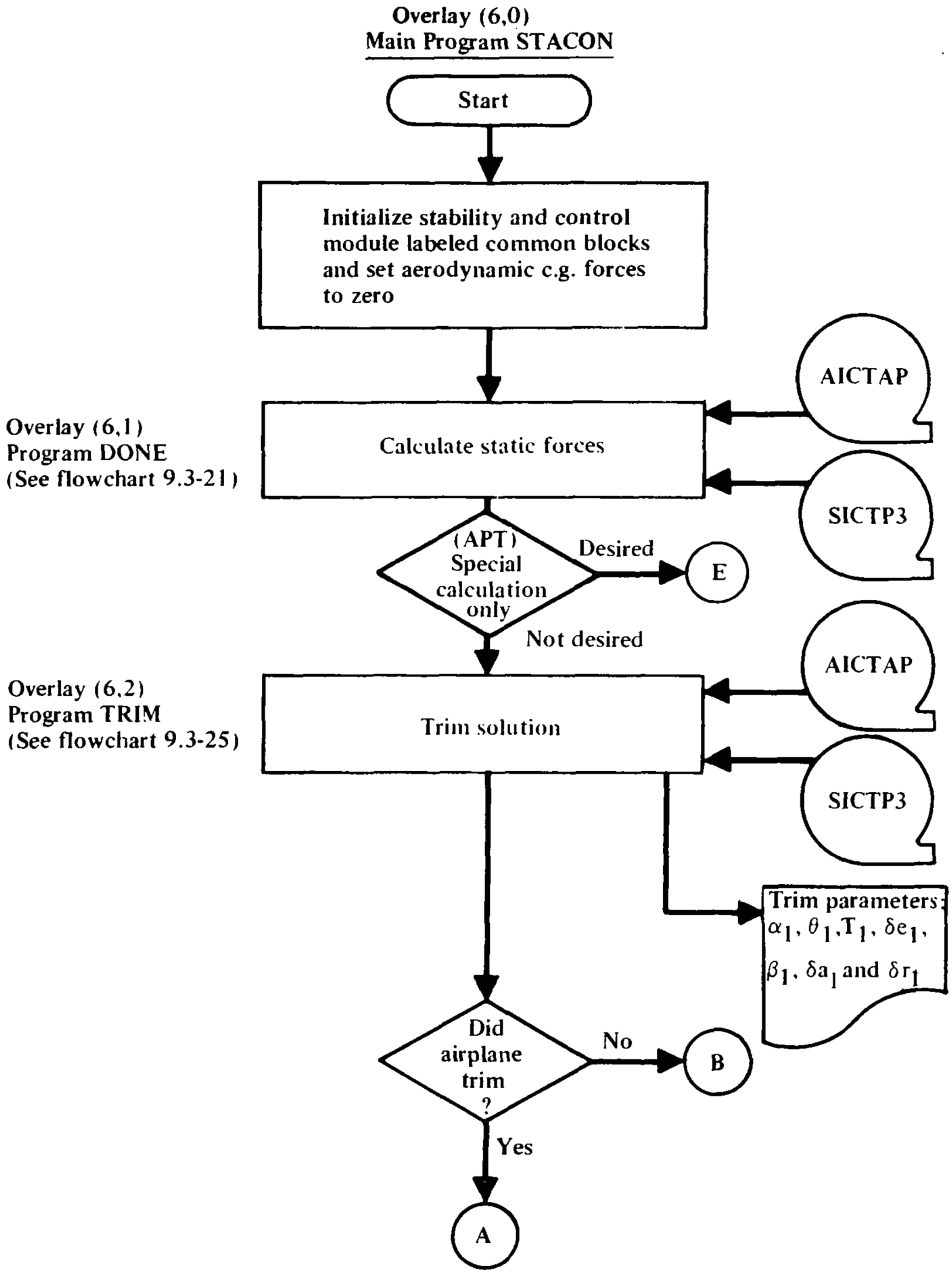
Subroutine ARBCON



FLOWCHART 9.3-18a.—ACTIVE CONTROL INCIDENCE MATRICES

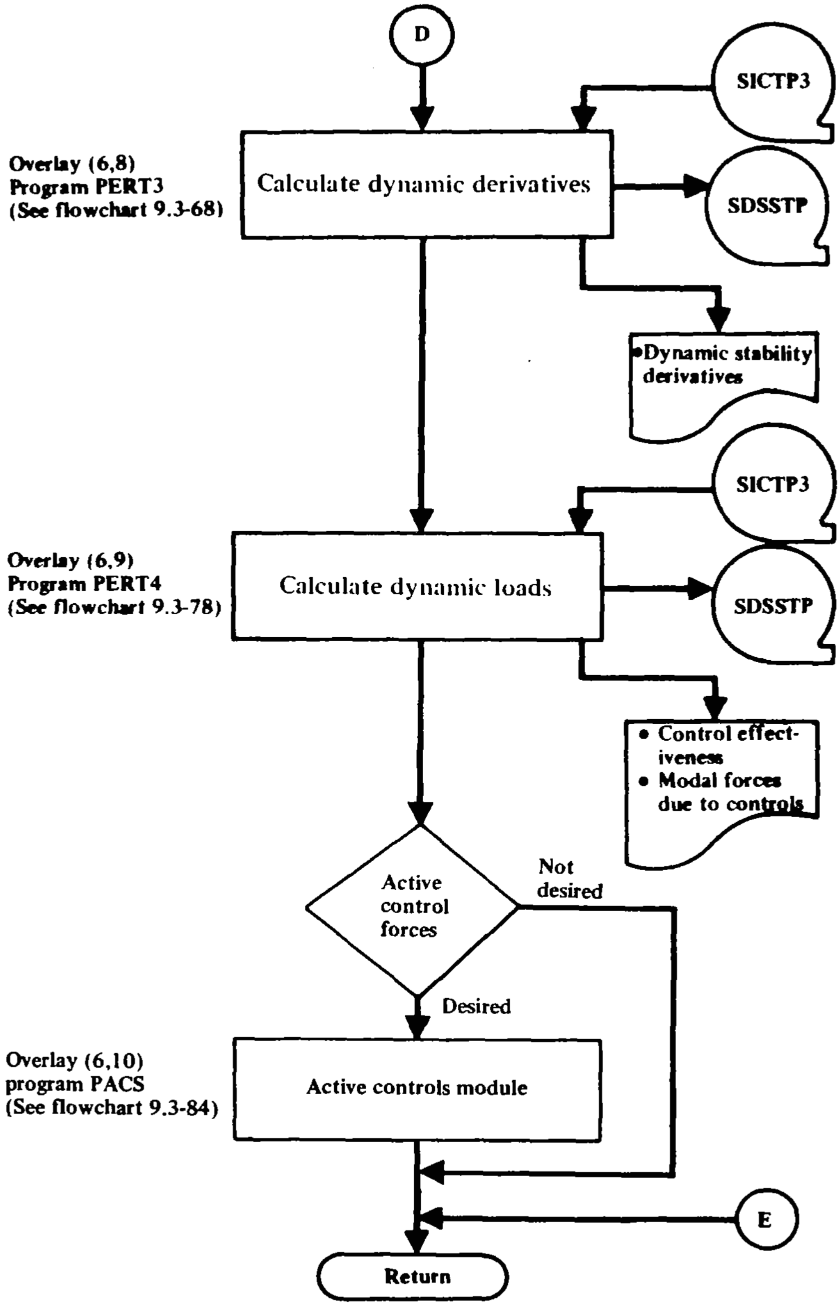


FLOWCHART 9.3-19.—FLOW INCIDENCE MATRICES



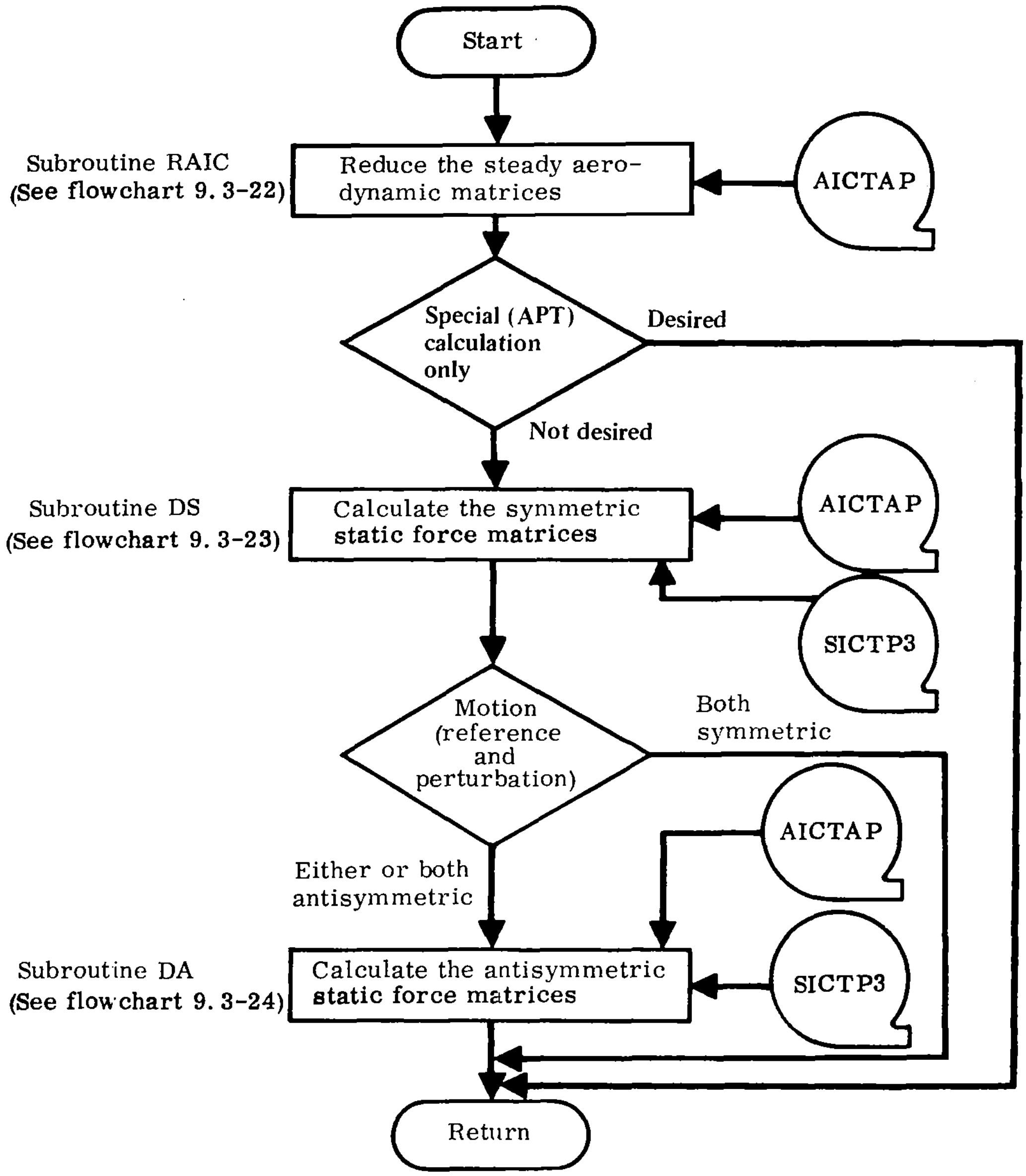
FLOWCHART 9.3-20.–STABILITY AND CONTROL CALCULATIONS

STACON (Cont.)

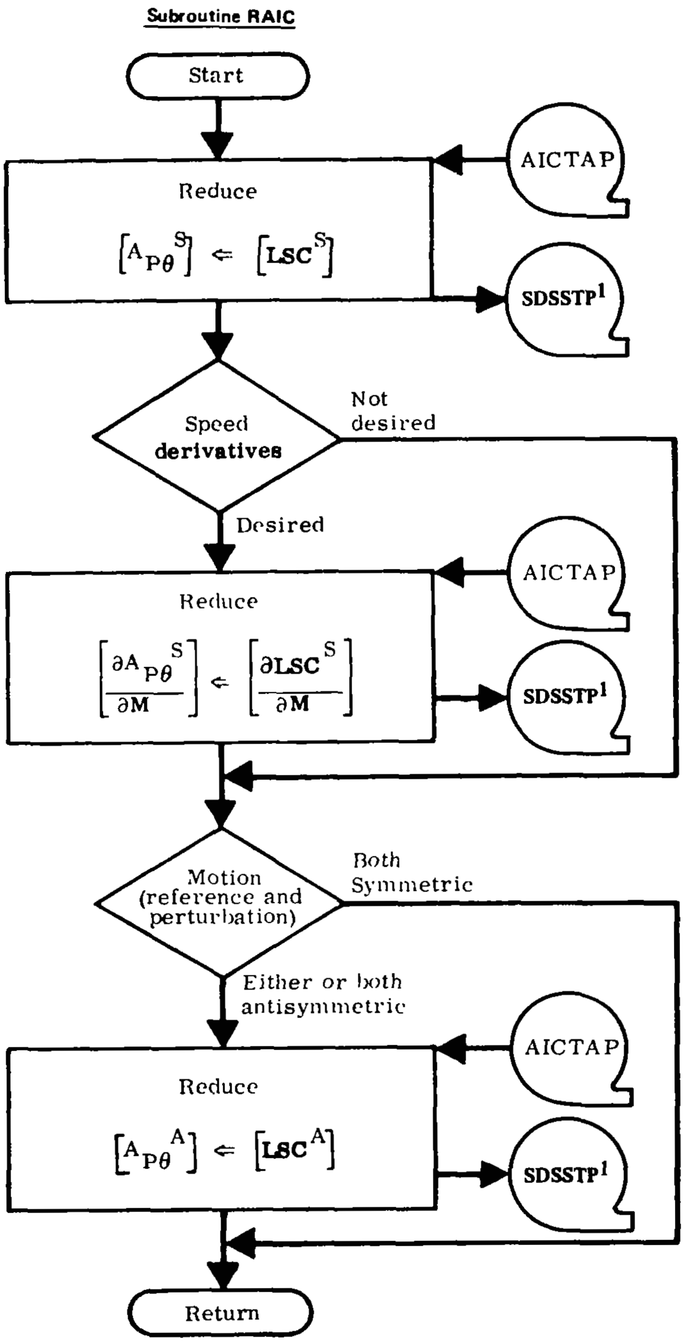


FLOWCHART 9.3-20.–CONCLUDED

Overlay (6,1)
Main Program DONE



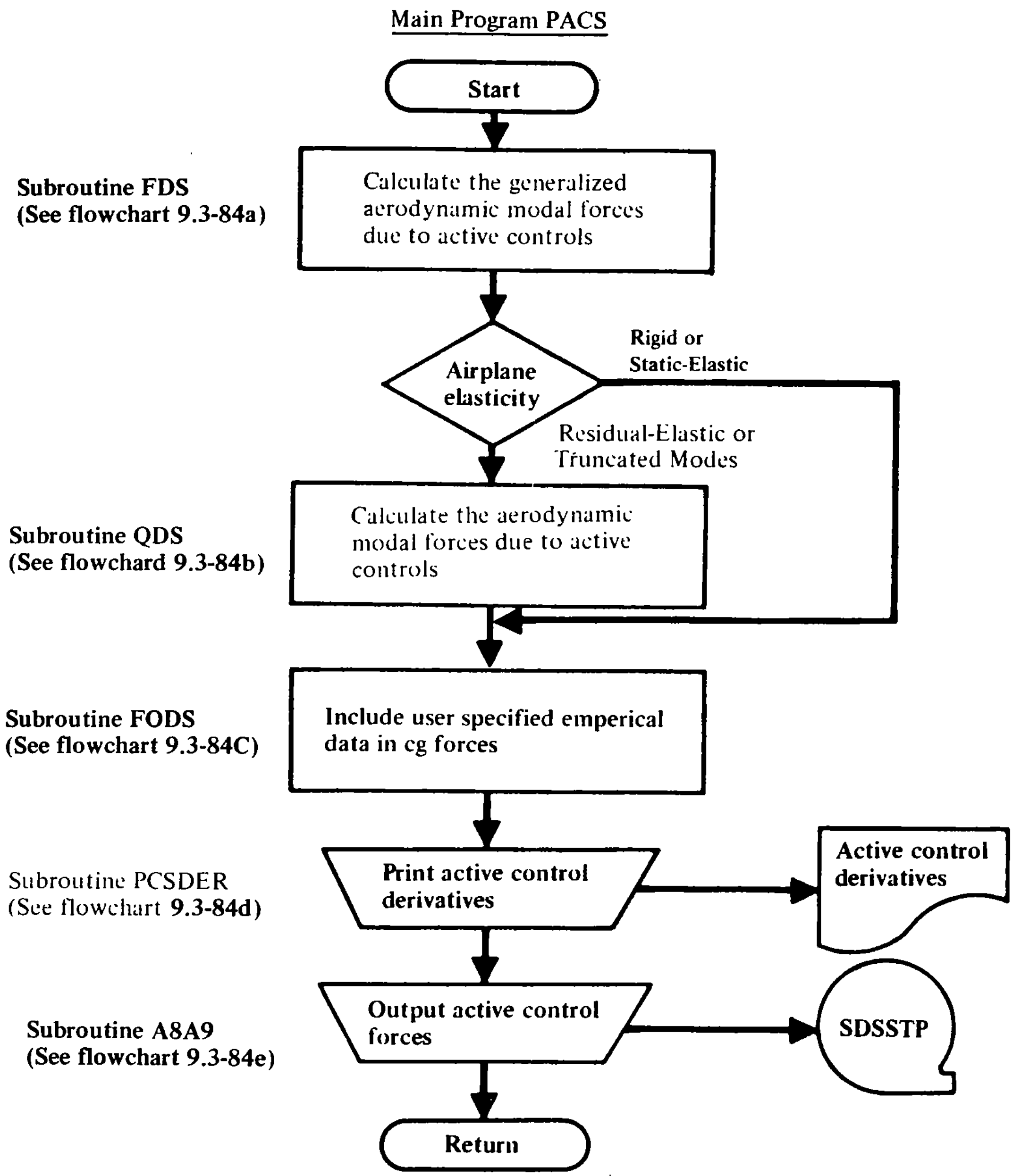
FLOWCHART 9.3-21.—STATIC FORCES



[1]These matrices are stored on SDSSTP when SD&SS is executed to calculate only the (APT) matrices

FLOWCHART 9.3-22.—REDUCTION OF THE STEADY AIC MATRICES

Overlay (6,10)



FLOWCHART 9.3-84.—ACTIVE CONTROLS MODULE

Subroutine FDS

Start

↓

Set force vectors to zero

↓

For each symmetrically deflected control, calculate the rigid force vector

$$\{F_{\delta c_i^S}^{S}\}_R = \bar{q}_1([PEPT8]\{\Psi_{\delta c_i}^{S}\}+[PERT9]\{\Psi'_{\delta c_i}{}^{S}\})$$

For each antisymmetrically deflected control, calculate the rigid force vector

$$\{F_{\delta c_i^A}^{A}\}_R = \bar{q}_1([PERT12]\{\Psi_{\delta c_i}^{A}\}+[PERT13]\{\Psi'_{\delta c_i}{}^{A}\})$$

If unsteady aerodynamic forces are wanted, calculate the unsteady rigid force vectors

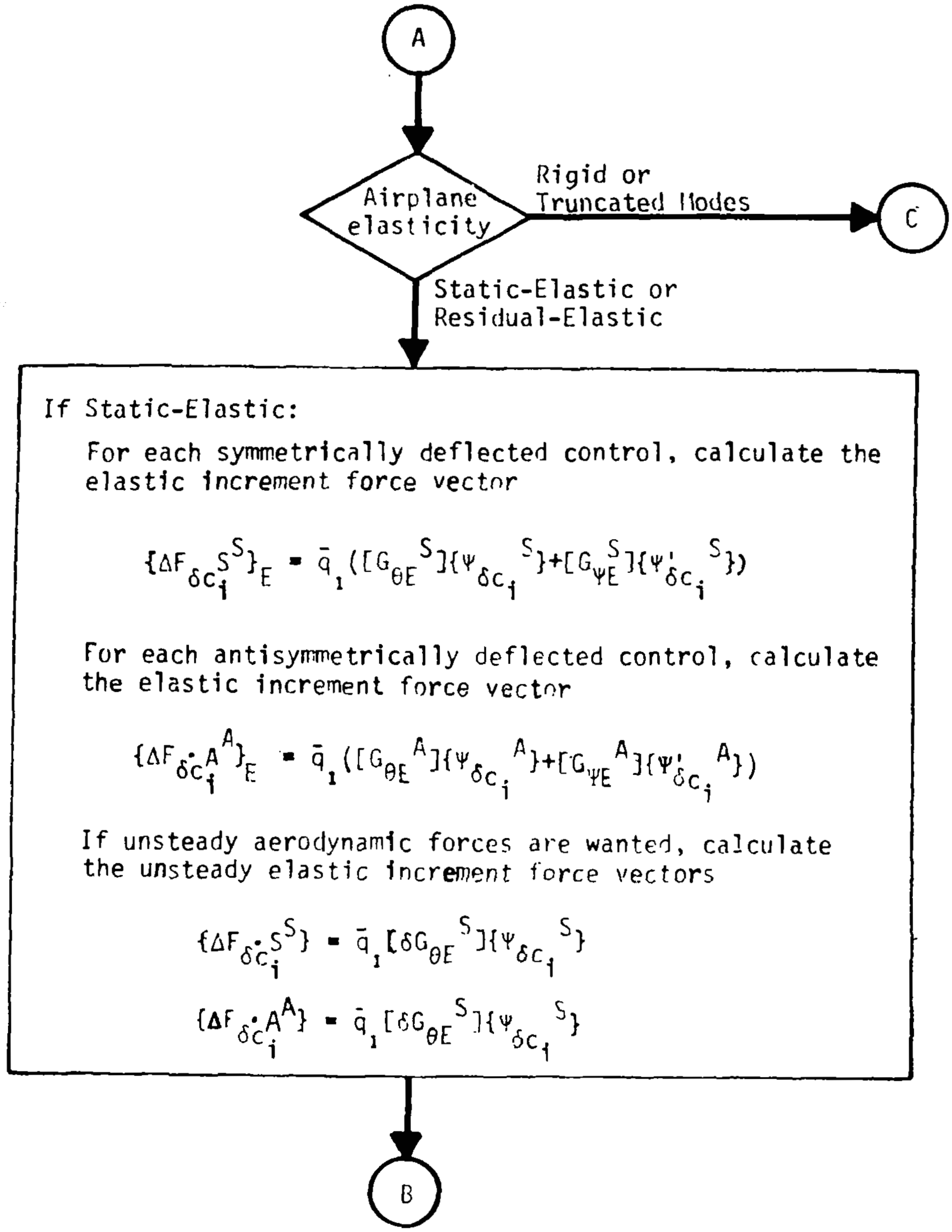
$$\{F_{\dot{\delta} c_i^S}^{S}\}_R = \bar{q}_1[\delta G_{\theta R}{}^{S}]\{\Psi_{\delta c_i}{}^{S}\}$$

$$\{F_{\dot{\delta} c_i^A}^{A}\}_R = \bar{q}_1[\delta G_{\theta P}{}^{A}]\{\Psi_{\delta c_i}{}^{A}\}$$

↓

(A)

FLOWCHART 9.3-84a.—AERODYNAMIC CG FORCES DUE TO ACTIVE CONTROLS



FLOWCHART 9.3-84a.–CONTINUED

B

If Residual-Elastic:

For each symmetrically deflected control, calculate the elastic increment force vector

$$\{\Delta F_{\delta c_i}{}^{S^S}\} = \bar{q}_1([G_{R_{\theta E}}{}^S]\{\Psi_{\delta c_i}{}^S\}+[G_{R_{\Psi E}}{}^S]\{\Psi'_{\delta c_i}{}^S\})$$

For each antisymmetrically deflected control, calculate the elastic increment force vector

$$\{\Delta F_{\delta c_i}{}^{A^A}\} = \bar{q}_1([G_{R_{\theta E}}{}^A]\{\Psi_{\delta c_i}{}^A\}+[G_{R_{\Psi E}}{}^A]\{\Psi'_{\delta c_i}{}^A\})$$

If unsteady aerodynamic forces are wanted, calculate the unsteady elastic increment force vector

$$\{\Delta F_{\dot{\delta c}_i}{}^{S^S}\} = \bar{q}_1[\delta G_{R_{\theta E}}{}^S]\{\Psi_{\delta c_i}{}^S\}$$

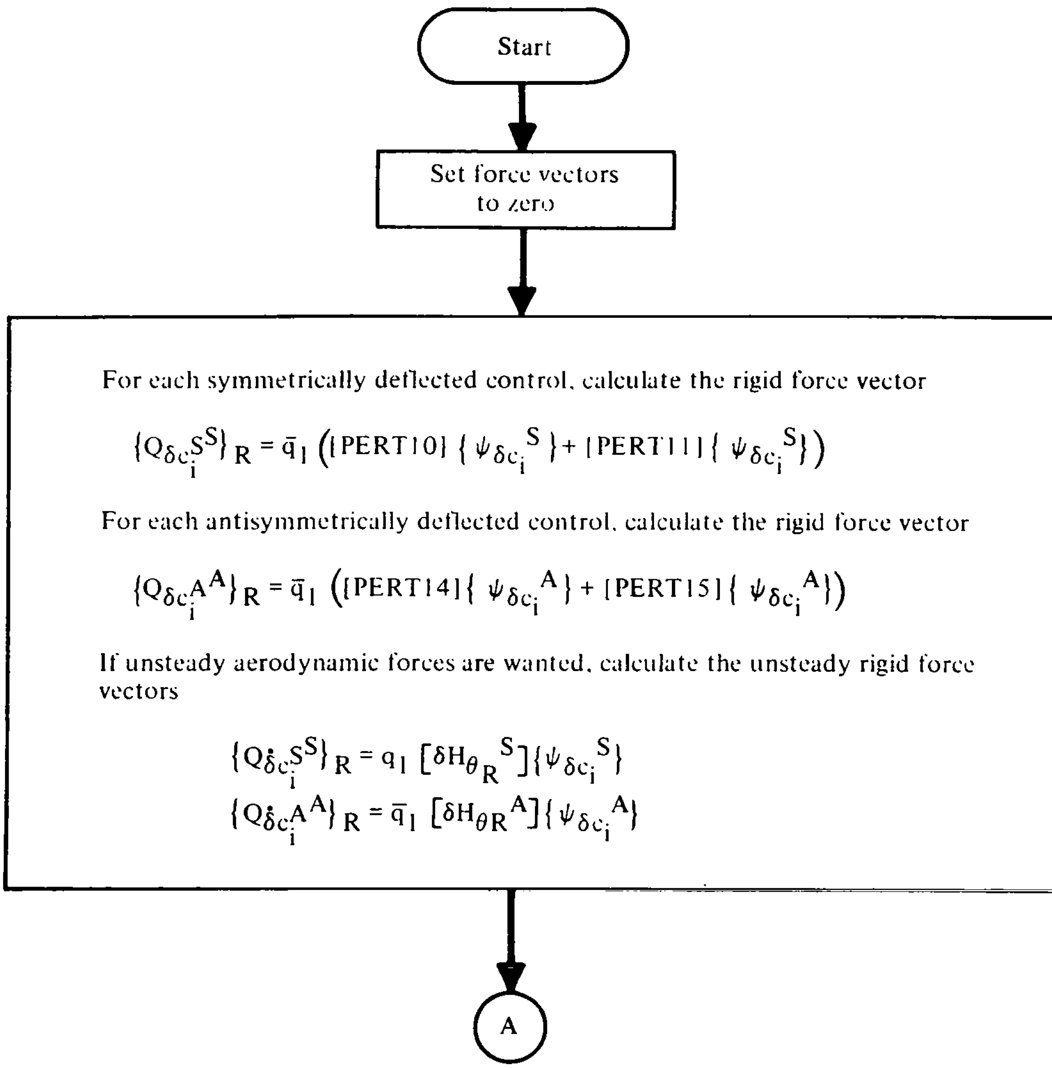
$$\{\Delta F_{\dot{\delta c}_i}{}^{A^A}\} = \bar{q}_1[\delta G_{R_{\theta E}}{}^A]\{\Psi_{\delta c_i}{}^A\}$$

C

Return

FLOWCHART 9.3-84a.—CONCLUDED

<u>Subroutine QDS</u>



FLOWCHART 9.3-84b.–GENERALIZED AERODYNAMIC MODAL FORCES DUE TO ACTIVE CONTROLS

QDS (Cont.)

(A)

↓

If Residual-Elastic:

For each symmetrically deflected control, calculate the elastic increment force vector

$$\{\Delta Q_{\delta c_i}{}^S\} = \bar{q}_1\left([H_{R_{\theta E}}{}^S]\{\psi_{\delta c_i}{}^S\} + [H_{R_{\psi E}}{}^S]\{\psi'_{\delta c_i}{}^S\}\right)$$

For each antisymmetrically deflected control, calculate the elastic increment force vector

$$\{\Delta Q_{\delta c_i}{}^A\} = \bar{q}_1\left([H_{R_{\theta E}}{}^A]\{\psi_{\delta c_i}{}^A\} + [H_{R_{\psi E}}{}^A]\{\psi'_{\delta c_i}{}^A\}\right)$$

If unsteady aerodynamic forces are wanted, calculate the unsteady elastic increment force vector

$$\{\Delta Q_{\dot{\delta} c_i}{}^S\} = \bar{q}_1[\delta H_{R_{\theta E}}{}^S]\{\psi_{\delta c_i}{}^S\}$$

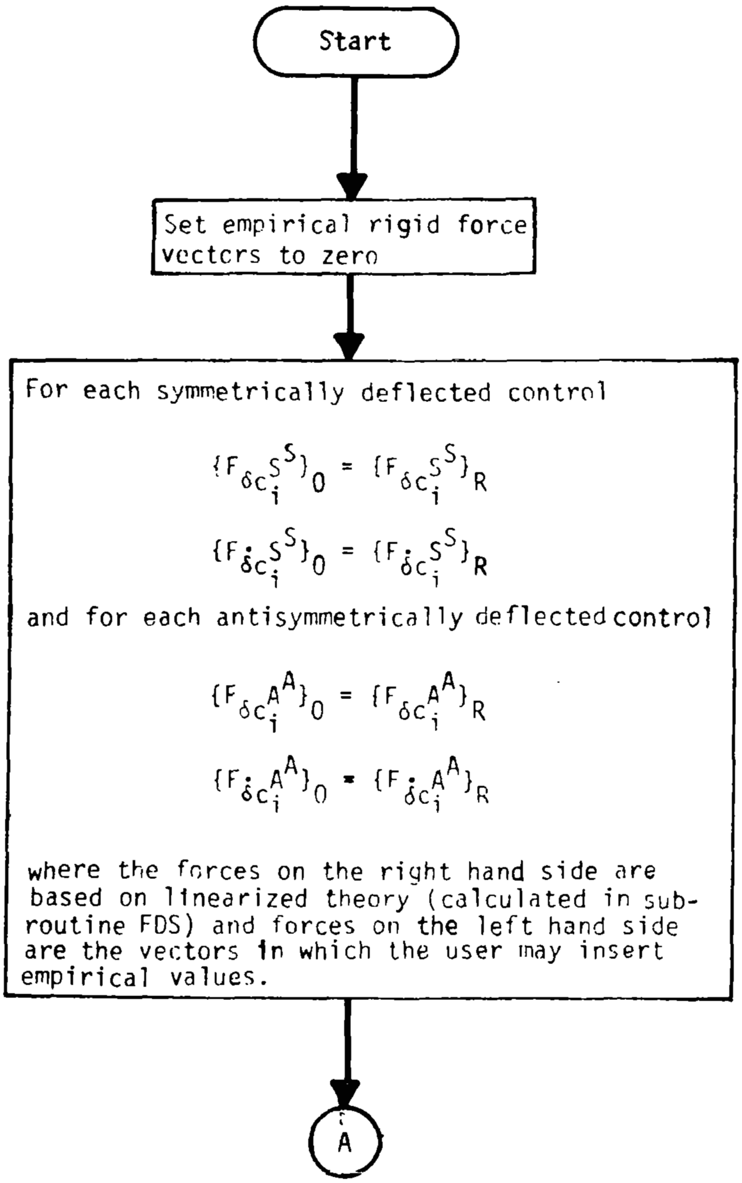
$$\{\Delta Q_{\dot{\delta} c_i}{}^A\} = \bar{q}_1[\delta H_{R_{\theta E}}{}^A]\{\psi_{\delta c_i}{}^A\}$$

↓

(Return)

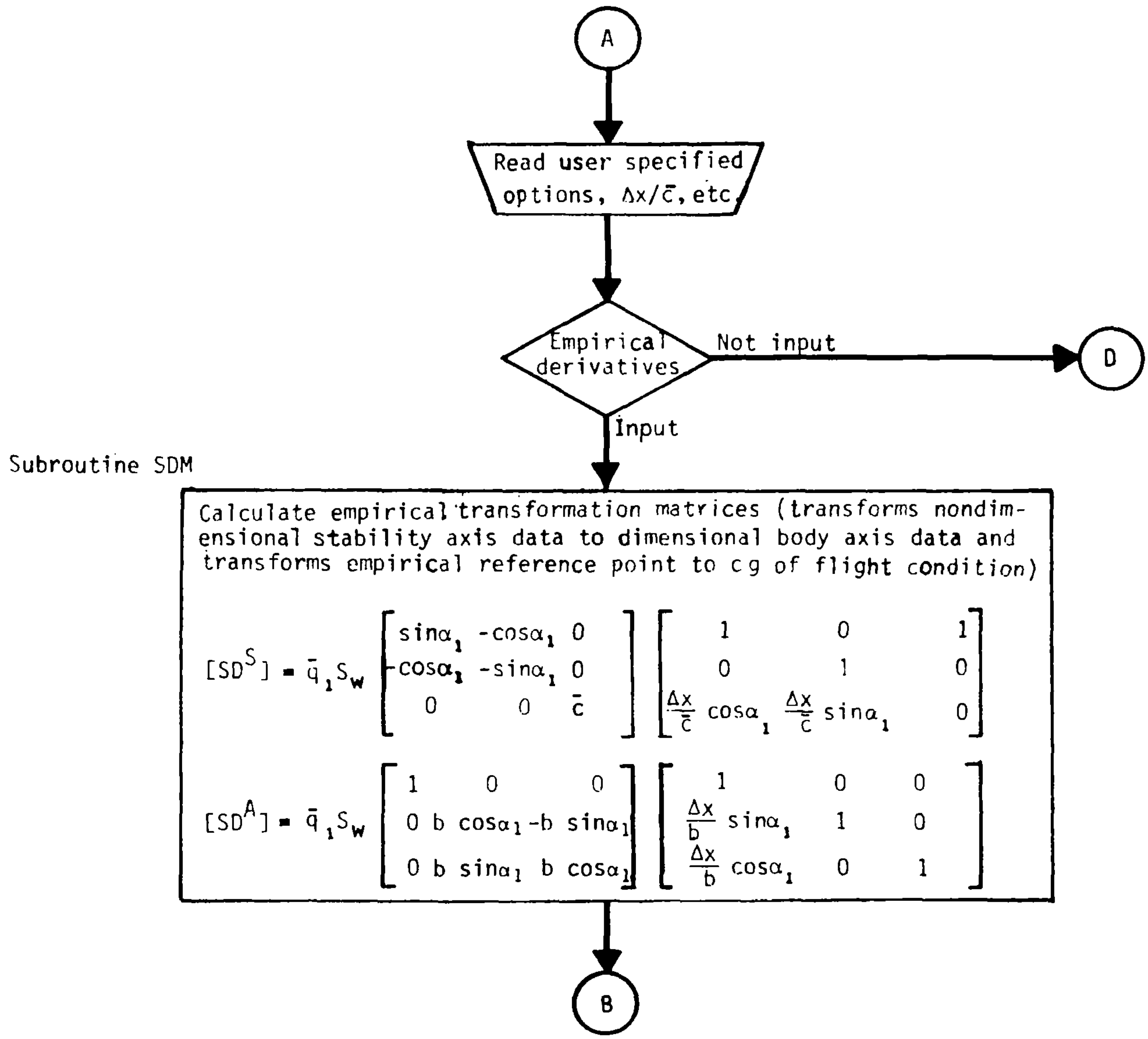
FLOWCHART 9.3-84b.—CONCLUDED

Subroutine FODS



FLOWCHART 9.3-84c.–INCLUSION OF EMPIRICAL DATA IN RIGID CONTROL FORCES

FODS (Cont.)



FLOWCHART 9.3-84c.—CONTINUED

(B)

Calculate the following force vectors if user inputs the derivatives

$$\{F_{\delta c_i}{}^{S^S}\}_0 = [SD^S] \begin{Bmatrix} C_{L_{\delta c_i}^S} \\ C_{D_{\delta c_i}^S} \\ C_{m_{\delta c_i}^S} \end{Bmatrix}$$

$$\{F_{\delta c_i}{}^{A^S}\}_0 = [SD^S] \begin{Bmatrix} C_{L_{\delta c_i}^A} \\ C_{D_{\delta c_i}^A} \\ C_{m_{\delta c_i}^A} \end{Bmatrix}$$

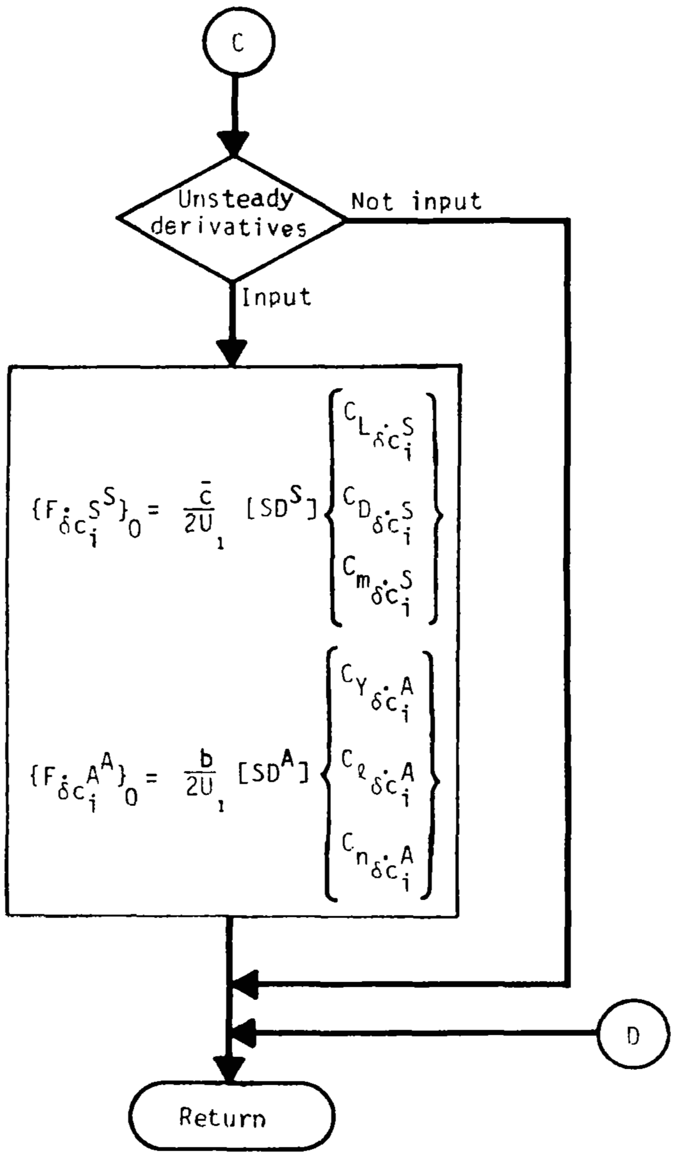
$$\{F_{\delta c_i}{}^{S^A}\}_0 = [SD^A] \begin{Bmatrix} C_{Y_{\delta c_i}^S} \\ C_{\ell_{\delta c_i}^S} \\ C_{n_{\delta c_i}^S} \end{Bmatrix}$$

$$\{F_{\delta c_i}{}^{A^A}\}_0 = [SD^A] \begin{Bmatrix} C_{Y_{\delta c_i}^A} \\ C_{\ell_{\delta c_i}^A} \\ C_{n_{\delta c_i}^A} \end{Bmatrix}$$

(C)

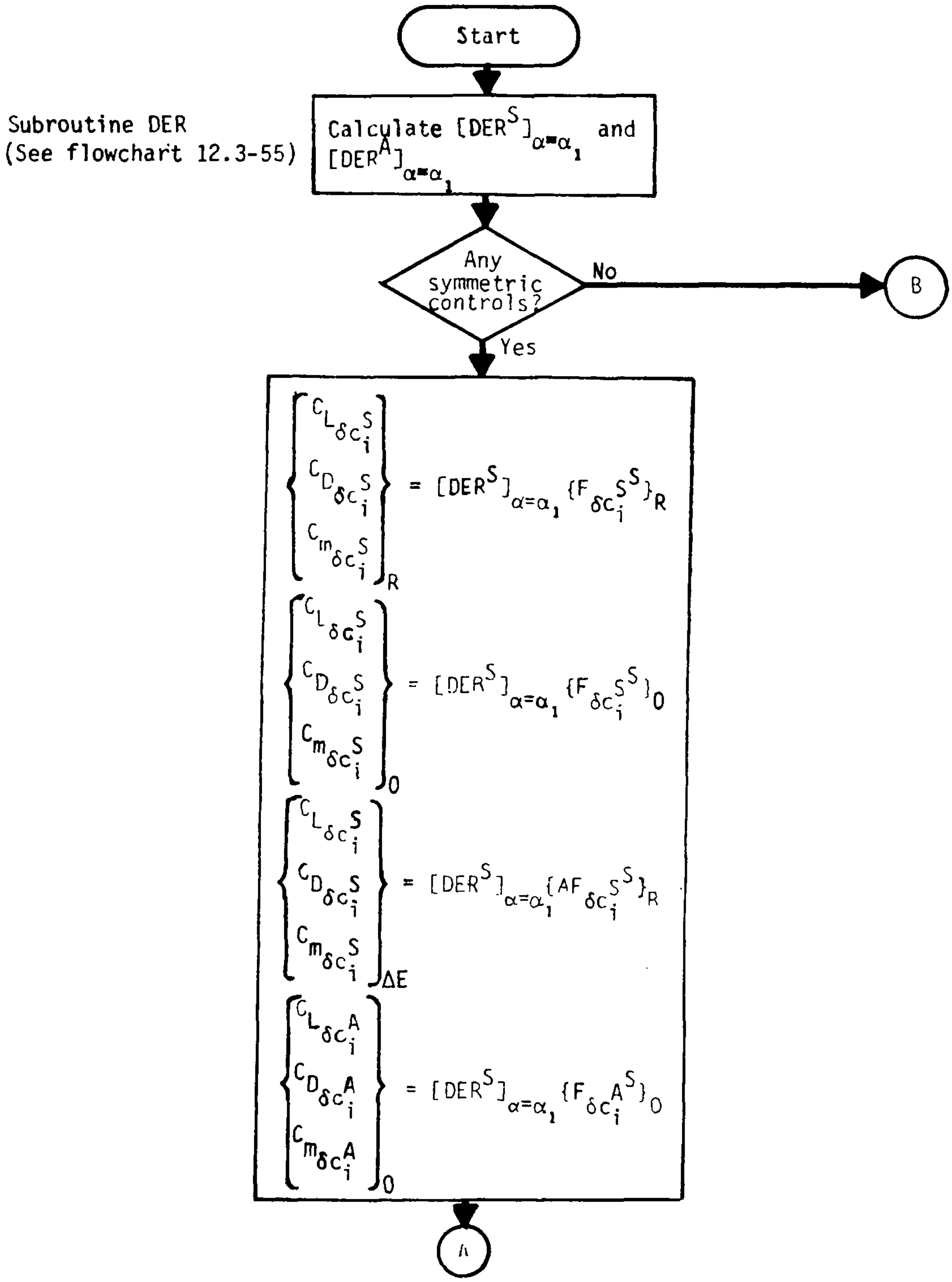
FLOWCHART 9.3-84c.—CONTINUED

FODS (Cont.)



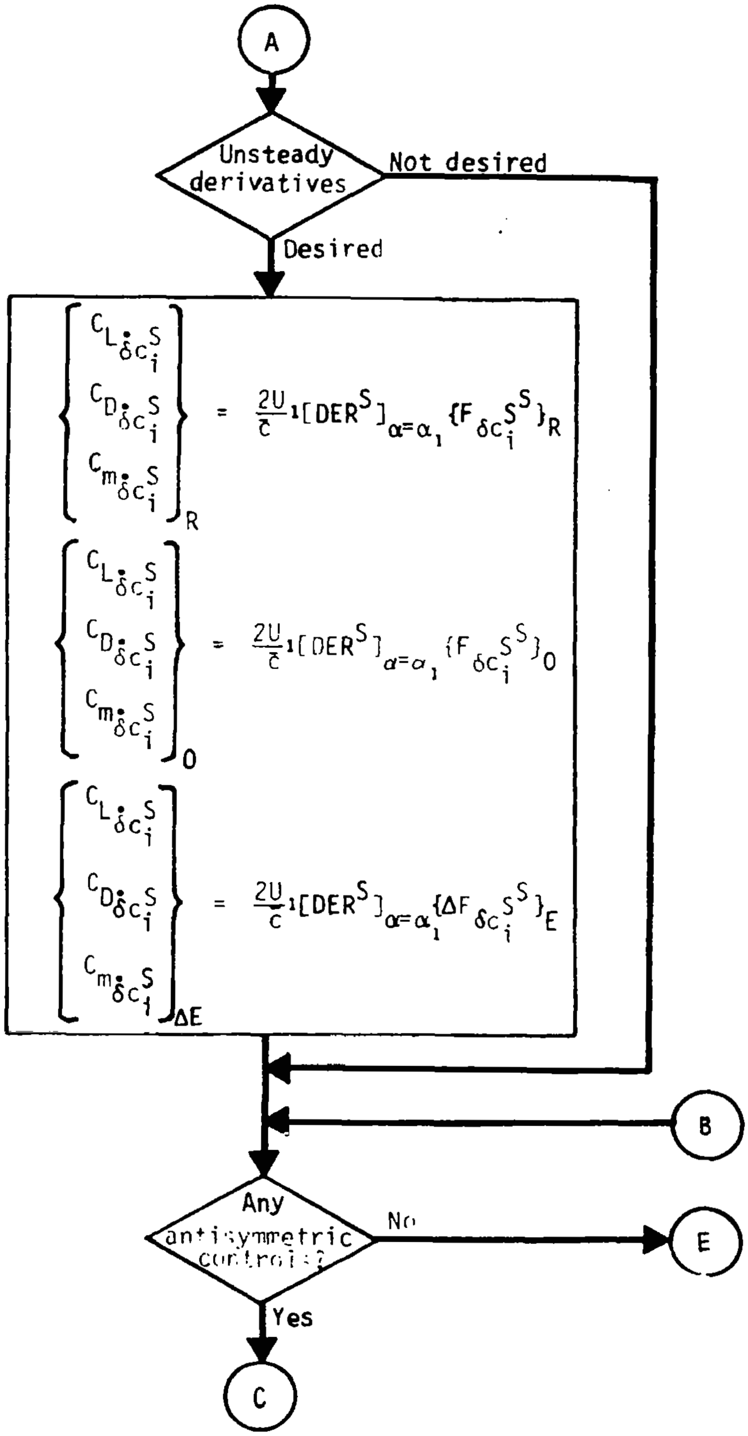
FLOWCHART 9.3-84c.–CONCLUDED

Subroutine PCSDER



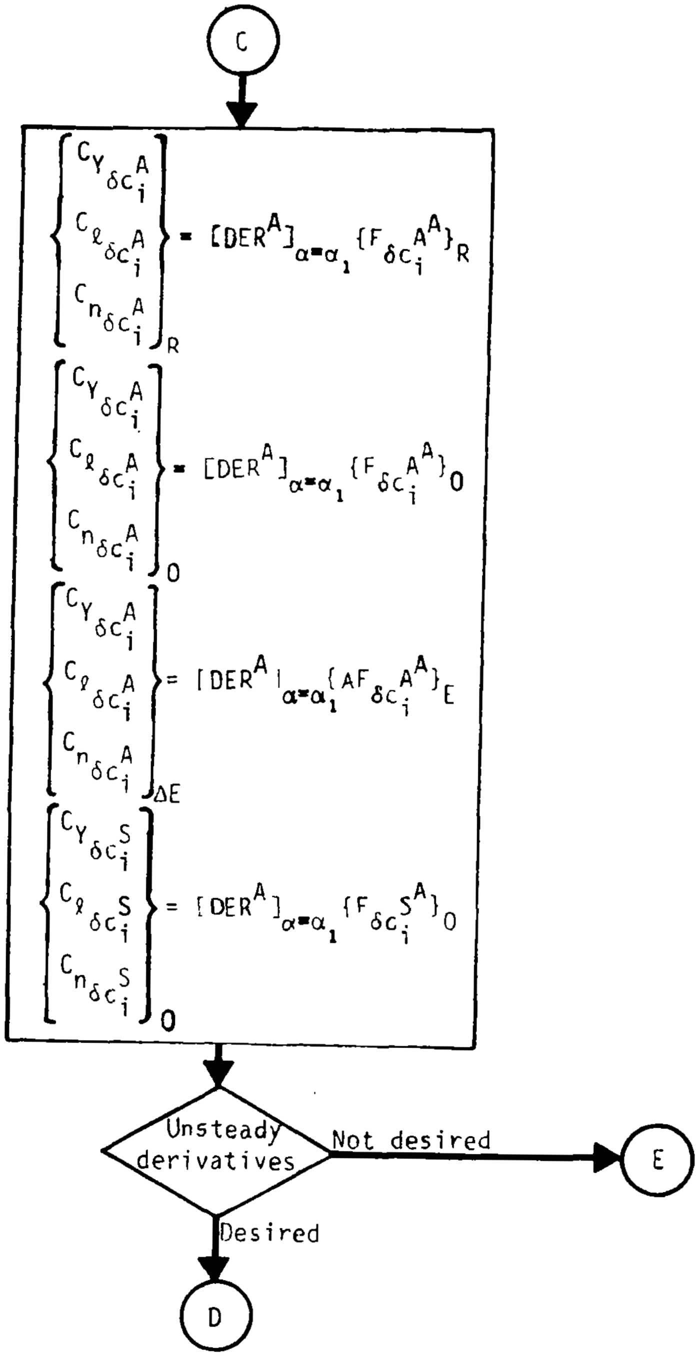
FLOWCHART 9.3-84d.–ACTIVE CONTROL DERIVATIVES

PCSDER (Cont.)

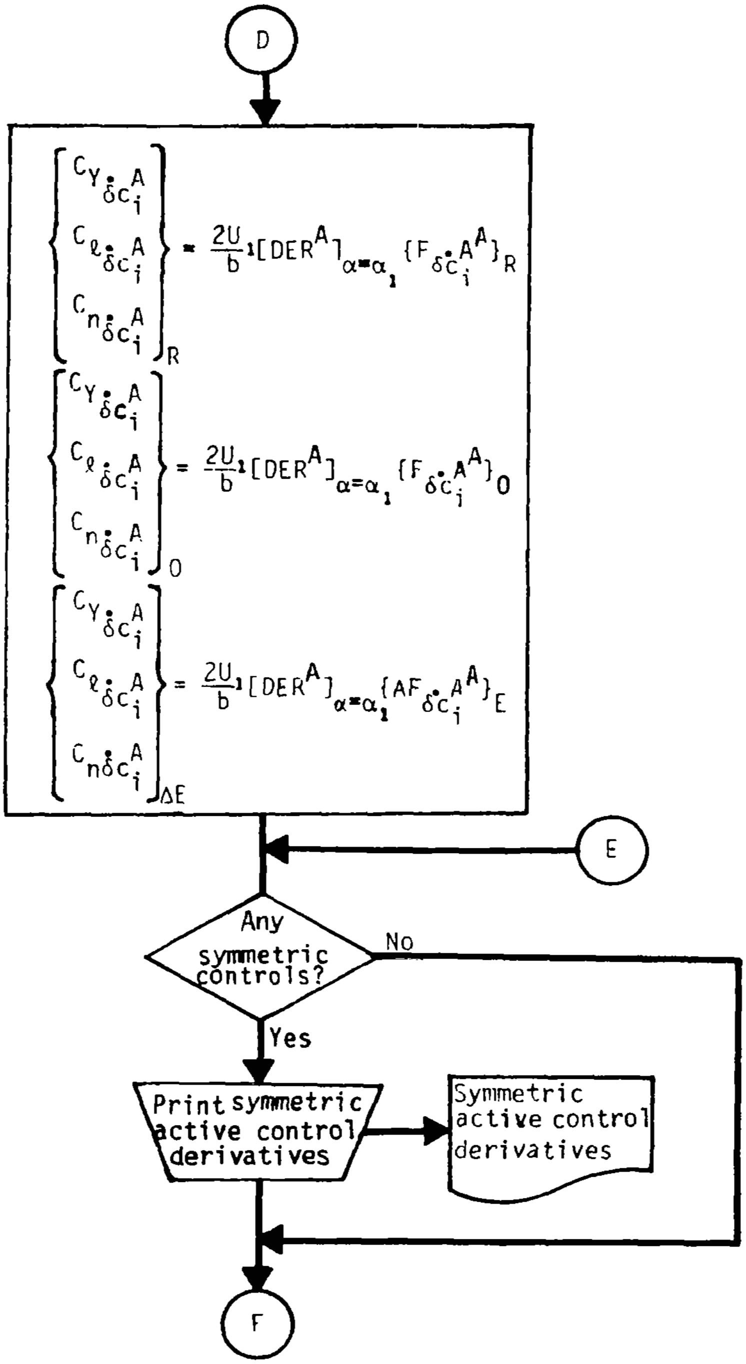


FLOWCHART 9.3-84d.—CONTINUED

PCSDER (Cont.)



FLOWCHART 9.3-84d.–CONTINUED

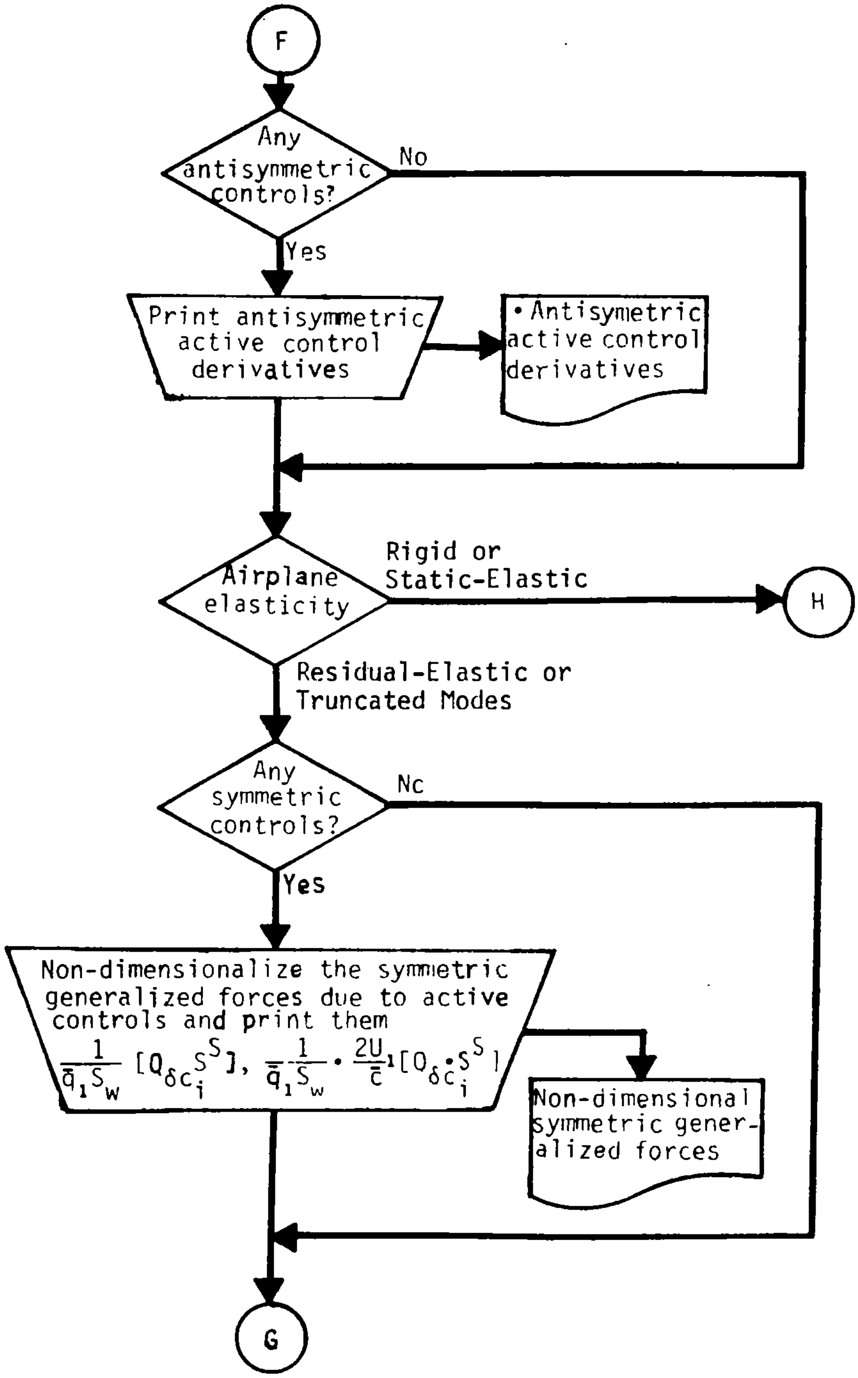


$$\begin{Bmatrix} C_{Y_{\dot{\delta c}_i}^A} \\ C_{\ell_{\dot{\delta c}_i}^A} \\ C_{n_{\dot{\delta c}_i}^A} \end{Bmatrix}_R = \frac{2U_1}{b}[DER^A]_{\alpha=\alpha_1}\{F_{\dot{\delta c}_i^A}^A\}_R$$

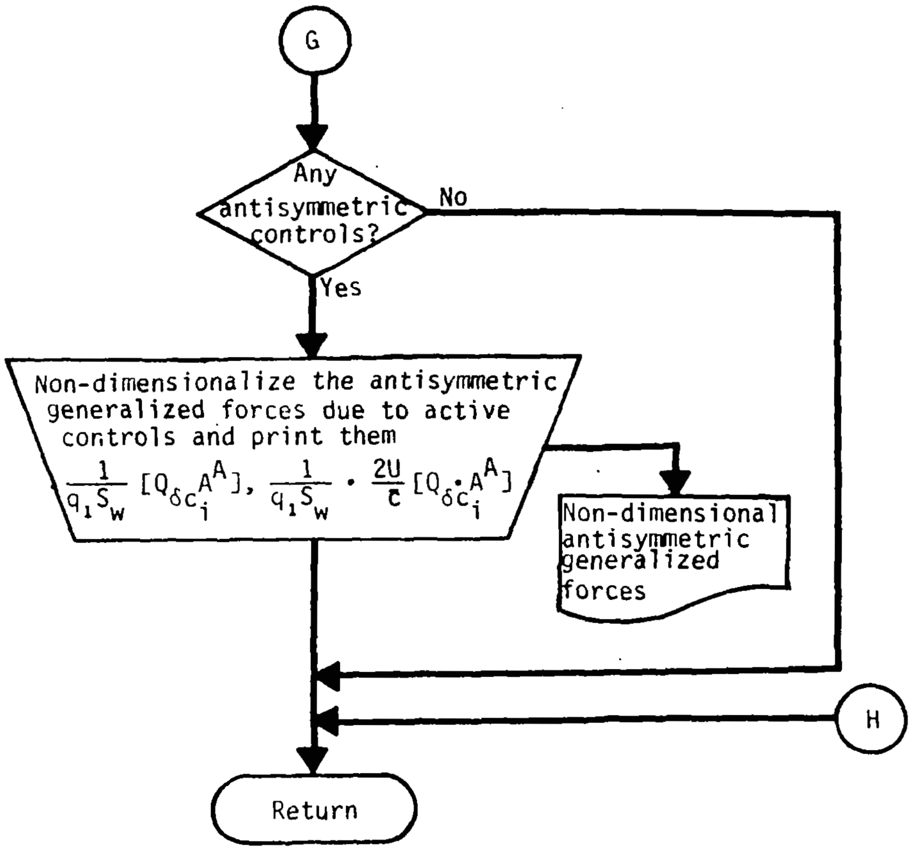
$$\begin{Bmatrix} C_{Y_{\dot{\delta c}_i}^A} \\ C_{\ell_{\dot{\delta c}_i}^A} \\ C_{n_{\dot{\delta c}_i}^A} \end{Bmatrix}_0 = \frac{2U_1}{b}[DER^A]_{\alpha=\alpha_1}\{F_{\dot{\delta c}_i^A}^A\}_0$$

$$\begin{Bmatrix} C_{Y_{\dot{\delta c}_i}^A} \\ C_{\ell_{\dot{\delta c}_i}^A} \\ C_{n_{\dot{\delta c}_i}^A} \end{Bmatrix}_{\Delta E} = \frac{2U_1}{b}[DER^A]_{\alpha=\alpha_1}\{AF_{\dot{\delta c}_i^A}^A\}_E$$

FLOWCHART 9.3-84d.–CONTINUED

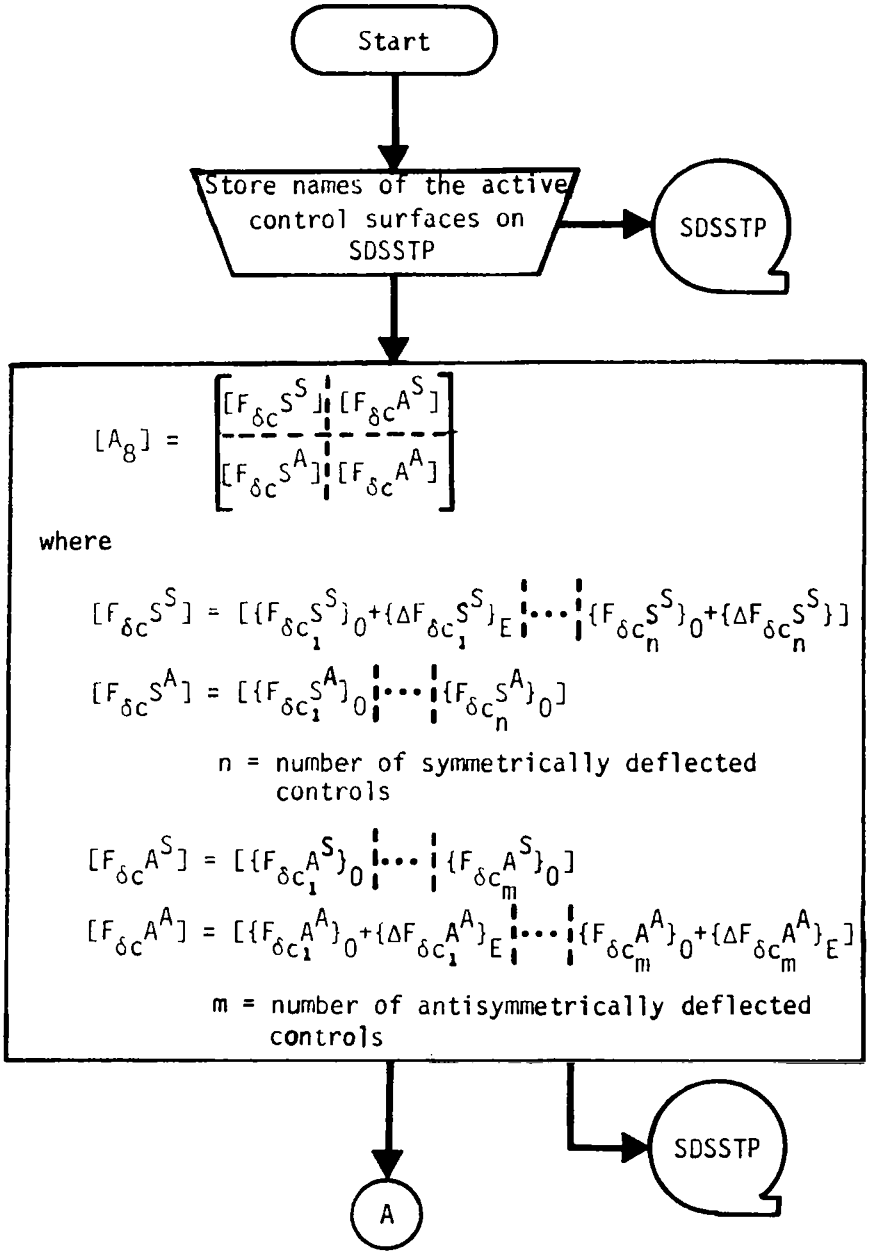


FLOWCHART 93-84d.—CONTINUED



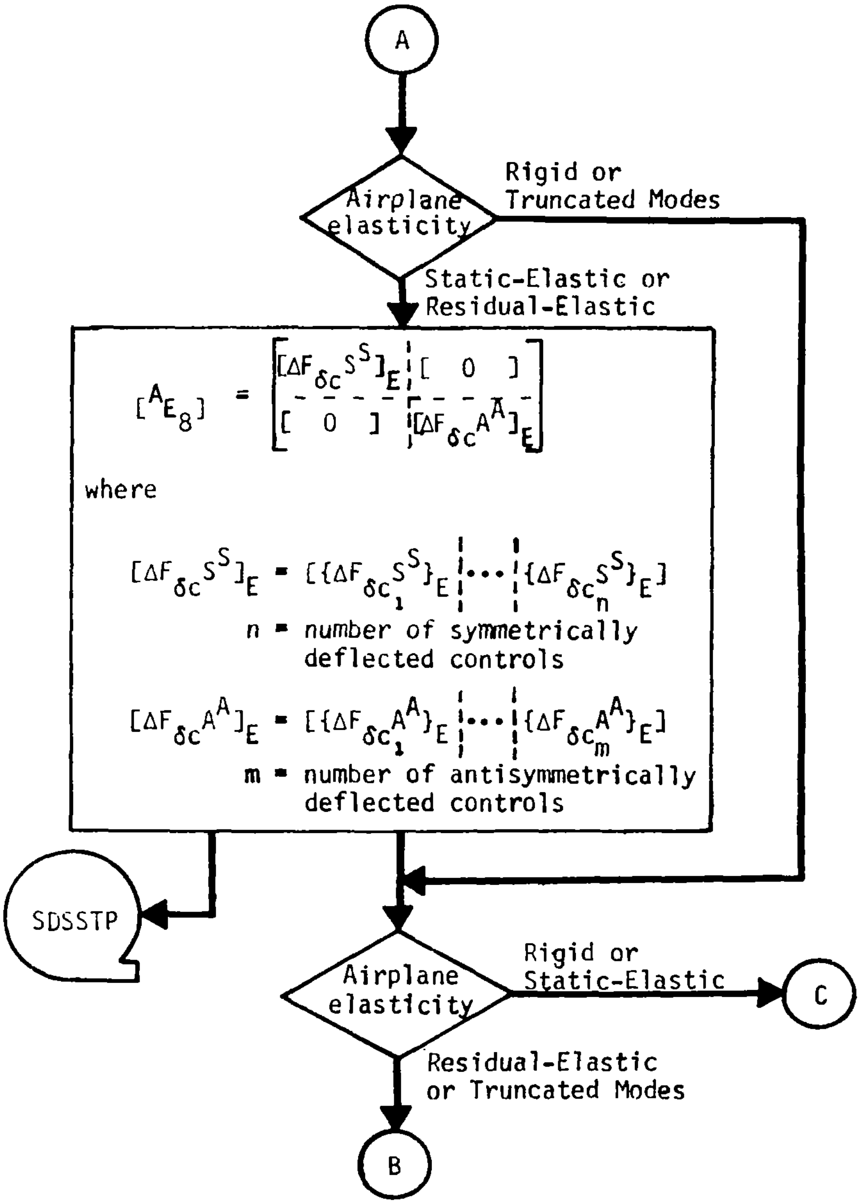
FLOWCHART 9.3-84d.–CONCLUDED

Subroutine A8A9

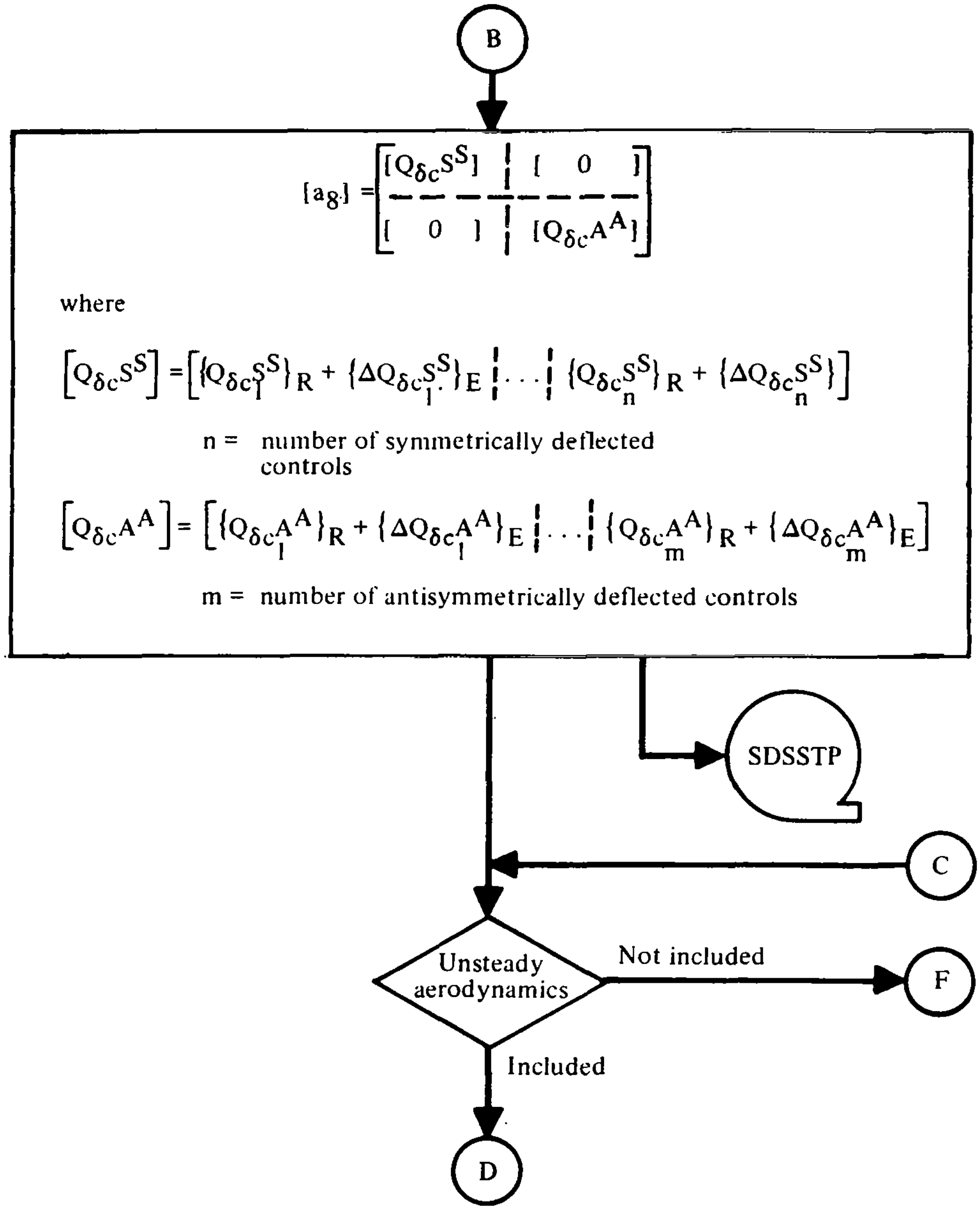


FLOWCHART 9.3-84e.—FORCES DUE TO ACTIVE CONTROLS

A8A9 (Cont.)

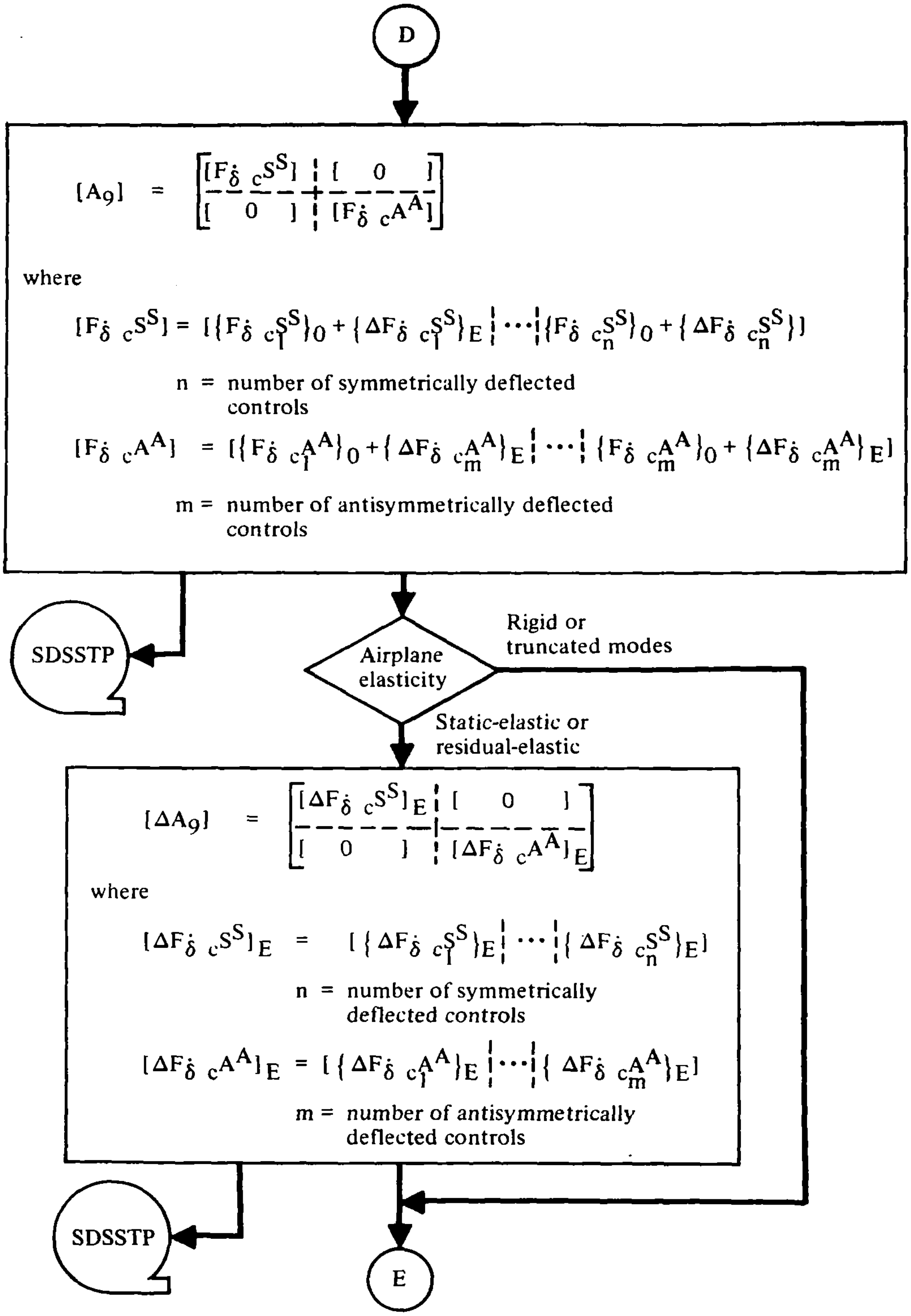


FLOWCHART 9.3-84e.—CONTINUED



FLOWCHART 9.3-84e.—CONTINUED

A8A9 (Cont.)



FLOWCHART 9.3-84e.—CONTINUED

A8A9 (Cont.)

E

$$[a_9] = \begin{bmatrix} [Q_{\dot{\delta}_c}^{SS}] & [\ 0\ ] \\ [\ 0\ ] & [Q_{\dot{\delta}_c}^{AA}] \end{bmatrix}$$

where

$$[Q_{\dot{\delta}_c}^{SS}] = [\ \{Q_{\dot{\delta}_{c_1}}^{SS}\}_R + \{\Delta Q_{\dot{\delta}_{c_1}}^{SS}\}_E \mid \cdots \mid \{Q_{\dot{\delta}_{c_n}}^{SS}\}_R + \{\Delta Q_{\dot{\delta}_{c_n}}^{SS}\}\ ]$$

n = number of symmetrically deflected controls

$$[Q_{\dot{\delta}_c}^{AA}] = [\ \{Q_{\dot{\delta}_{c_1}}^{AA}\}_R + \{\Delta Q_{\dot{\delta}_{c_1}}^{AA}\}_E \mid \cdots \mid \{Q_{\dot{\delta}_{c_m}}^{AA}\}_R + \{\Delta Q_{\dot{\delta}_{c_m}}^{AA}\}_E\ ]$$

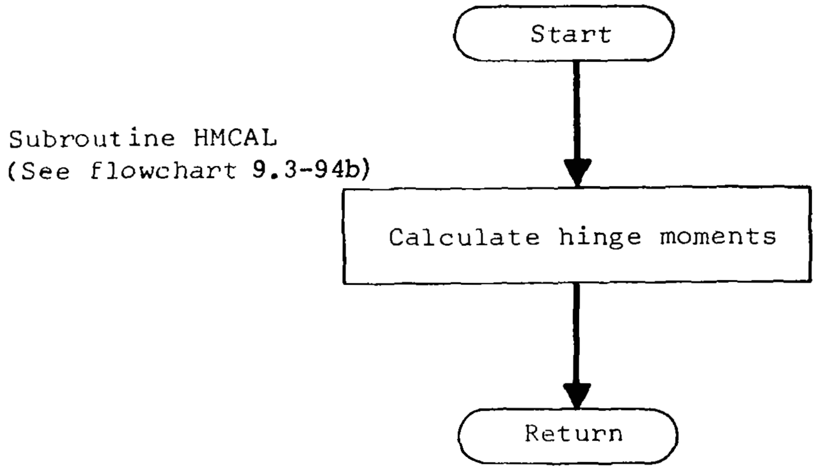
m = number of antisymmetrically deflected controls

F

Return

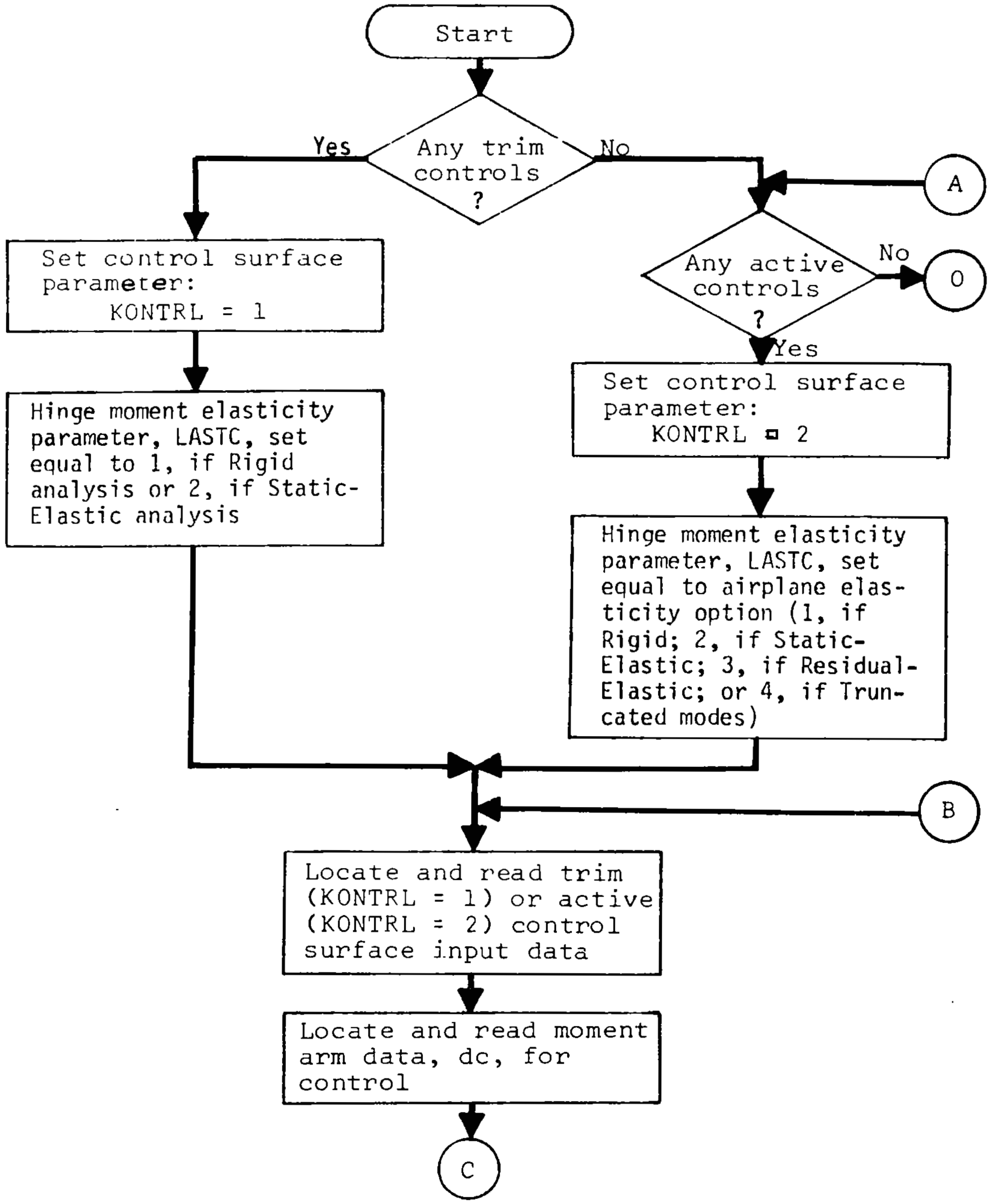
FLOWCHART 9.3-84e.—CONCLUDED

Overlay (9,0)
Main Program HM

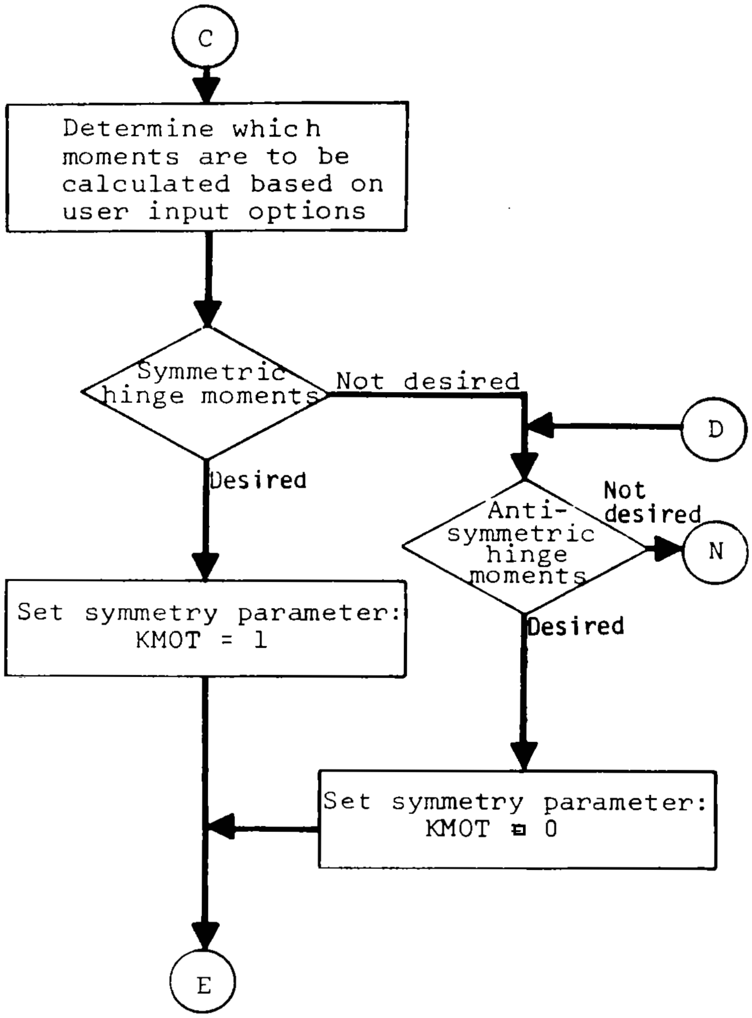


FLOWCHART 9.3-94a.—HINGE MOMENT MODULE

Subroutine HMCAL

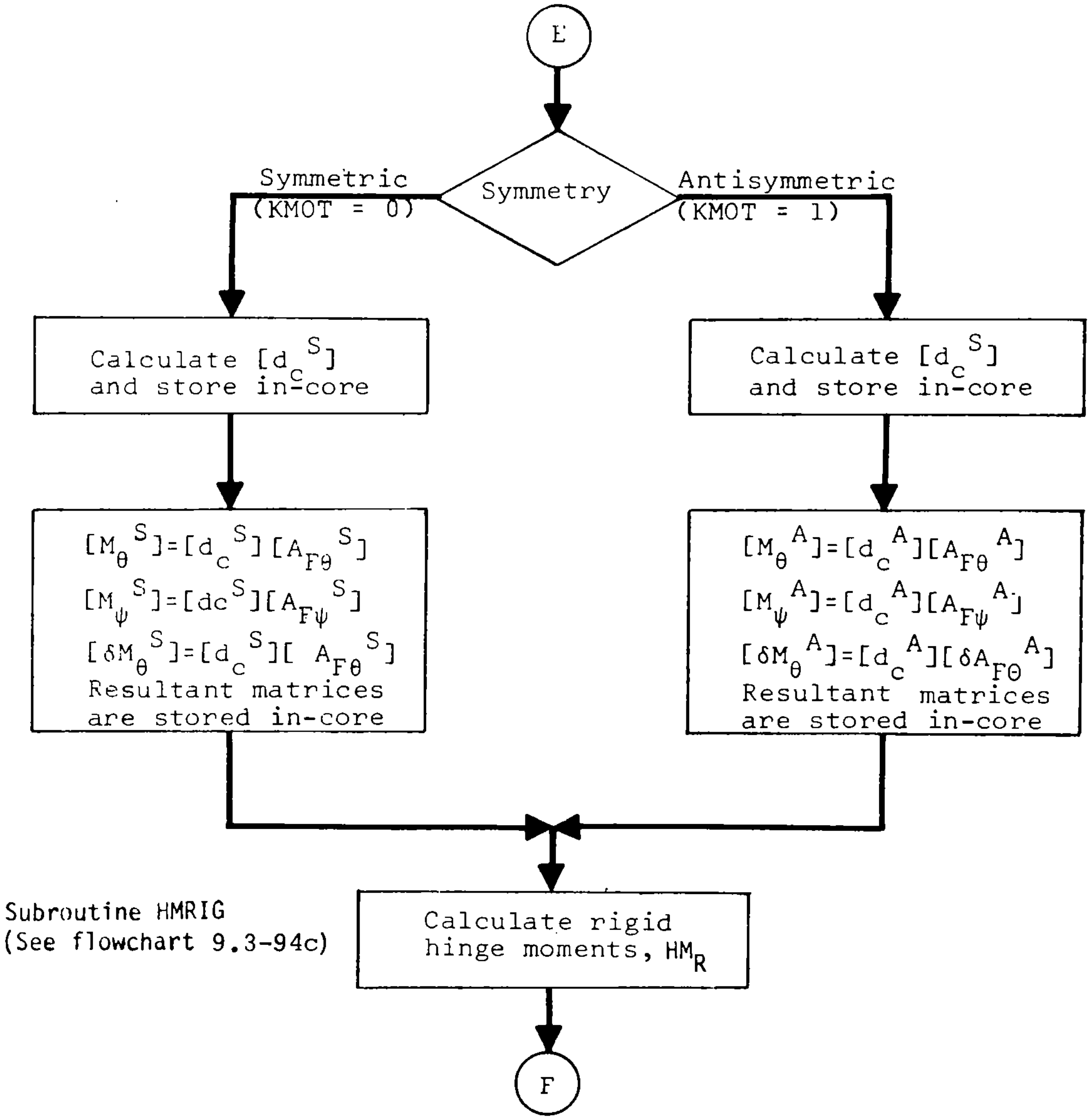


FLOWCHART 9.3-94b.—HINGE MOMENT CALCULATIONS

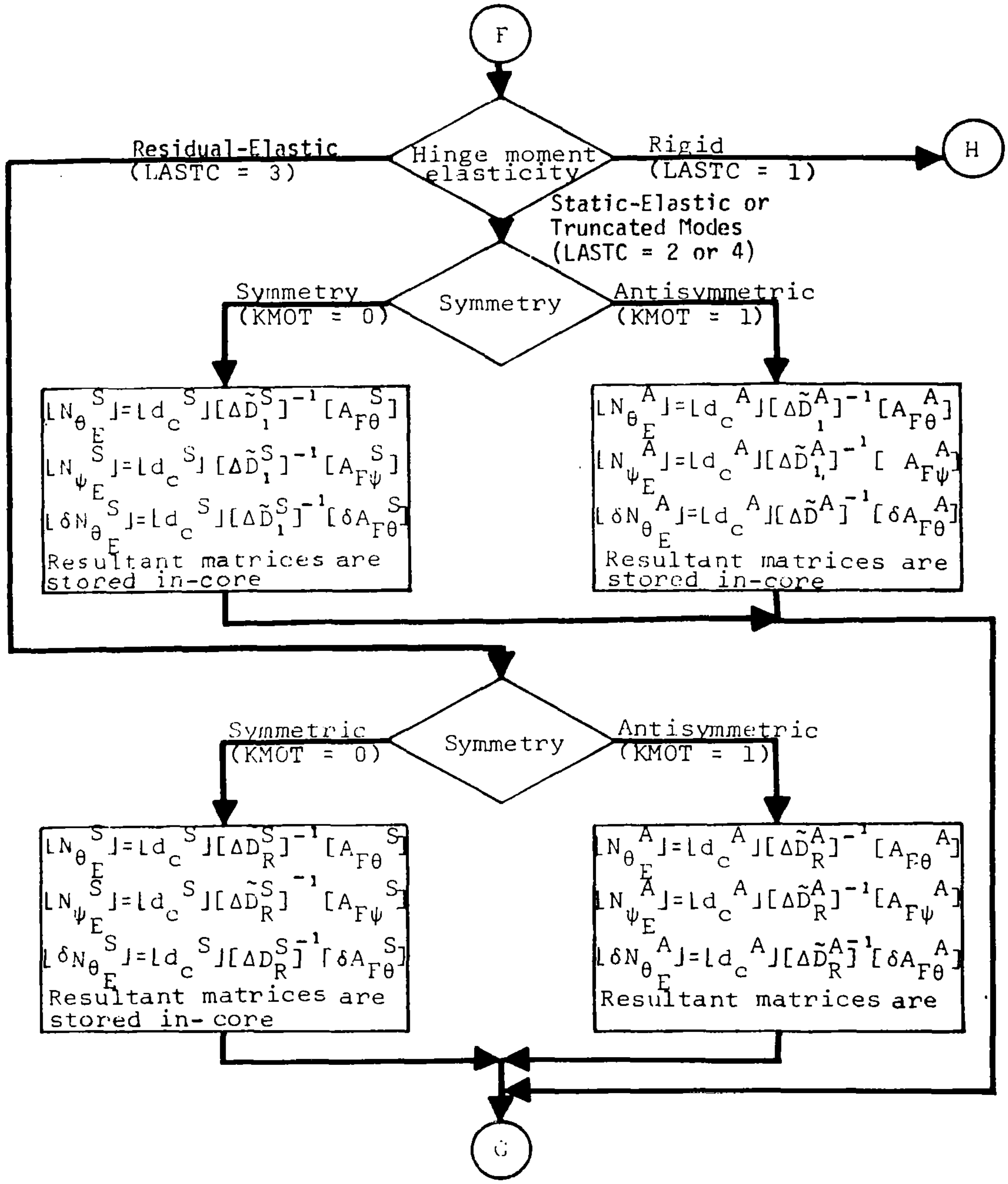


FLOWCHART 9.3-94b.—CONTINUED

HMCAL (Cont.)

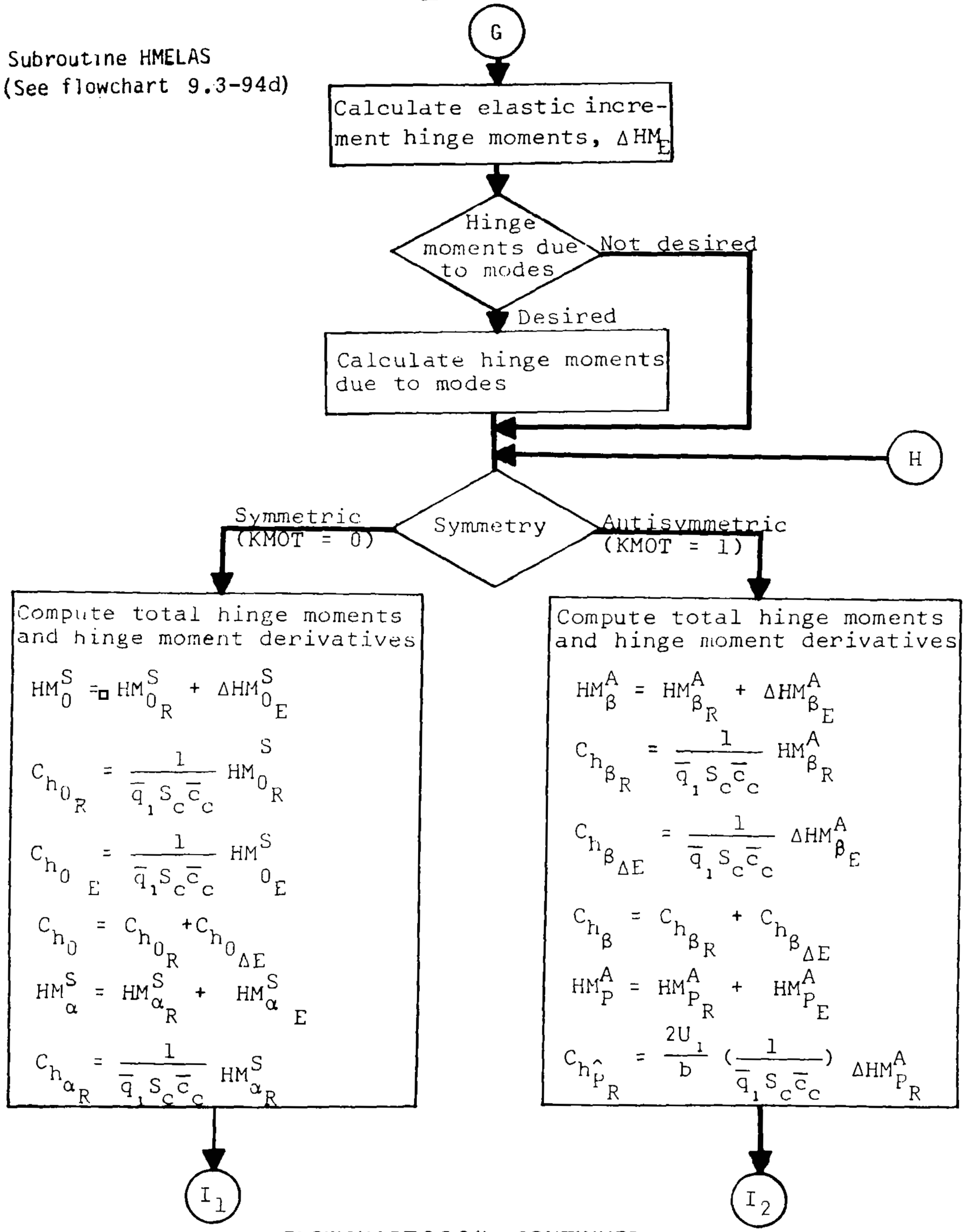


FLOWCHART 9.3-94b.–CONTINUED



FLOWCHART 9.3-94b.—CONTINUED

HMCAL (Cont.)



FLOWCHART 9.3-94b.—CONTINUED

I_1

$$C_{h_{\alpha_{\Delta E}}} = \frac{1}{\bar{q}_1 S_c \bar{c}_c} HM^S_{\alpha_E}$$

$$C_{h_\alpha} = C_{h_{\alpha_R}} + C_{h_{\alpha_{\Delta E}}}$$

$$HM^S_Q = HM^S_{Q_R} + \Delta HM^S_{Q_E}$$

$$C_{h_{\hat{q}_R}} = \frac{2U_1}{\bar{c}}\left(\frac{1}{q_1 S_c \bar{c}_c}\right)\Delta HM^S_{Q_R}$$

$$C_{h_{\hat{q}_{\Delta E}}} = \frac{2U_1}{c}\left(\frac{1}{\bar{q}_1 S_c \bar{c}_c}\right)\Delta HM^S_{Q_E}$$

$$C_{h_{\hat{q}}} = C_{h_{\hat{q}_R}} + C_{h_{\hat{q}_{\Delta E}}}$$

$$HM^S_{\delta c_i} = HM^S_{\delta c_{i_R}} + \Delta HM^S_{\delta c_{i_E}}$$

$$C^S_{h_{\delta c_{i_R}}} = \frac{1}{\bar{q}_1 S_c \bar{c}_c} HM^S_{\delta c_{i_R}}$$

$$C_{h_{\delta c_{i_{\Delta E}}}} = \frac{1}{\bar{q}_1 S_c \bar{c}_c} HM^S_{\delta c_{i_E}}$$

$$C^S_{h_{\delta c_i}} = C^S_{h_{\delta c_{i_R}}} + C^S_{h_{\delta c_{i_{\Delta E}}}}$$

$$HM^S_u = HM^S_{u_R} + \Delta HM^S_{u_E}$$

$$C_{h_{u_R}} = U_1\left(\frac{1}{\bar{q}\ S_c \bar{c}_c}\right) HM^S_{u_R}$$

$$C_{h_{\hat{u}_{\Delta E}}} = U_1\left(\frac{1}{\bar{q}_1 S_c \bar{c}_c}\right) HM^S_{u_E}$$

J_1

I_2

$$C_{h_{P_{\Delta E}}} = \frac{2U_1}{b}\frac{1}{\bar{q}_1 S_c \bar{c}_c}\Delta HM^A_{P_E}$$

$$C_{h_{\hat{P}}} = C_{h_{\hat{P}_R}} + C_{h_{\hat{P}_{\Delta E}}}$$

$$HM^A_R = HM^A_{R_R} + \Delta HM^A_{R_E}$$

$$C_{h_{\hat{r}_R}} = \frac{2U_1}{b}\left(\frac{1}{\bar{q}_1 S_c \bar{c}_c}\right) HM^A_{R_R}$$

$$C_{h_{\hat{r}_{\Delta E}}} = \frac{2U_1}{b}\left(\frac{1}{\bar{q}_1 S_c \bar{c}_c}\right)\Delta HM^A_{R_E}$$

$$C_{h_{\hat{r}}} = C_{h_{\hat{r}_R}} + C_{h_{\hat{r}_{\Delta E}}}$$

$$HM^A_{\delta c_i} = HM^A_{\delta c_{i_R}} + HM^A_{\delta c_{i_E}}$$

$$C^A_{h_{\delta c_{i_R}}} = \frac{1}{\bar{q}_1 S_c \bar{c}_c} HM^A_{\delta c_{i_E}}$$

$$C^A_{h_{\delta c_{i_{\Delta E}}}} = \frac{1}{\bar{q}_1 S_c \bar{c}_c}\Delta HM^A_{\delta c_{i_E}}$$

$$C^A_{h_{\delta c_i}} = C^A_{h_{\delta c_{i_R}}} + C^A_{h_{\delta c_{i_{\Delta E}}}}$$

$$HM^A_{\dot{v}} = HM^A_{\dot{v}_R} + \Delta HM^A_{\dot{v}_E}$$

$$C_{h_{\hat{\dot{\beta}}_R}} = \frac{4U_1^3}{b^2}\left(\frac{1}{\bar{q}_1 S_c \bar{c}_c}\right) HM^A_{\dot{v}_R}$$

$$C_{h_{\hat{\dot{\beta}}_{\Delta E}}} = \frac{4U_1^3}{b^2}\left(\frac{1}{\bar{q}_1 S_c \bar{c}_c}\right) HM^A_{\dot{v}_E}$$

J_2

FLOWCHART 9.3-94b.–CONTINUED

J1

$$C_{h_{\hat{u}}} = C_{h_{\hat{u}_R}} + C_{h_{\hat{u}_{\Delta E}}}$$

$$HM^{S}_{\dot{w}} = HM^{S}_{\dot{w}_R} + HM^{S}_{\dot{w}_E}$$

$$C_{h_{\hat{\alpha}_R}} = \frac{4U_1^3}{\bar{c}^2}\left(\frac{1}{\bar{q}_1 S_c \bar{c}_c}\right) HM^{S}_{\dot{w}_R}$$

$$C_{h_{\hat{\alpha}_{\Delta E}}} = \frac{4U_1^3}{\bar{c}^2}\left(\frac{1}{\bar{q}_1 S_c \bar{c}_c}\right) HM^{S}_{\dot{w}_E}$$

$$C_{h_{\hat{\dot{\alpha}}}} = C_{h_{\hat{\dot{\alpha}}_R}} + C_{h_{\hat{\dot{\alpha}}_{\Delta E}}}$$

$$HM^{S}_{\dot{Q}_R} = HM^{S}_{\dot{Q}_R} + \Delta HM^{S}_{\dot{Q}_E}$$

$$C_{h_{\hat{\dot{q}}_R}} = \frac{4U_1^2}{\bar{c}^2}\left(\frac{1}{\bar{q}_1 S_c \bar{c}_c}\right) HM^{S}_{\dot{Q}_R}$$

$$C_{h_{\hat{\dot{q}}_{\Delta E}}} = \frac{4U_1^2}{\bar{c}^2}\left(\frac{1}{\bar{q}_1 S_c \bar{c}_c}\right) \Delta HM^{S}_{\dot{Q}_E}$$

$$C_{n_{\hat{\dot{q}}}} = C_{h_{\hat{\dot{q}}_R}} + C_{h_{\hat{\dot{q}}_{\Delta E}}}$$

$$HM^{S}_{\dot{\delta} c_i} = HM^{S}_{\dot{\delta} c_{i_R}} + \Delta HM^{S}_{\dot{\delta} c_{i_E}}$$

$$C^{S}_{h_{\dot{\delta} c_{i_R}}} = \frac{1}{\bar{q}_1 S_c \bar{c}_c} HM^{S}_{\dot{\delta} c_{i_R}}$$

$$C^{S}_{h_{\dot{\delta} c_{i_{\Delta E}}}} = \frac{1}{\bar{q}_1 S_c \bar{c}_c} \Delta HM^{S}_{\delta c_{i_E}}$$

$$C^{S}_{h_{\dot{\delta} c_i}} = C^{S}_{h_{\dot{\delta} c_R}} + C^{S}_{h_{\dot{\delta} c_{i_{\Delta E}}}}$$

J2

$$C_{h_{\hat{\dot{\beta}}}} = C_{h_{\hat{\dot{\beta}}_R}} + C_{h_{\hat{\dot{\beta}}_{\Delta E}}}$$

$$HM^{A}_{\dot{P}} = HM^{A}_{\dot{P}_R} + HM^{A}_{\dot{P}_E}$$

$$C_{h_{\hat{\dot{p}}_R}} = \frac{4U_1^2}{b^2}\left(\frac{1}{\bar{q}_1 S_c \bar{c}_c}\right) HM^{A}_{\dot{P}_R}$$

$$C_{h_{\hat{\dot{p}}_{\Delta E}}} = \frac{4U_1^2}{b^2}\left(\frac{1}{\bar{q}_1 S_c \bar{c}_c}\right) \Delta HM^{A}_{\dot{P}_E}$$

$$C_{h_{\hat{\dot{p}}}} = C_{h_{\hat{\dot{p}}_R}} + C_{h_{\hat{\dot{p}}_{\Delta E}}}$$

$$HM^{A}_{\dot{R}} = HM^{A}_{\dot{R}_R} + HM^{A}_{\dot{R}_E}$$

$$C_{h_{\hat{\dot{r}}_R}} = \frac{4U_1^2}{b^2}\left(\frac{1}{\bar{q}_1 S_c \bar{c}_c}\right) HM^{A}_{\dot{R}_R}$$

$$C_{h_{\hat{\dot{r}}_{\Delta E}}} = \frac{4U_1^2}{b^2}\left(\frac{1}{\bar{q}_1 S_c \bar{c}_c}\right) \Delta HM^{A}_{\dot{R}_E}$$

$$C_{h_{\hat{\dot{r}}}} = C_{h_{\hat{\dot{r}}_R}} + C_{h_{\hat{\dot{r}}_{\Delta E}}}$$

$$HM^{A}_{\dot{\delta} c_i} = HM^{A}_{\dot{\delta} c_{i_R}} + HM^{A}_{\dot{\delta} c_{i_E}}$$

$$C^{A}_{h_{\dot{\delta} c_{i_R}}} = \frac{1}{\bar{q}_1 S_c \bar{c}_c} \Delta HM^{A}_{\dot{\delta} c_{i_R}}$$

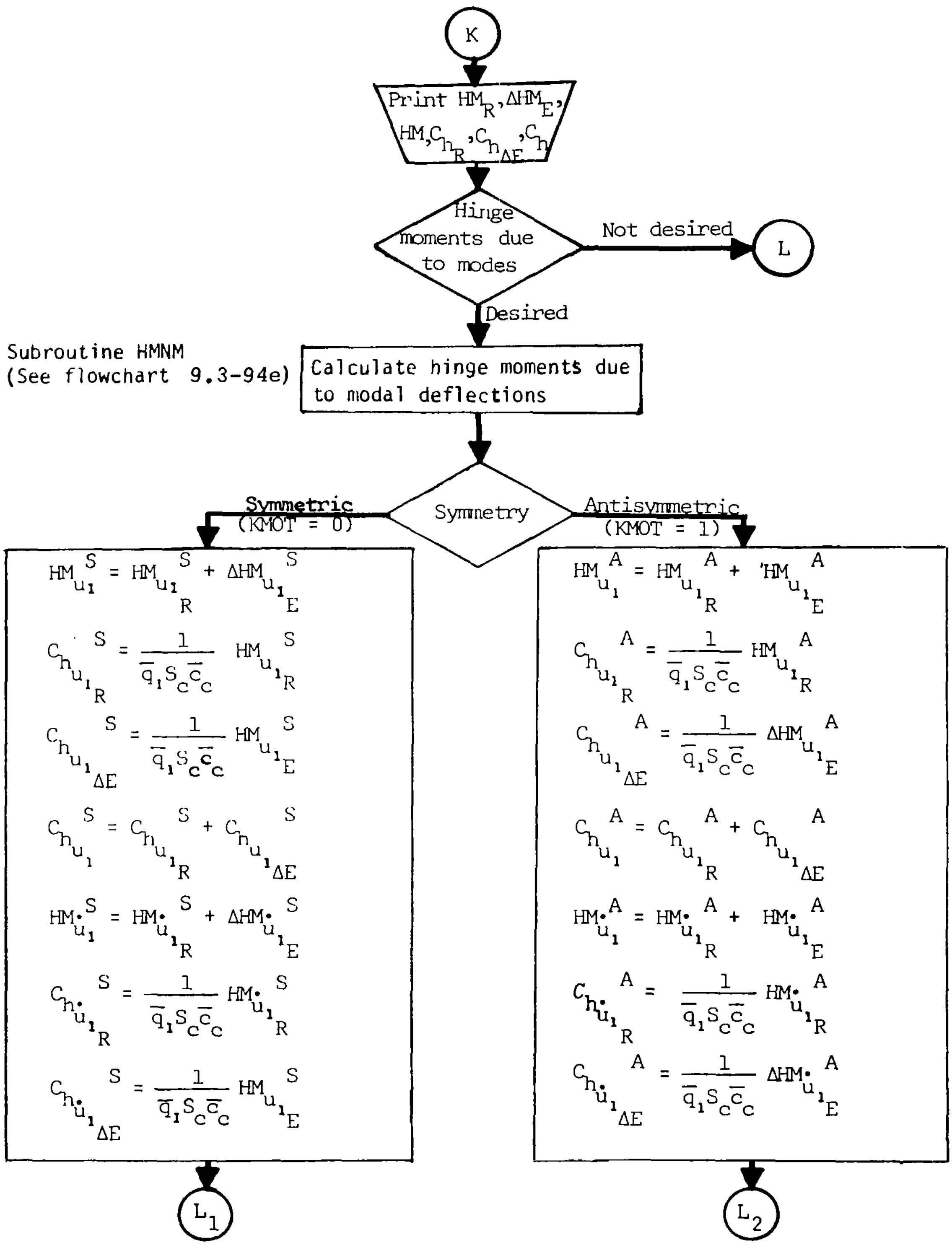
$$C^{A}_{h_{\dot{\delta} c_{i_{\Delta E}}}} = \frac{1}{\bar{q}_1 S_c \bar{c}_c} HM^{A}_{\dot{\delta} c_{i_E}}$$

$$C^{A}_{h_{\dot{\delta} c_i}} = C^{A}_{h_{\dot{\delta} c_{i_R}}} + C^{A}_{h_{\dot{\delta} c_{i_{\Delta E}}}}$$

K

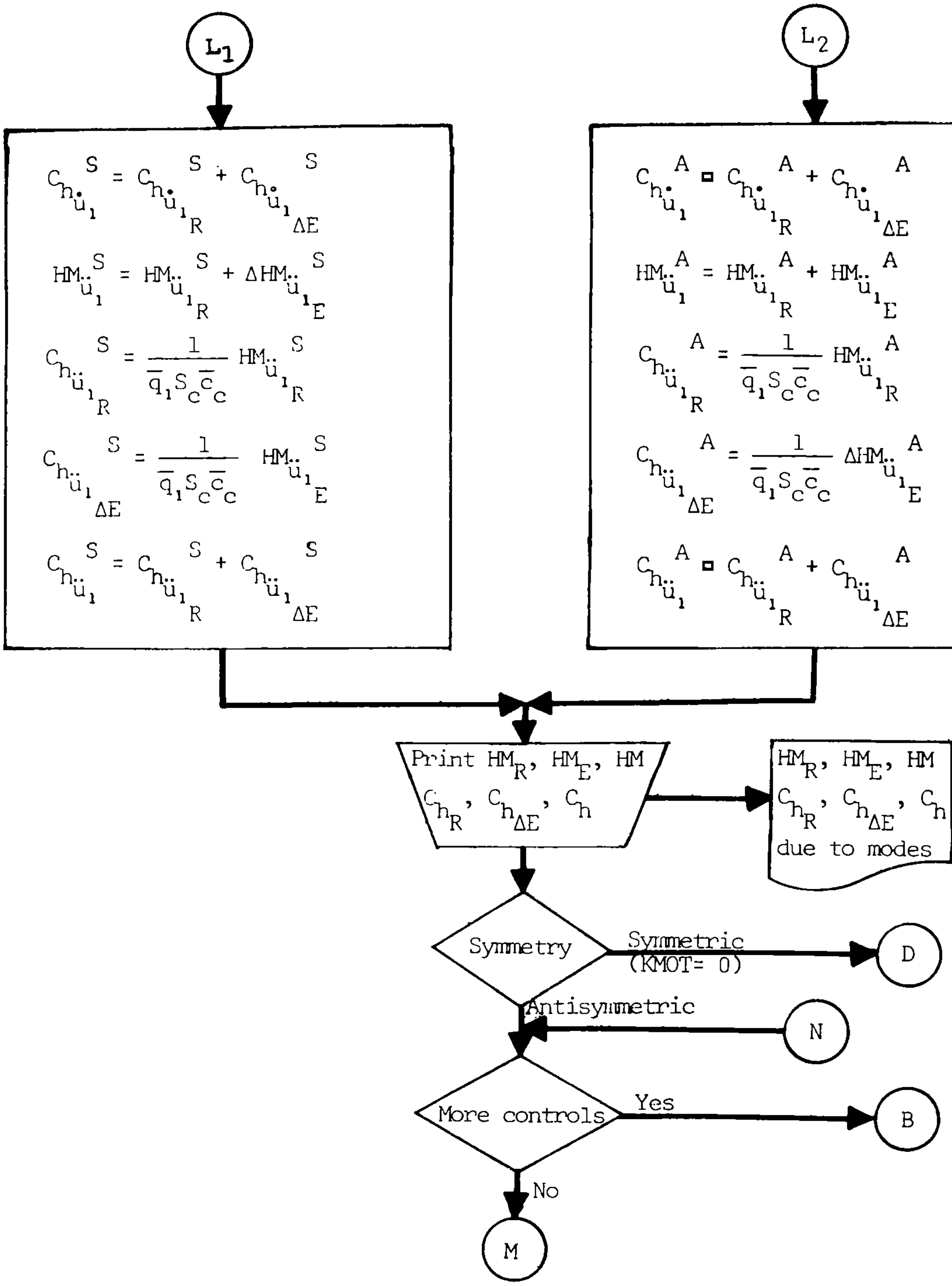
FLOWCHART 9.3-94b.—CONTINUED

HMCAL (Cont.)



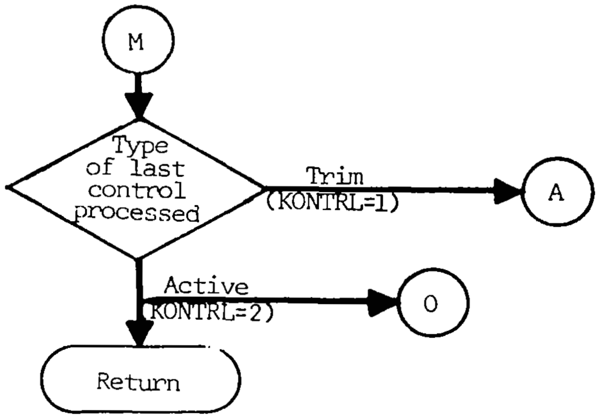
FLOWCHART 9.3-94b.—CONTINUED

HMCAL (Cont.)



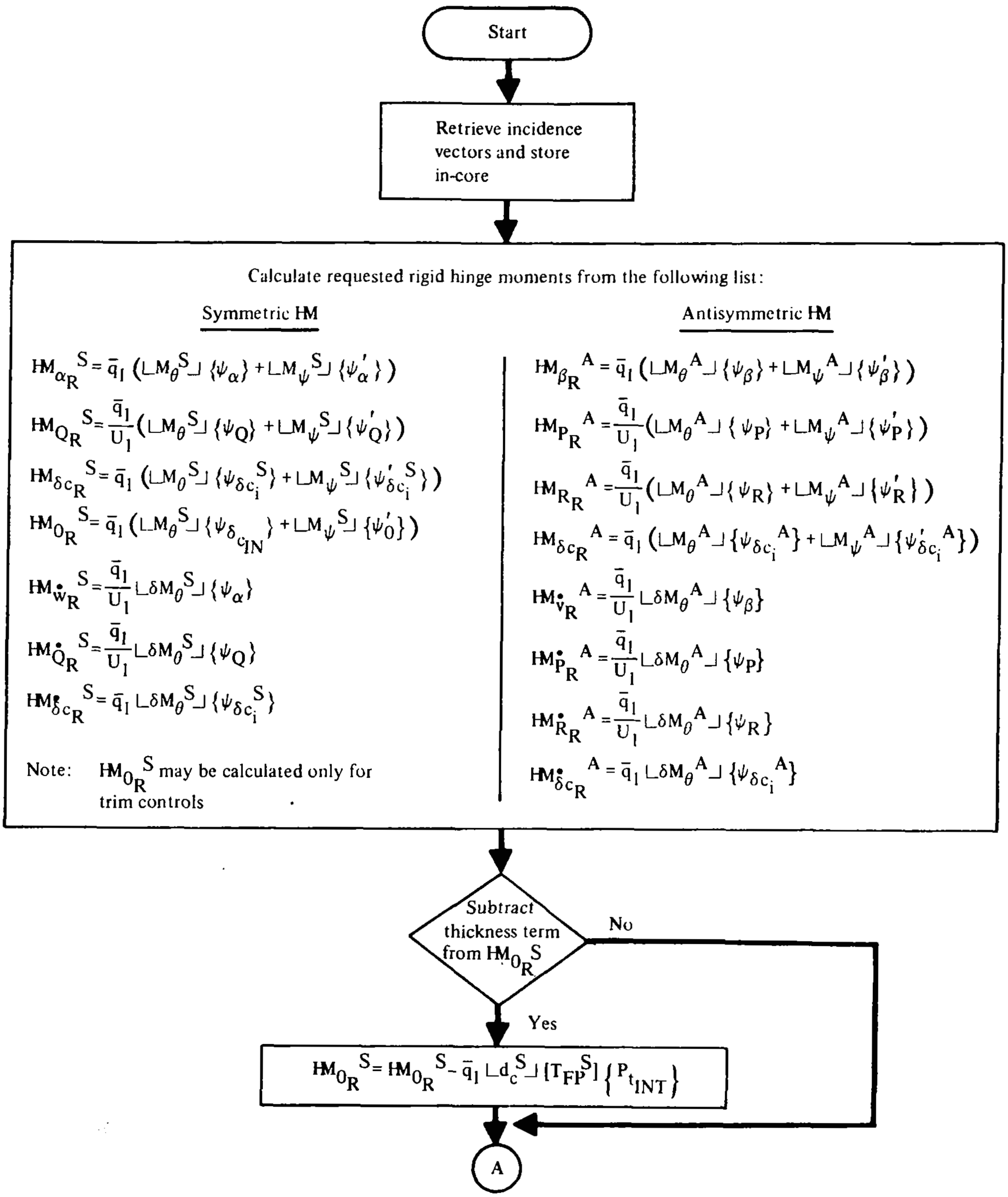
FLOWCHART 9.3-94b.–CONTINUED

HMCAL (Cont.)



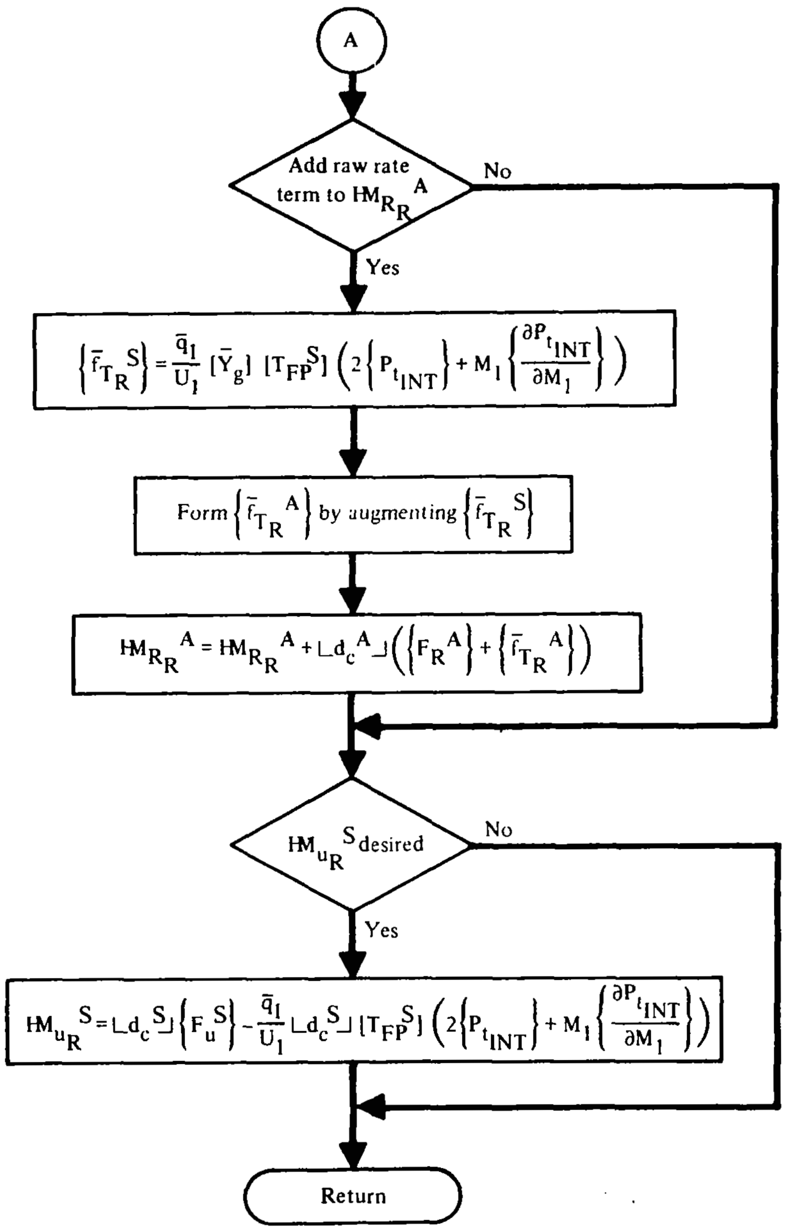
FLOWCHART 9.3-94b.—CONCLUDED

Subroutine HMRIG



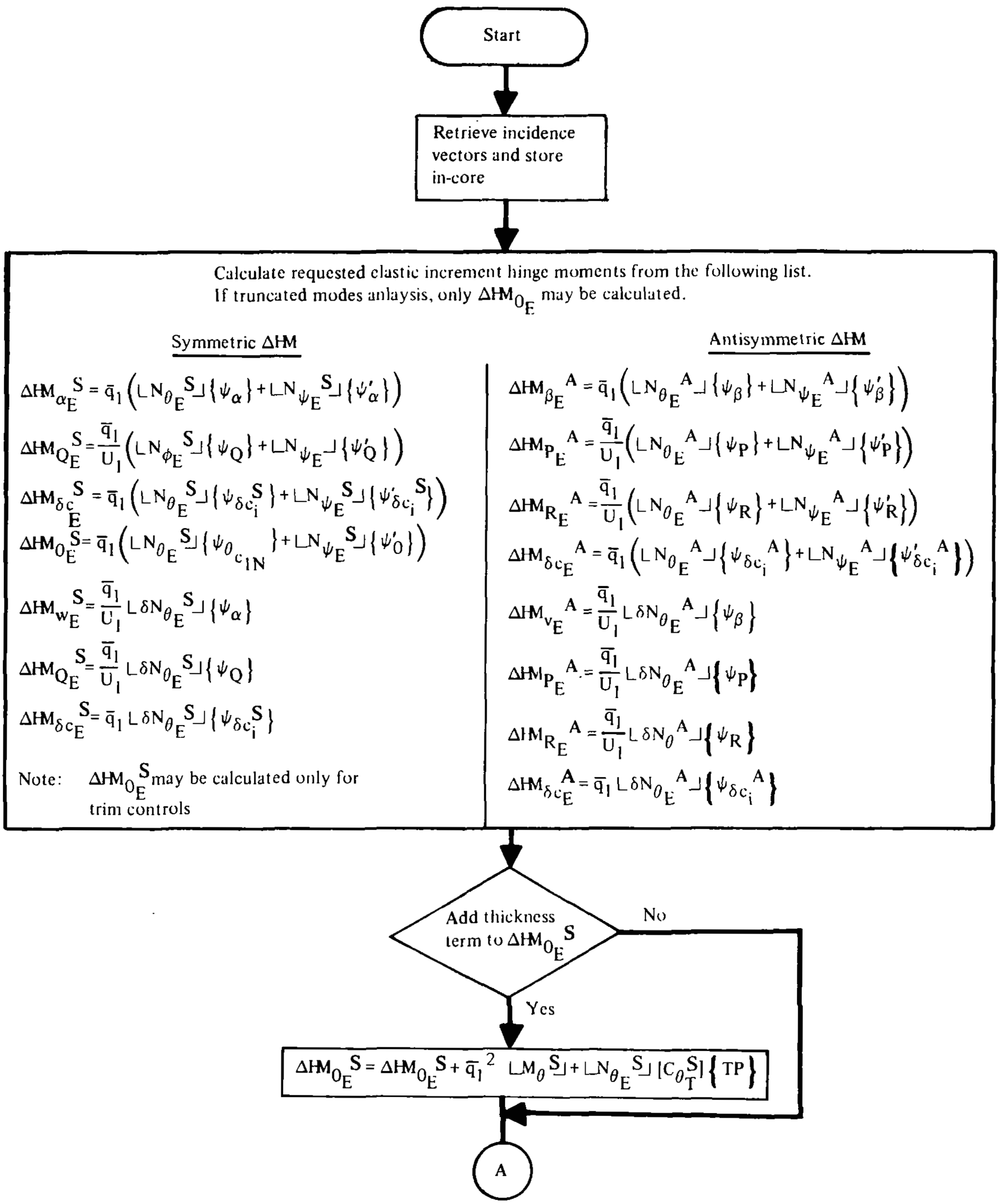
FLOWCHART 9.3-94c.—RIGID HINGE MOMENTS

HMRIG (Cont.)



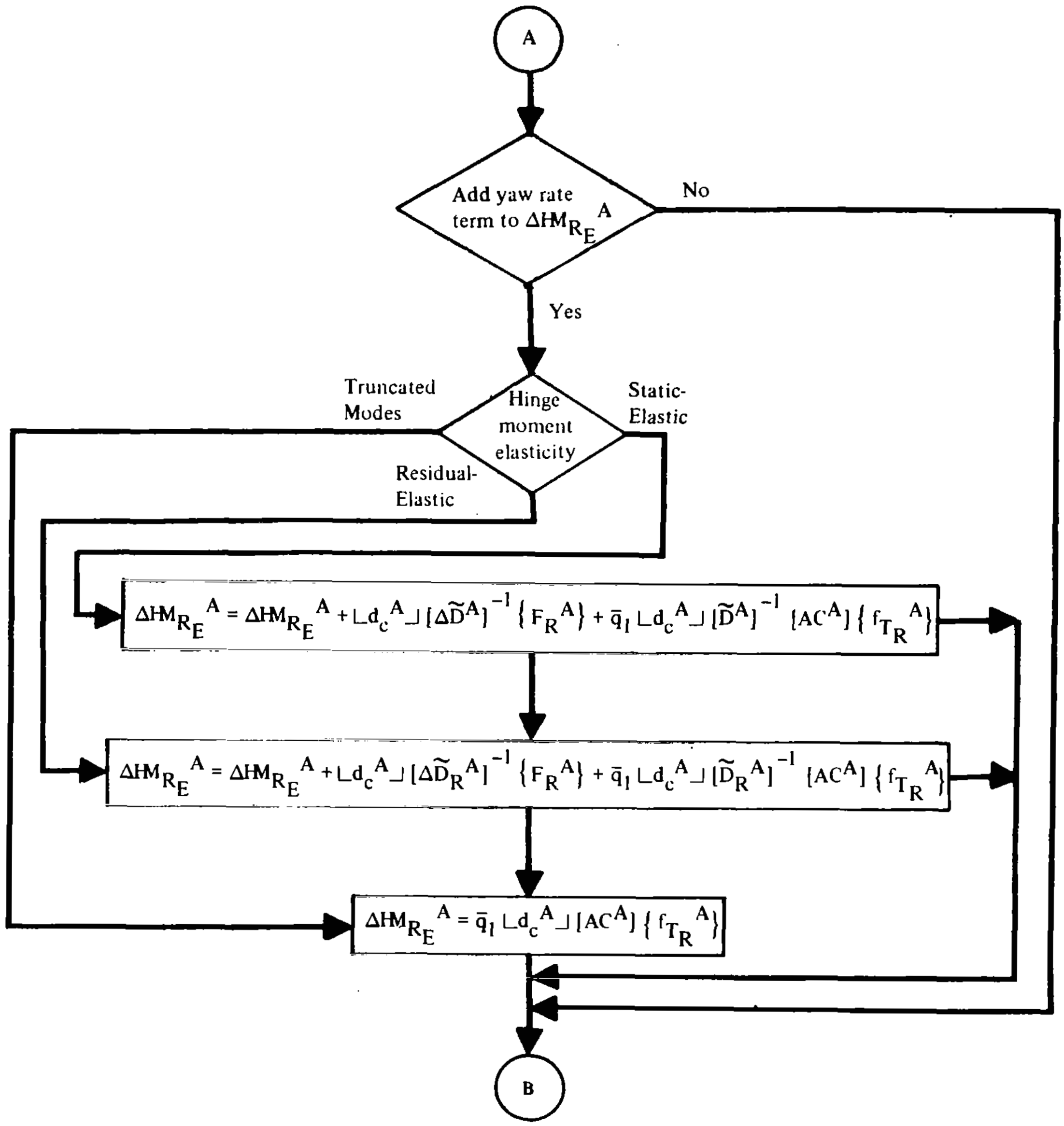
FLOWCHART 9.3-94c.—CONCLUDED

Subroutine HMELAS



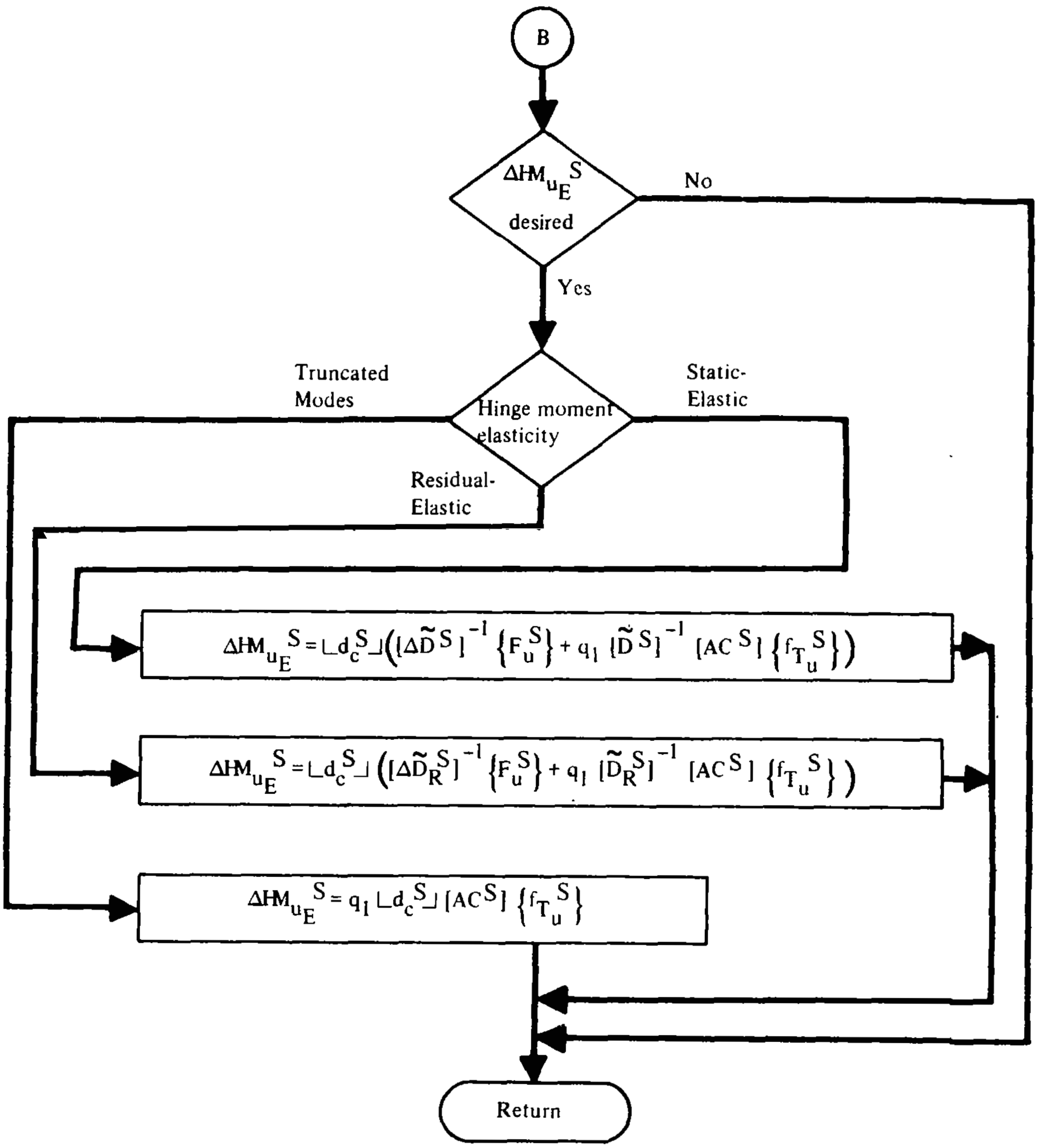
FLOWCHART 9.3-94d.—ELASTIC INCREMENT HINGE MOMENTS

HMELAS (Cont.)



FLOWCHART 9.3-94d.—CONTINUED

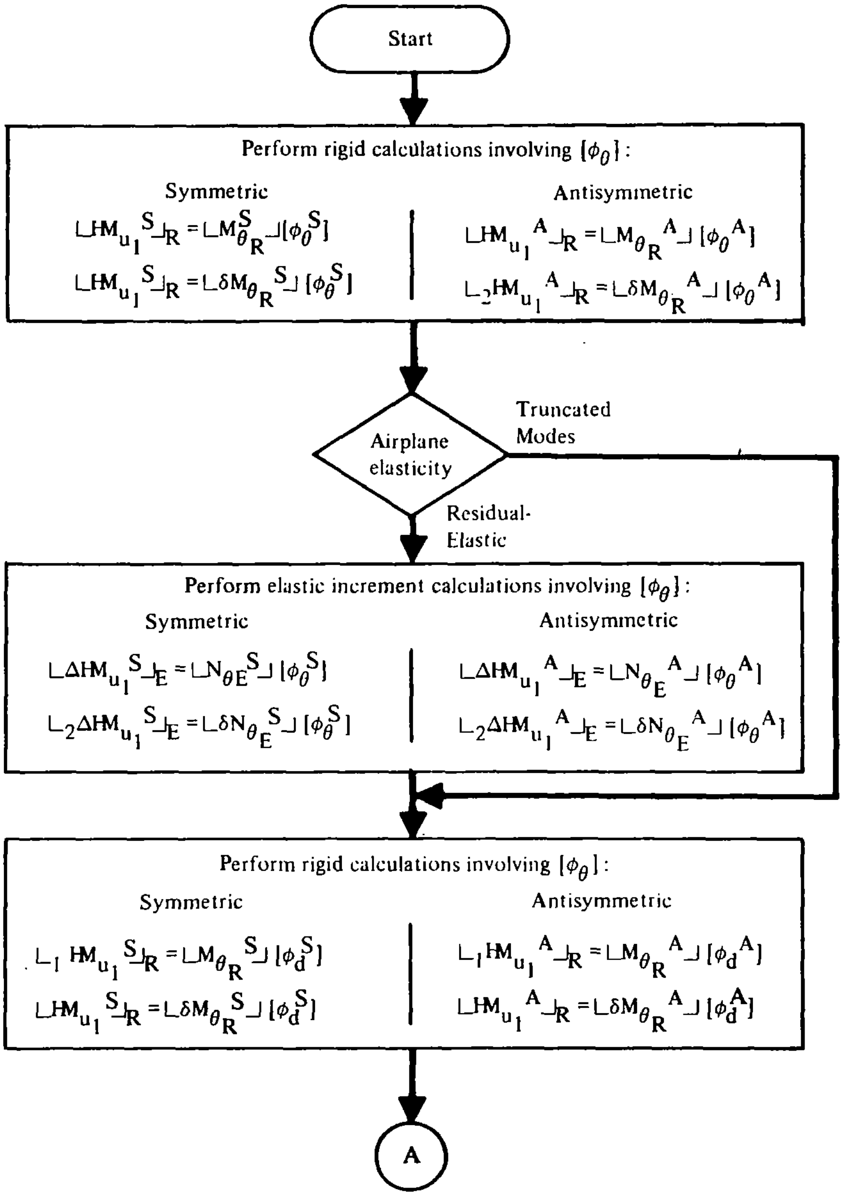
HMELAS (Cont.)



FLOWCHART 9.3-94b.—CONCLUDED

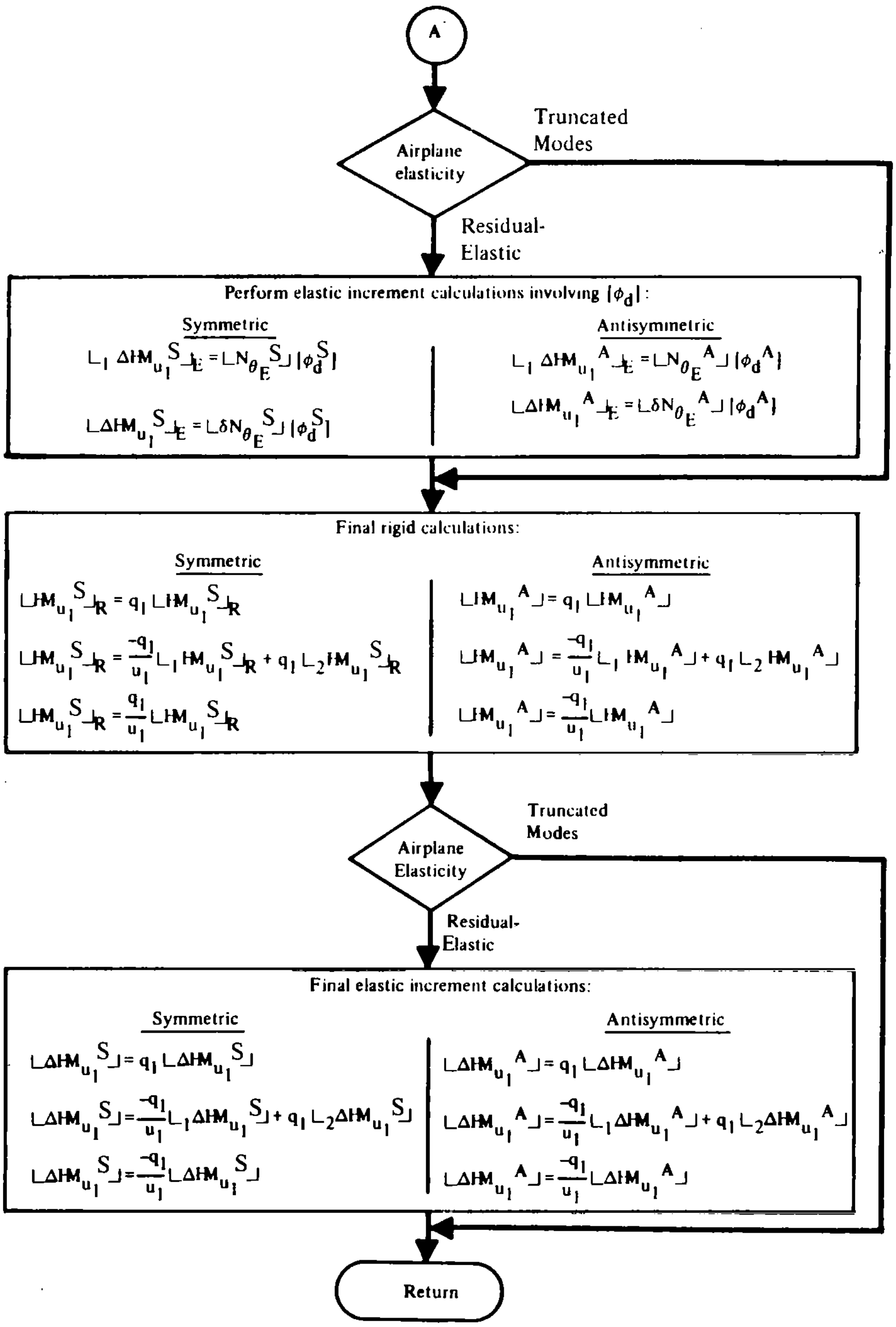
Subroutine HMNM

Purpose—To calculate the hinge moments due to modal forces



FLOWCHART 9.3-94e.—NORMAL MODES HINGE MOMENTS

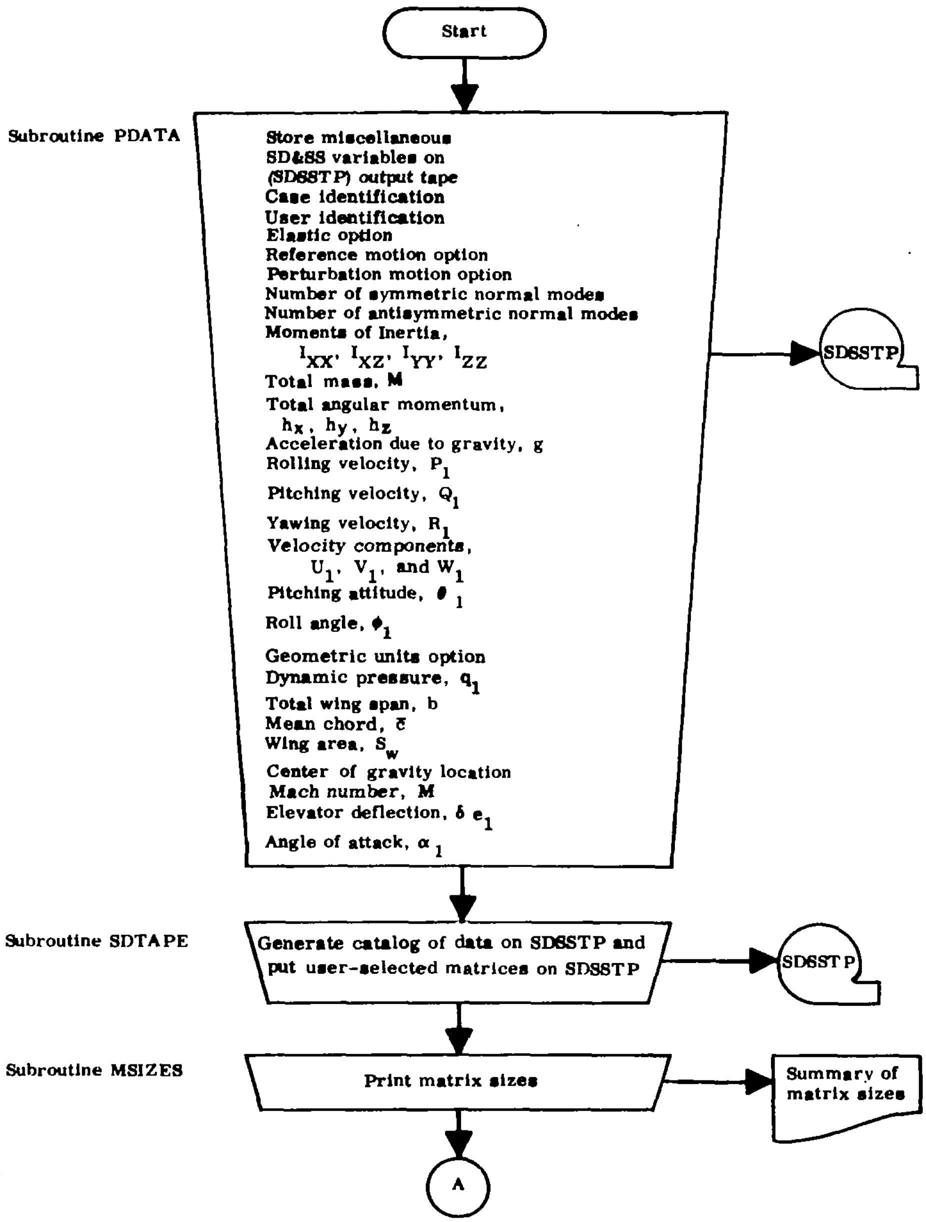
HMNM (Cont.)



FLOWCHART 9.3-94e.—CONCLUDED

Overlay (10,0)

Main Program POST



FLOWCHART 9.3-95.–SD&SS POSTPROCESSOR

A.11 STABILITY DATA TAPE (SDSSTP)

SDSSTP is a binary tape composed of many logical files. In general, these files consist of:

- A master catalog of the contents of SDSSTP. This catalog is always the first file on the tape.
- Miscellaneous data required by the TH, SLOADS, and ALOADS programs. These data are stored in one file and consist of information such as moments of inertia, center of gravity location, number and size of the stability derivative matrices, etc.
- Slender Body and Thin Body lifting pressure data. These data are stored in one logical file.
- The $\lceil k_I \rfloor$ and $\lceil m_I \rfloor$ structural matrices. These matrices (if they exist) are copied from SICTP3 onto SDSSTP.
- Stability derivative matrices.
- Displacement and camber slope matrices.
- Elastic axis load matrices (optional).
- Gust matrices (optional).
- Any user-specified matrices. An option in the SD&SS program allows the user to specify matrices to be stored on SDSSTP in addition to those which are normally saved.[a]

Each matrix is stored as one logical file. Tables A.11-1 and A.11-1a give a complete list of the matrices that are *automatically* saved (depending on options) on SDSSTP.

Only the formats of the first file (master catalog), the file containing the miscellaneous data, and the pressure data file will be described. The remaining files on SDSSTP contain matrices and, as such, conform to the Standard FLEXSTAB Matrix Format explained in appendix A.1.

The first file on SDSSTP is the master catalog. It is composed of several data records. There are two types of data records in this catalog: Matrix Records and Terminal Records. A Matrix Record contains information pertaining to the data stored in one particular file of SDSSTP. Thus, for each file on SDSSTP (not counting the master catalog) there is a corresponding Matrix Record in the master catalog. A Terminal Record is used to signify the end of the catalog. The formats of these two data records are shown in tables A.11-2 and A.11-3.

[a]Any matrix generated internally by SD&SS or input to SD&SS via AICTAP or SICTP3 may be specified for storage on SDSSTP. See appendix B-1 for a complete list of matrices.

Error

An error occurred while processing this page. See the system log for more details.

TABLE A.11-1a.—CONCLUDED

FLEXSTAB name	Engineering symbol							
(STATIC)–S	$C_{L_{1_{rigid}}}$	$C_{L_{1_{elastic\ incr}}}$	$C_{L_{\hat{U}_{rigid}}}$	$C_{L_{\hat{U}_{elastic\ incr}}}$	$C_{L_{\alpha_{rigid}}}$	$C_{L_{\alpha_{elastic\ incr}}}$	$C_{L_{\hat{q}_{rigid}}}$	$C_{L_{\hat{q}_{elastic\ incr}}}$
	0	0	$C_{D_{\hat{U}_{rigid}}}$	$C_{D_{\hat{U}_{elastic\ incr}}}$	$C_{D_{\alpha_{rigid}}}$	$C_{D_{\alpha_{elastic\ incr.}}}$	$C_{D_{q_{rigid}}}$	$C_{D_{\hat{q}_{elastic\ incr}}}$
	0	0	$C_{m_{\hat{U}_{rigid}}}$	$C_{m_{\hat{U}_{elastic\ incr}}}$	$C_{m_{\alpha_{rigid}}}$	$C_{m_{\alpha_{elastic\ incr.}}}$	$C_{m_{\hat{q}_{rigid}}}$	$C_{m_{\hat{q}_{elastic\ incr}}}$
(STATIC)–A	$C_{Y_{\beta_{rigid}}}$	$C_{Y_{\beta_{elastic\ incr}}}$	$C_{Y_{\hat{p}_{rigid}}}$	$C_{Y_{\hat{p}_{elastic\ incr}}}$	$C_{Y_{\hat{r}_{rigid}}}$	$C_{Y_{\hat{r}_{elastic\ incr}}}$		
	$C_{\ell_{\beta_{rigid}}}$	$C_{\ell_{\beta_{elastic\ incr}}}$	$C_{\ell_{\hat{p}_{rigid}}}$	$C_{\ell_{\hat{p}_{elastic\ incr}}}$	$C_{\ell_{\hat{r}_{rigid}}}$	$C_{\ell_{\hat{r}_{elastic\ incr}}}$		
	$C_{n_{\beta_{rigid}}}$	$C_{n_{\beta_{elastic\ incr}}}$	$C_{n_{\hat{p}_{rigid}}}$	$C_{n_{\hat{p}_{elastic\ incr}}}$	$C_{n_{\hat{r}_{rigid}}}$	$C_{n_{\hat{r}_{elastic\ incr}}}$		

$N_{u_a}^S$	Number of symmetric external structural (ESIC) degrees of freedom; i.e., d_z and d_x for each node (the d_y component is not retained)
$N_{u_a}^A$	Number of antisymmetric external structural (ESIC) degrees of freedom; i.e., d_y for each node (the d_z and d_x components are not retained)
N_{ACS}^A	Number of antisymmetric active control surfaces
N_C^A	$2\left(N_{ACS}^A + 2\right)$
N_{ACS}^S	Number of symmetric active control surfaces
N_C^S	$2\left(N_{ACS}^S + 1\right)$

- Matrix directory

  Informs the user or programmer where information on the definition or formulation of the matrices can be found, viz, equation number in volume I and flowchart number in volume III. The equation numbers from volume I identify the equations where the matrices are first introduced. A complete description and definition of the matrices usually involves the text of volume I, both preceding and following the cited equation. The Table of Contents in volume I is detailed and will aid the reader in finding related details of a specific matrix (e.g., the matrix $[CPM^S]$ of table B-1 is defined by equation (3.4-167) in section 3.4.7.1 of volume I; and the reader is directed to sections 3.4.4, 3.4.5, and 3.4.6)

  Some matrices appearing in table B-1 have no volume I equation number cited. These matrices are defined by the equations appearing in the flowcharts and they will be found to be solely defined in the flowcharts.

  The program in which the matrix is created is also shown.

- Interprogram file name

  Name of the magnetic tape containing the matrix. This applies only to matrices involved in interprogram transfer.

- Printout available

  Indicates whether a matrix may be printed or not.

- Description

  Brief comment on the nature of the matrix.

TABLE B-1.—Continued

FLEXSTAB name	Engineering symbol	Matrix size	Matrix Directory: Program	Matrix Directory: Vol. III flowchart no.	Matrix Directory: Vol. I equation no.	Inter-program file name	Printout available	Description
(C AA)-A	$[C^A]$	$N_{u_a}^A \times N_u^A$	ESIC	NA[b]	4.2-60	NASTAP	No	Constrained flexibility matrix
(C AA)-S	$[C^S]$	$N_{u_a}^S \times N_{u_a}^S$	ESIC	NA[b]	4.2-60	NASTAP	No	Constrained flexibility matrix
(CA1)	$[A_1]$	6×6	SD&SS	9.3-74	6.3-40	SDSSTP	Yes	Coefficients of steady aerodynamic c.g. forces in equations of motion
(CA2)	$[A_2]$	6×6	SD&SS	9.3-74	6.3-44	SDSSTP	Yes	Coefficients of unsteady aerodynamic c.g. forces equations of motion
(CA3)	$[A_3]$	$6 \times N_{NM}$	SD&SS	9.3-75	6.3-48	SDSSTP	Yes	Coefficients of modal deflections in equations of motion
(CA4)	$[A_4]$	$6 \times N_{NM}$	SD&SS	9.3-75	6.3-51	SDSSTP	Yes	Coefficients of modal velocity in equations of motion
(CA5)	$[A_5]$	$6 \times N_{NM}$	SD&SS	9.3-75	6.3-55	SDSSTP	Yes	Coefficients of modal acceleration in equations of motion
(CD)-S	$[CD^S]$	$n_R^S \times M^S$	SD&SS	9.3-51	—	—	Yes	Intermediate matrix
(CDA)-S	$[CDA^S]$	$n_R^S \times n_R^S$	SD&SS	9.3-51	—	—	Yes	Intermediate matrix
(C DF)-A	$[\bar{C}_{dQ}^A]$	$n_R^A \times N_{\delta e}^A$	ISIC	6.3-14	4.3-196	SICTP1	No	Constrained flexibility matrix
(C DF)-S	$[\bar{C}_{dQ}^S]$	$n_R^S \times N_{\delta e}^S$	ISIC	6.3-14	4.3-196	SICTP1	No	Constrained flexibility matrix
(C DG)-A	$[\tilde{C}_{dG}^A]$	$n_R^A \times L_{TRST}^A$	ISIC ESIC	6.3-14 8.3-7	4.3-211 5.7-14	SICTP2 SICTP3	Yes[a]	Unconstrained flexibility matrix
(C DG)-S	$[\tilde{C}_{dG}^S]$	$n_R^S \times L_{TRST}^S$	ISIC ESIC	6.3-14 8.3-7	4.3-211 5.7.14	SICTP2 SICTP3	Yes[a]	Uncontrained flexibility matrix
(C DT)-A	$[\tilde{C}_{dT}^A]$	$n_R^A \times N^A$	ISIC ESIC	6.3-14 8.3-7	4.3-209 5.7.14	SICTP2 SICTP3	Yes[a]	Unconstrained flexibility matrix
(C DT)-S	$[\tilde{C}_{dT}^S]$	$n_R^S \times N^S$	ISIC ESIC	6.3-14 8.3-7	4.3-209 5.7.14	SICTP2 SICTP3	Yes[a]	Unconstrained flexibility matrix
C.O.G.-S or C.O.G.-A	$\{X_{c.g.}, Y_{c.g.}, Z_{c.g.}\}$	1×3	ISIC ESIC	6.3-9 8.3-4	2.2-6	SICTP2 SICTP3	Yes	Center of gravity of configuration
(CONTRL)-A	–	$3xN_C^A$	SD&SS	–	–	SDSSTP	Yes	The anntisymmetric static and dynamic control surface derivatives
(CONTRL)-S	–	$3xN_C^S$	SD&SS	–	–	SDSSTP	Yes	The symmetric static and dynamic control surface derivatives

[a] The user may print the matrix only during execution of SD&SS

[b] Matrix is created external to FLEXSTAB when input via NASTAP

TABLE B-1.—Continued

FLEXSTAB name	Engineering symbol	Matrix size	Matrix Directory: Program	Matrix Directory: Vol. III flowchart no.	Matrix Directory: Vol. I equation no.	Inter-program file name	Printout available	Description
(CPB)-DM	$[CPM_{BJ,BJ}^{S}]_{M+\Delta M}$	$\ell'_S \times \ell'_S$	AIC	5.3-4	3.4-227	——	Yes	Slender Body source pressure coefficient matrix
(CPB)-S	$[CPM_{BJ,BJ}^{S}]$	$\ell'_S \times \ell'_S$	AIC	5.3-4	3.4-95	——	Yes	Slender Body source pressure coefficient matrix
(CPM)-A	$[CPM^{A}]$	$n \times n$	AIC	5.3-4	3.4-167	——	Yes	Lifting pressure coefficent matrix
(CPM)-DM	$[CPM^{S}]_{M + \Delta M}$	$n \times n$	AIC	5.3-4	3.4-232	——	Yes	Lifting pressure coefficient matrix
(CPM)-S	$[CPM^{S}]$	$n \times n$	AIC	5.3-4	3.4-167	——	Yes	Lifting pressure coefficient matrix
(CPWC)-DM	$[CP_{WI,WI}^{CS}]_{M+\Delta M}$	$\ell'_T \times \ell'_T$	AIC	5.3-4	3.4-226	——	Yes	Pressure coefficient matrix due to constant sources on Thin Bodies
(CPWC)-S	$[CP_{WI,WI}^{CS}]$	$\ell'_T \times \ell'_T$	AIC	5.3-4	3.4-37	——	Yes	Pressure coefficient matrix due to constant sources on Thin Bodies
(CPWL)-DM	$[CP_{WI,WI}^{LS}]_{M+\Delta M}$	$\ell'_T \times \ell'_T$	AIC	5.3-4	3.4-226	——	Yes	Pressure coefficient matrix due to linearly varying sources on Thin Bodies
(CPWL)-S	$[CP_{WI,WI}^{LS}]$	$\ell'_T \times \ell'_T$	AIC	5.3-4	3.4-37	——	Yes	Pressure coefficient matrix due to linearly varying sources on Thin Bodies
(C RTHG)-A	$[\tilde{C}_{R_{\theta G}}^{A}]$	$n_R^A \times L_{TRST}^A$	ESIC	8.3-8	6.3-43	SICTP3	Yes[a]	Unconstrained residual flexibility matrix due to gyroscopic couples
(C RTHG)-S	$[\tilde{C}_{R_{\theta G}}^{S}]$	$n_R^S \times L_{TRST}^S$	ESIC	8.3-8	6.3-43	SICTP3	Yes[a]	Unconstrained residual flexibility matrix due to gyroscopic couples
(C RTHT)-A	$[\tilde{C}_{R_{\theta T}}^{A}]$	$n_R^A \times N^A$	NM ESIC	7.3-8 8.3-8	4.3-222 6.3-2	NMTAP2 SICTP3	Yes[a]	Unconstrained residual flexibility matrix
(C RTHT)-S	$[\tilde{C}_{R_{\theta T}}^{S}]$	$n_R^S \times N^S$	NM ESIC	7.3-8 8.3-8	4.3-222 6.3-2	NMTAP2 SICTP3	Yes[a]	Unconstrained residual flexibility matrix
(CSNAMES)A	——	$1x(N_{ACS}^{A} + 2)$	SD&SS	——	——	SDSSTP	No	The antisymmetric control surface names
(CSNAMES)S	——	$1x(N_{ACS}^{S}$	SD&SS	——	——	SDSSTP	No	The symmetric control surface names
(C THA)-A	$[\bar{C}_{\theta A}^{A}]$	$n_R^A \times N^A$	ISIC	——	——	SICTP2 SICTP3	Yes[a]	Constrained flexibility matrix (not currently used)
(C THA)-S	$[\bar{C}_{\theta A}^{S}]$	$n_R^S \times N^S$	ISIC	——	——	SICTP2 SICTP3	Yes[a]	Constrained flexibility matrix (not currently used)
(C THF)-A	$[\bar{C}_{\theta Q}^{A}]$	$n_R^A \times N_{\delta e}^A$	ISIC	6.3-14	4.3-197	SICTP1	No	Constrained flexibility matrix
(C THF)-S	$[\bar{C}_{\theta Q}^{S}]$	$n_R^S \times N_{\delta e}^S$	ISIC	6.3-14	4.3-197	SICTP1	No	Constrained flexibility matrix
(C THG)-A	$[\tilde{C}_{\theta G}^{A}]$	$n_R^A \times L_{TRST}^A$	ISIC ESIC	6.3-14 8.3-7	4.3-212 5.3-1	SICTP2 SICTP3	Yes[a]	Unconstrained flexibility matrix due to gyroscopic couples
(C THG)-S	$[\tilde{C}_{\theta G}^{S}]$	$n_R^S \times L_{TRST}^S$	ISIC ESIC	6.3-14 8.3-7	4.3-212 5.3-1	SICTP2 SICTP3	Yes[a]	Unconstrained flexibility matrix due to gyroscopic couples

[a] The user may print the matrix only during execution of SD&SS

TABLE B-1.—Continued

FLEXSTAB name	Engineering symbol	Matrix size	Matrix Directory: Program	Matrix Directory: Vol. III flowchart no.	Matrix Directory: Vol. I equation no.	Inter-program file name	Printout available	Description
(SA1)	$[a_1]$	$N_{NM} \times 6$	SD&SS	9.3-76	6.3-60	SDSSTP	Yes	Generalized aerodynamic modal force matrix
(SA2)	$[a_2]$	$N_{NM} \times 6$	SD&SS	9.3-76	6.3-64	SDSSTP	Yes	Generalized aerodynamic modal force matrix
(SA3)	$[a_3]$	$N_{NM} \times N_{NM}$	SD&SS	9.3-77	6.3-68	SDSSTP	Yes	Generalized aerodynamic modal force matrix due to modal deflection
(SA4)	$[a_4]$	$N_{NM} \times N_{NM}$	SD&SS	9.3-77	6.3-71	SDSSTP	Yes	Generalized aerodynamic modal force matrix due to modal velocity
(SA5)	$[a_5]$	$N_{NM} \times N_{NM}$	SD&SS	9.3-77	6.3-75	SDSSTP	Yes	Generalized aerodynamic modal force matrix due to modal acceleration
(SB)	$\{s^S_{BJ}\}$	$\ell_S^{\prime} \times 1$	AIC	5.3-9	3.4-77	——	No	Slender Body source strength matrix
(SBFP)-A	$[SB^A_{F\psi}]$	$n \times M^A$	SD&SS	9.3-13	——	——	Yes	Noncircular Slender Body camber transformation matrix (not currently used)
(SBFP)-S	$[SB^S_{F\psi}]$	$n \times M^S$	SD&SS	9.3-13	——	——	Yes	Noncircular Slender Body camber transformation matrix (not currently used)
(SBFT)-A	$[SB^A_{F\theta}]$	$n^A_R \times M^A$	SD&SS	9.3-13	——	——	Yes	Noncircular Slender Body camber transformation matrix (not currently used)
(SBFT)-S	$[SB^S_{F\theta}]$	$n^S_R \times M^S$	SD&SS	9.3-13	——	——	Yes	Noncircular Slender Body camber transformation matrix (not currently used)
(SFPDG)-A	$[f_{\dot{\psi}_g}{}^A]$	$N^A_{NM} \times n^A_R$	SD&SS	9.3-85	——	SDSSTP	Yes	Unsteady gust generalized aerodynamic modal force matrix due Y incidence rate
(SFPDG)-S	$[f_{\dot{\psi}_g}{}^S]$	$N^S_{NM} \times n^S_R$	SD&SS	9.3-85	——	SDSSTP	Yes	Unsteady gust generalized aerodynamic modal force matrix due Y incidence rate
(SFPG)-A	$[f_{\psi_g}{}^A]$	$N^A_{NM} \times n^A_R$	SD&SS	9.3-85	——	SDSSTP	Yes	Gust generalized modal force matrix due to incidence
(SFPG)-S	$[f_{\psi_g}{}^S]$	$N^S_{NM} \times n^S_R$	SD&SS	9.3-85	——	SDSSTP	Yes	Gust generalized modal force matrix due to incidence
(SP)-S	$\{SP^S\}$	$M^S \times 1$	SD&SS	9.3-59	——	——	Yes	Speed change matrix
(STATIC)-A		3x6	SD&SS			SDSSTP	Yes	The antisymmetric static and dynamic motion derivatives
(STATIC)-S		3x8	SD&SS			SDSSTP	Yes	The symmetric static and dynamic motion derivatives
(SWC)	$\{S^{CS}_{WI}\}$	$\ell_T^{\prime} \times 1$	AIC	5.3-2	3.4-30	——	Yes	Thin Body constant source strength matrix
(SWL)	$\{S^{LS}_{WI}\}$	$\ell_T^{\prime} \times 1$	AIC	5.3-2	3.4-30	——	Yes	Thin Body linearly varying source strength matrix
(TDP)	$[T_{\Delta P}]^{-1}$	$\ell_T \times \ell_T$	SD&SS	9.3-10	5.7-21	——	No	Matrix of surface area reciprocals
(TD)-DM	$[TD^S]_{M+\Delta M}$	$n \times (\ell_S + 2\ell_T)$	AIC	5.3-4	3.4-231	——	Yes	Thickness incidence matrix due to Mach change
(TD)-S	$[TD^S]$	$n \times (\ell_S + 2\ell_T)$	AIC	5.3-4	3.4-175	——	Yes	Thickness incidence matrix
(T E)-A	$[T^A_e]$	$N^A_{LM} \times N^A_{\delta e}$	ISIC	6.3-8	4.3-150	SICTP1	Yes	Lumped mass transformation matrix for independent elastic translation
(T E)-S	$[T^S_e]$	$N^S_{LM} \times N^S_{\delta e}$	ISIC	6.3-8	4.3-150	SICTP1	Yes	Lumped mass transformation matrix for independent elastic translation

TABLE C.3-1–AMMP SUBPROGRAM DESCRIPTIONS

Name	Purpose	Calls	Labeled common	Available in compass
AUTOSV	To check the matrix or data set being generated against the list that the user has designated to be OUTPUT onto the program output tape.	–	/CM14/	No
CKSRAT	To return the number (not the I/O unit number) in a scratch unit name. For example the integer 2 is returned from the name SCRATCH02.	–	–	No
CLRTAB	To clear (zero) the AMMP tables and to initialize option codes used by routines of the AMMP and MOP packages.	–	/MOP1/ /MOP2/ /MOP3/ /MOP4/ /MOP5/ /MOP6/	No
CREATE	To assign an I/O unit and logical file position to a matrix about to be created.	CKSRAT OPTFIL PURGE	/CM03/ /CM05/ /MOP1/ /MOP2/ /MOP5/ /MOP6/	No
DMPTAB	To print a summary of the information contained in the AMMP tables.	–	/CM03/ /CM04/ /MOP1/ /MOP6/	No
FDLOC	To find and locate a matrix.	–	/CM03/ /CM05/ /MOP3/ /MOP6/	No
FETCHM	To locate a matrix and read it into core.	FIND RHEAD RVEC UTABUP	/CM03/ /CM05/	No

TABLE C.3-1—CONTINUED

Subprogram name	Purpose	Calls	Labeled common	Available in compass
FIND	To find a matrix and determine the most efficient way to assess it.	CKSRAT OPTFIL	/CM03/ /MOP1/ /MOP6/	No
INPTAB	To place information about previously created matrices into the AMMP tables. This information includes for each matrix: 1. Name of the matrix 2. ID number 3. I/O unit containing the matrix 4. Logical file position of the matrix. This information can be read from tape, disk, or data cards.	ENFILE UREWND	/MOP1/	No
MOP	To automate the out-of-core matrix operations performed by the Matrix Operations Package (MOP)	AUTOSV CKSRAT COPYM CREATE FIND NEEDS OPTFIL PNAME TAAB TAINV TEMAB TINVER TMAB TMABT TMATB	/CM03/ /CM05/ /MOP1/ /MOP3/ /MOP4/ /MOP5/ /MOP6/ /TM01/ /TM02/	No

TABLE F-6.—SD&SS DATA CARD READ STATEMENT LOCATIONS

Card Number	Subprogram Name	Statement Number
Card 1	INTURP DATA	5 41
Card 2	DATA	42
Card 3	DATA	43
Card 4	INTURP	5
Card 5	SPECS	20
Card 6	SPECS	40
Card 7	SPECS	100
Card 8	SPECS	150
Card 9	SPECS	190
Card 10	SPECS	300
Card 11	SPECS	380
Card 12	SPECS	400
Card 13	INTURP	5
Card set 14	MATPRT	40
Card 15	MATPRT	40
Card 16	INTURP	5
Card set 17	MATTAP	40
Card 18	MATTAP	40
Card 19	INTURP	5
Card 20	DTRST	5
Card 21	DTRST	10
Card 22	DTRST	15
Card 23	INTURP	5
Card set 24	DGYRO	2
Card set 25	DGYRO	4
Card 26	DGYRO	52
Card set 27	DGYRO	54
Card 28	INTURP	5
Card 29	DTCS	20
Card 30	DCONRL	30
Card 31	DCONRL	105
Card set 32	DCONRL	110
32A	DCONRL	180
32B	DCONRL	400
32C	DCONRL	840
33	DCONRL or DTCS	840 20
33A	INTURP	5
33B	DACS	20
33C	DACS	40
33D	DCONRL	30
33E	DCONRL	105
33F	DCONRL	110
33G	DCONRL	180
33H	DCONRL	400
33I	DCONRL	730
33J	DCOMRL	770
33K	DCONRL	770
33L	DCONRL	840
33M	DACS	160
33N	DACS	180
33O	DACS	220
33P	DACS	240
33Q	DCOMRL or DACS	840 or 20
Card 34	INTURP	5
Card 35	DSTAB	10
Card 36	DSTAB	600
Card 37	DSTAB	640
Card 38	DSTAB	645
Card set 39	DSTAB	646
Card 40	DSTAB	645
Card set 41	DSTAB	646
Card 42	DSTAB	662

TABLE F-6.—CONCLUDED

Card Number	Subprogram Name	Statement Number
Card 82	DSTRU	20
Card 83	DSTRU	60
Card 84	DSTRU	80
Card 85	INTURP	5
Card 86	DPRESS	10
Card 87	DPRESS	30
Card set 88	DPRESS	40
Card set 89	DPRESS	60
Card set 90	DPRESS	80

Card Number	Subprogram Name	Statement Number
Card set 91	DPRESS	100
Card 92	DPRESS	30
Card 93	INTURP	5
Card 94	DAREA	30
Card set 95	DAREA	40
Card set 96	DAREA	60
Card 97	DAREA	30
Card 98	INTRUP	5
Card 99	DSPLEX	5
Card 100	DSPLEX	5
Card 101	INTURP	5
Card 102	INTURP	5

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15. Supplementary Notes

Langley Technical Monitors: Robert C. Goetz and Boyd Perry III
Final Report

16. Abstract

This document describes the required changes made to the SD&SS program of the FLEXSTAB Computer Program System allowing it to be interfaced with the DYLOFLEX Program System. Appendix A of this document describes the changes to specific pages in the FLEXSTAB User's Manual (NASA CR-114714). Appendix B describes the changes to specific pages in the FLEXSTAB Programmer's Manual (NASA CR-114715).

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