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16. Abstract

The purpose of this project has been to expand the Crash Victim Simulation software, originally developed at Calspan Corp. The objectives were to: 1. review the capability of advanced features of the software; 2. improve the contact algorithm in the CVS; 3. develop software for use in correlation and validation studies; and, 4. apply the software to problems in side impact.

This report is organized in three volumes which are supplementary to existing CVS documentation. The first volume describes the analysis of new features (moveable contact surfaces, sharing of deflections between ellipsoids and contact surfaces, and bivariate representation of force-deflection characteristics in deflection as well as deflection rate). This volume is intended for the analyst who wishes to understand the basic assumptions incorporated in this model. Volume II presents an updated User's Manual for the entire CVS model which is expected to serve as sufficient documentation for the ordinary user of the model. Volume III presents information concerning the CVS model as a computer program and is intended for professional programmers who need to study or make changes in the program.

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NOTICE

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1.0 INTRODUCTION

1.1 General

The purpose of this project has been to expand the Crash Victim Simulation software, originally developed at Calspan Corp. The objectives were to: 1. review the capability of advanced features of the software; 2. improve the contact algorithm in the CVS; 3. develop software for use in correlation and validation studies; and, 4. apply the software to problems in side impact. This three volume report considers the first two of the objectives.

1.2 Organization of Report

This report is organized in three volumes. The first volume deals with the analysis of the new features and is supplementary to the initial CVS writeups (1) and updates (2). This volume is intended for the analyst who wishes to understand the basic assumptions incorporated in this model. The second volume presents an updated user's manual for the entire CVS model as now constituted and is expected to serve as sufficient documentation for the ordinary user of the model. The third volume presents information concerning the CVS model as a computer program and is intended for professional programmers who need to make changes in the program.

Volume One contains sections dealing with the new ellipsoid-plane contact algorithms, the material properties now available, and shared deflection.

Volume Two contains sections dealing with the updated, machine-produced input writeup, a general description of output options and an example run.

Volume Three contains sections describing the layout of packing tables for variable information, the structures of the program and a detailed layout of possible output from the program.

1.3 Scope of Changes

The HSRI Version of the CALSPAN CVS Model is based on Version 18A of that model augmented by some of the corrections of Version 19 con-

cerning Euler joints. HSRI refined the contact algorithms for ellipsoid-panel interactions. Three important basic problems in the contact algorithms were addressed. The first problem is accurate computation of deflections even for the case of complete penetration of an ellipsoid into a contact surface. The second problem is the computation of contact forces based on mutual deformation of the interacting elements. The third problem is handling of permanent deformation by contact surfaces.

The contact section of the old CVS was largely replaced with an algorithm based on the approach taken in earlier HSRI models (3,4,5) incorporating some of the ideas of British Leyland (6). In our early dealings with the old CVS, we modified the input section to read and check the ID field of the input cards. In addition, we modified the output section to use only one logical device and to print optionally in equal increments of simulated time. These changes were made to partially facilitate the use of the model. A more general specification of vehicle initial conditions and more flexibility in reporting of kinematics were later incorporated for the same reason. In general, we have followed the policy of making changes only where such changes were defendable by their utility to Occupant Side Impact Simulation.

1.4 References

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2.0 THE ORGANIZATION OF PACKED INTERNAL TABLES

The contact algorithms developed for the HSRI version of the CVS allow a great deal of flexibility in number and attachment of both ellipsoids and planar panels. This flexibility makes the use of a tree-type data structure effective. The essence of this type of structure is that the tables include data elements which function to describe the organization of the table itself. Such data elements are called control elements and point to the beginning of a part of the tables, or state the amount of information present, or in some cases identify the type of information.

2.1 The Advantages and Disadvantages of Packing

The advantages of this type of data structure are maximizing flexibility in what combinations of data that can be specified and minimizing the use of computer storage. The disadvantages are the complexity of programming and the longer computer times involved in accessing through the structure. Experience in earlier models has shown that the advantages outweigh the disadvantages for the storage of contact information.

2.2 Packing Used in CVS Contacts

The following tables present a complete description of the data structure employed. The information described in these tables physically resides in two large arrays, one integer and one real. A value of KONTL (the beginning index of the standard area) is provided by means of a COMMON. When you look in the integer array with index KONTL, you find first the word of the Standard Control Area entry as shown in Table 1. The first four words or elements give the number of body segments, planar panels, interactions, and materials. Then follows the index of the beginning element of the Secondary Table Beginnings entry described in Table 10. This serves as a backdoor into the interaction, G-R, tangential, bivariate polynomials and bivariate table information. The next NSEG (the number contained in the first element) elements contain the index of the first element of an entry of one of the body segments. Each of those entries is laid out as specified in Table 2.

This is the way these tables are used, going from table to table looking for the pointer to the next table until the index of the piece

of information that is needed is obtained. The next paragraph is a more formal restatement of the explanation just given.

The Standard Area of the Control Array serves as a table of contents for the other control entries and is presented as Table 1. The Standard Area refers to the other control entries by recording the beginning index in the Control Array of each entry. For convenience sake, each type of control entry has a particular name assigned to the beginning index of the "typical entry." The following Tables present the layout of each such typical control entry. The control entries in turn record the beginning indices of information entries and working storage entries. It should be understood that all entries occur as often as needed by the data set for each run and that the typical entry merely presents the format of each such entry. Tables 1 through 19 contain integer information and tables 20 through 32 contain real information.

TABLE 1 Standard Control Area

Relative Index	Description
KONTL	Number of body segments (m) (NSEG)
KONTL + 1	Number of planar panels (n) (NPL)
KONTL + 2	Number of interactions active (1)
KONTL + 3	Number of materials (k)
KONTL + 4	Secondary Table Beginnings Entry beginning index (KESTAB)
KONTL + 4 + I,I=1,m	Beginning indices of segment controls (KSEG) (Zero indicates no such entry.)
KONTL + 4 + m + I,I=1,n	Beginning indices of planar panels (KPAN)
KONTL + 4 + m + n + I,I=1,k	Beginning indices for material properties (KMATL)

TABLE 2 Typical Segment Control Entry

Relative Index	Description
KSEG	Number of ellipsoids for this segment (k)
KSEG + 1 through KSEG + k	Beginning indices for ellipsoid control entries (KELLP)

TABLE 3 Typical Planar Panel Control Entry

Relative Index	Description
KPAN	Beginning index of real information entry (KPANR)
KPAN + 1	Beginning index of material control entry (KMATL) Zero indicates panel considered rigid.
KPAN + 2	Switch NINTRL = Body Segment Number means Input W.R.T. Body; NVEH = NSEG+1 means Input W.R.T. Vehicle; NGRND = NSEG+NBAG+2 means Input W.R.T. Inertial
KPAN + 3	Solid switch (0 = isolated, 1 = face of solid) (ISOLAT)
KPAN + 4	Number of time points (NUMTIM)
KPAN + 5 through KPAN + 8	Panel Name (16 characters)
KPAN + 9	Number of plane in input
KPAN + 10	External panel number
KPAN + 11	Current time point beginning index (KPANRE)
KPAN + 12	Last time point beginning index
KPAN + 13	Switch (LEDGSW) = 0 for Normal Scaling = 1 for No Edge Scaling = 2 for No Depth Scaling = 3 for No Scaling

TABLE 4 Typical Ellipsoid Control Entry

Relative Index	Description
KELLP	Beginning index of real information entry (KELR)
KELLP + 1	Beginning index of material control entry (KMATL) Zero indicates ellipsoid considered rigid.
KELLP + 2	Body segment number attached to
KELLP + 3 through KELLP + 6	Name of ellipsoid (16 characters)
KELLP + 7	Beginning index of B Matrix Entry or zero if no ellipsoid-ellipsoid contact allowed (NBMATX)
KELLP + 8	Number of allowed panels (NPALOW)
KELLP + 9	Number of allowed ellipsoids (NEALOW)
KELLP + 10	Beginning index of allowed panel entry (KKPALOW)
KELLP + 11	Beginning index of allowed ellipsoid entry (KEALOW)
KELLP + 12	External ellipsoid number

TABLE 5 Typical Allowed Ellipsoid Entry

Relative Index		Description
KEALOW through KEALOW + 2*NEALOW - 1	0	NEALOW entries of form: Beginning indices of allowed ellipsoids (KELLP)
	+1	Beginning indices of ellipsoid-ellipsoid interaction controls (KACT)

TABLE 6 Typical Allowed Panel Entry

Relative Index		Description
KPALOW through KPALOW + 2*NPALOW - 1	0	NPALOW entries of form: Beginning indices of allowed panels (KPAN)
	+1	Beginning indices for ellipsoid-panel interaction controls (KACT)

TABLE 7 Typical Material Control Entry

Relative Index	Description
KMATL	Beginning index of real information (KMATR)
KMATL + 1	Loading Curve Specification if < 0, -KPOLY polynomial beginning index if = 0, zero properties if > 0, NBIVTK table beginning index
KMATL + 2	Friction class (IFRIK)
KMATL + 3	G-R Table Beginning Index (KGRTAB) if = 0, G = 0. and R = 1.
KMATL + 4	Unloading Switch (MUNLSW) = 1 G-R unloading 2 Unload on loading curve 3 G only 4 G as slope only 5 1,3,4 mixed 6 G=0. and R=1.
KMATL + 5	Loading curve Type =

LODTYP	Means
-7	bivariate random table
-6	rate table
-5	bivariate general polynomial
-4	4th to 6th power rate polynomial
-3	cubic rate polynomial
-2	quadratic rate polynomial
-1	linear rate polynomial
+1	linear deflection polynomial
+2	quadratic deflection polynomial
+3	cubic deflection polynomial
+4	4th to 6th power deflection polynomial
+5	bivariate linear polynomial
+6	deflection table
+7	bivariate lattice table

KMATL + 6	External Material Number
KMATL + 7 through KMATL + 10	Material Name (16 characters)

TABLE 8 Relationships of LODSWT to LODTYP's for Shared Deflection.

LODTYP for first force producer	LODTYP for second force producer: 1	2	3	4	5	6	7	-1	-2	-3	-4	-5	-6	-7
1	+1	+2	+3	+4	+5	+6	+12	+5	-5	-5	-5	-5	+12	+12
2	+2	+2	+3	+4	-5	+7	+13	-5	-5	-5	-5	-5	+13	+13
3	+3	+3	+3	+4	-5	+8	+13	-5	-5	-5	-5	-5	+13	+13
4	+4	+4	+4	+4	-5	+9	+13	-5	-5	-5	-5	-5	+13	+13
5	+5	-5	-5	-5	+5	+12	+13	+5	-5	-5	-5	-5	+12	+13
6	+6	+7	+8	+9	+12	+10	+11	+12	+13	+13	+13	+13	+11	+11
7	+12	+13	+13	+13	+13	+11	+11	+12	+13	+13	+13	+13	+11	+11
-1	+5	-5	-5	-5	+5	+12	+12	-1	-2	-3	-4	-5	-6	+12
-2	-5	-5	-5	-5	-5	+13	+13	-2	-2	-3	-4	-5	-7	+13
-3	-5	-5	-5	-5	-5	+13	+13	-3	-3	-3	-4	-5	-8	+13
-4	-5	-5	-5	-5	-5	+13	+13	-4	-4	-4	-4	-5	-9	+13
-5	-5	-5	-5	-5	-5	+13	+13	-5	-5	-5	-5	-5	+13	+13
-6	+12	+13	+13	+13	+12	+11	+11	-6	-7	-8	-9	+13	-10	+11
-7	+12	+13	+13	+13	+13	+11	+11	+12	+13	+13	+13	+13	+11	+11

TABLE 9 Relationships of LODSWT to Routine Used for Shared Deflection.

LODSWT	ROUTINE
-10 thru -6	SHARED via SHARET (rate only)
-5	SHAREG
-4 thru +4	SHARED (positive deflection only; negative rate only)
+5	SHAREL (bivariate linear)
+6 thru +10	SHARED via SHARET (deflection only)
+11, +12	SHAREL via SHARET (bivariate linear)
+13	SHAREG after set-up in SHARET

TABLE 10 Secondary Table Beginnings Entry

Relative Index	Description
KESTAB	Interaction Table of Contents Beginning Index (KIACT)
KESTAB + 1	G-R Table Table of Contents Beginning Index (KNTLGR)
KESTAB + 2	Tangential Specification Table of Contents Beginning Index (KNTANG)
KESTAB + 3	Bivariate Polynomials Table of Contents Beginning Index (KPOLYC)
KESTAB + 4	Bivariate Tables Table of Contents Beginning Index (NBIVIC)

TABLE 11 Interaction Table of Contents Entry

Relative Index	Description
KIACT	Number of Allowed Interactions (NINACT)
KIACT + 1	Number of Allowed Plane-Ellipsoid Interactions (NIPLEL)
	NIPLEL entries of form:
KIACT + 2 through KIACT+NIPLEL+1	Beginning Index of Interaction Control of Plane-Ellipsoid Type (KACT)
	(NINACT-NIPLEL) entries of form:
KIACT+NIPLEL+2 through KIACT+NINACT+1	Beginning Index of Interaction Controls of Ellipsoid-Ellipsoid Type (KACT)

TABLE 12 G-R Table of Contents Entry

Relative Index			Description
KNTLGR			Number of G-R Tables (NTABGR)
KNTLGR + 1 through KNTLGR + 2*NTABGR	KGRTAB	0	NTABGR entries of form: Number of points in Table (NPTSGR)
		+1	Beginning index of Real Entry (KTBGRR)

TABLE 13 Tangential Specifications Table of Contents Entry

Relative Index		Description
KNTANG		Number of Tangential Specifications (NUTANG)
KNTANG + 1 through KNTANG + 3*NUTANG		NUTANG entries of form:
	0	Friction class A (IFRIKA)
	+1	Friction class B (IFRIKB)
	+2	Beginning index of real entry (KTANG)

TABLE 14 Typical Interaction Control Entry

Relative Index	Description
KACT	Interaction type (INACT) 1 = ellipsoid-panel 2 = ellipsoid-ellipsoid
KACT + 1	Beginning index of second force producer (KPAN or KELLP2)
KACT + 2	Beginning index of first force producer (KELLP)
KACT + 3	Beginning of real work entry established last time (KACTR)
KACT + 4	Beginning of real work entry being established current time (contains current output) (KACTO)
KACT + 5	Beginning of integer work entry established last time (KACTI)
KACT + 6	Beginning of integer work entry being established current time (KACTJ)
KACT + 7	Shared deflection switch (KSHAR) (0 = both hard; 1 & 2 names soft one; 3 and up both (LODSWT) soft; < 0 rolling)
KACT + 8	Number of this interaction in order of scanning of all interactions of this type
KACT + 9	Beginning index of tangential force specification (KTANG)

TABLE 15 Typical Interaction Integer Work Entry

Relative Index	Description
KACTI (or KACTJ)	Contact control switch (η_S, ETAS)
KACTI + 1	Contact corner switch (η_{SB}, ETASB)
KACTI + 2	Contact edge switch (η_{SE}, ETASE)
KACTI + 3	Algorithm control for first force producer (IALGOR) = 1 regular loading 2 regular unloading 3 regular reloading 4 alternative reloading 5 saturation loading 6 saturation unloading 7 saturation reloading 8 breakdown loading 9 breakdown unloading 10 breakdown reloading 11 complete breakdown if unloading complete--negative sign applied.
KACTI + 4	Algorithm control for second force producer (JALGOR) (Settings the same as IALGOR).
KACTI + 5	IAO -1 proportional materials 0 first time +1 thereafter
KACTI + 6	Contact control switch (η_r, ETAR)

TABLE 16 Bivariate Polynomials Table of Contents Entry

Relative Index	Description
KPOLYC	Number of Bivariate Polynomials (NBPOLY)
KPOLYC + 1 through KPOLYC + 2 NBPOLY	NBPOLY Entries: 0 External polynomial number (NPOLYE) 1 Beginning Index of Polynomial Specification Entry (KPOLY)

TABLE 17 Table of Contents Entry for Bivariate Tables

Relative Index		Description
NBIVTC		Number of Bivariant Tables (NUMBIV)
	+1	External Table No. (NBIVEX)
	+2	Beginning index of individual table control (NBIVTK)

TABLE 18 Typical Control Entry for Individual Bivariate Table (Non-Lattice Case)

Relative Index		Description
NBIVTK		Beginning index of real bivariate table entry (NBIVRL)
NBIVTK + 1		Column spacing index for box description (NBIVLC)
NBIVTK + 2		Switch: 0 = linear interpolation, 1 = log interpolation
NBIVTK + 3		Number of boxes (NBILVN)
NBIVTK + 4 through NBIVTK + 2*NBIVLN + 3		NBIVLN entries of form:
	0	Beginning index of box entry (NBIVRB)
	+1	Number of points in box entry (NBIVBN)

TABLE 19 Typical Entry for Individual Bivariate Table (Lattice Case)

Relative Index	Description
NBIVTK	Set -1 for x-dependence only, -2 for y-dependence only, -3 for both (LATCON)
NBIVTK + 1	Beginning index of Real X Entry (KBIVXL)
NBIVTK + 2	Beginning index of Real Y Entry (KBIVYL)
NBIVTK + 3	Beginning index of Real Force Entry (KBIVFL)
NBIVTK + 4	Number of X Entries (NBIVX) (0 if LATCON = -2)
NBIVTK + 5	Number of Y Entries (NBIVY) (0 if LATCON = -1)
NBIVTK + 6	Number of Force Entries (NBIVF)
NBIVTK + 7	Interpolation switch as before (INMETA)
NBIVTK + 8	Last X number (LBIVX)
NBIVTK + 9	Last Y number (LBIVY)

TABLE 20 Typical Panel Real Information Entry

Relative Index		Description
KPANR through KPANR + 21*NUMTIM - 11	NUMTIM entries of form. The last such entry omits +10 through +20.	
0	t	Effective time
+1	X_1, Y_1, Z_1	Coordinates of point 1
+4	X_2, Y_2, Z_2	Coordinates of point 2
+7	X_3, Y_3, Z_3	Coordinates of point 3
+10	r_t	Time Ramp Length for Velocities
+11	l_t	Time Span Covered by Current time segment
+12	$\hat{X}_1, \hat{Y}_1, \hat{Z}_1$	Coordinate slopes of point 1
+15	$\hat{X}_2, \hat{Y}_2, \hat{Z}_2$	Coordinate slopes of point 2
+18	$\hat{X}_3, \hat{Y}_3, \hat{Z}_3$	Coordinate slopes of point 3

TABLE 21 Typical Ellipsoid Real Information Entry

Relative Index		Description
KELLPR (KELR)	A, B, C	Semi-major axes
KELLPR + 3	X_0, Y_0, Z_0	Coordinates of center relative to body segment system.
KELLPR + 6	ψ, θ, ϕ	Euler angles of ellipsoid system relative to body segment system.
KELLPR + 9	$\bar{r}$	Effective radius
KELLPR + 10 through KELLPR + 18	De	Direction cosine matrix of ellipsoid system from body system.

TABLE 22 Typical Ellipsoid B-Matrix Entry

Relative Index	Description
NBMATX through NBMATX + 8	B matrix stored in columns where

$$B = D_e^T \begin{pmatrix} 1/A^2 & 0 & 0 \\ 0 & 1/B^2 & 0 \\ 0 & 0 & 1/C^2 \end{pmatrix} D_e$$

TABLE 23 Typical Material Real Information Entry

Relative Index	Description
KMATR	Force Saturation Value (FSAT, = 0 for no test)
KMATR + 1	Saturation Unloading Slope (DM, < 0, use as G instead)
KMATR + 2	Yield Point (DC)
KMATR + 3	Start Breakdown (DE)
KMATR + 4	Finish Breakdown (DF)

TABLE 24 Interaction Real Work Entry

Relative Index	Description
KACTR (or KACTO)	Deflection of first force producer (δ_1).
KACTR + 1	Deflection of second force producer (δ_2).
KACTR + 2	Deflection rate of first force producer ($\dot{\delta}_1$).
KACTR + 3	Deflection rate of second force producer ($\dot{\delta}_2$).
KACTR + 4	Combined deflection (δ).
KACTR + 5	Combined deflection rate ($\dot{\delta}$).
KACTR + 6	Force (F_N).
KACTR + 7	Tangential force (F_T).
KACTR + 8	Tangential deflection ($\bar{\delta}$).
KACTR + 9, + 10, + 11	Contact point in segment 1 system (X1, Y1, Z1)
KACTR + 12, + 13, + 14	Contact point in segment 2 system (X2, Y2, Z2)
KACTR + 15, +16	Ellipsoid center in panel system (XXO, YYO)
KACTR + 17	Friction force(F_F).
KACTR + 18	Snap back force (F_R).
KACTR + 19, + 20, + 21, + 22, + 23	Unloading coefficients UNLCOF (1 to 5)
KACTR + 24	Turnaround point to being unloading (Ω, BOG).
KACTR + 25	Permanent deflection (ω, OG)
KACTR + 26	Turnaround point to begin reloading ($\bar{\omega}$, OGB)
KACTR + 27	Fraction of force produced by pure deflection terms (S)
KACTR + 28	Energy

Note: KACTR + 29 through KACTR + 38 are the corresponding information for the second force producer that KACTR + 19 through KACTR + 28 are for the first force producer.

TABLE 24 Interaction Real Work Entry (continued)

Relative Index	Description
KACTR + 39	Coefficient used in shared deflection involving tables (AO)
KACTR + 40	Time of last contact (TM)
KACTR + 41 through KACTR + 47	Coefficients used in shared deflection (C_{60}, C_{06}, C_{15}, C_{24}, C_{33}, C_{42}, C_{51} respectively)
KACTR + 48	Tangential deflection rate ($\dot{\delta}$)
KACTR + 49	X-coordinate (in panel system) of reference point for edge effects (XX1)
KACTR + 50	Y-coordinate (in panel system) of reference point for edge effects (YY1)
KACTR + 51	Previous value of DELTA (δ_p) => RQ(KACTO+4)
KACTR + 52	Distance from mid point of panel to point of first contact (dmid)
KACTR + 53	Total Deflection Double Time Derivative ($\ddot{\delta}$)
KACTR + 54	Total Deflection Triple Time Derivative ($\dddot{\delta}$)
KACTR + 55	Partial of Force w.r.t. deflection for 1st material (PFD(1)).
KACTR + 56	Partial of Force w.r.t. deflection for 2nd material (PFD(4)).
KACTR + 57	Partial of Force w.r.t. deflection rate for 1st material (PFDD(1)).
KACTR + 58	Partial of Force w.r.t. deflection rate for 2nd material (PFDD(4)).

TABLE 25 Typical G-R Table Real Entry

Relative Index		Description
KTBGRR through KTBGRR + 3*NPTSGR - 1		NPTSGR entries of form:
	0	Deflection (δ)
	+1	G-Ration (G)
	+2	R-Ratio (R)

TABLE 26 Typical Tangential Real Information Entry

Relative Index	Description
KTANG	Friction coefficient 0 (FMU0)
KTANG + 1	Friction coefficient 1 (FMU1)
KTANG + 2	Friction coefficient 2 (FMU2)
KTANG + 3	Snap back coefficient 1 (A1)
KTANG + 4	Snap back coefficient 2 (A2)
KTANG + 5	Maximum force (FTMAX)
KTANG + 6	Velocity ramp length (TVON)

TABLE 27 Typical Bivariate Polynomial Real Specification

Relative Index	Description
KPOLY through KPOLY + 26	Coefficients of terms of form: $A_{ij}\,\delta^{i}\dot{\delta}^{j}$ where order is presented on E.5.A. - E.5.C. description.

TABLE 28 Typical Real Bivariate Table Entry (Non-Lattice Case)

Relative Index	Description
NBIVRL	X of lower left corner point of control box
NBIVRL + 1	Y of lower left corner point of control box
NBIVRL + 2	X of upper right corner point of control box
NBIVRL + 3	Y of upper right corner point of control box
NBIVRL + 4	X increment for control box
NBIVRL + 5	Y increment for control box
NBIVRL + 6	Offset to one

TABLE 29 Typical Real Box Entry for Bivariate Tables

Relative Index		Description
NBIVRB through NBIVRB + 3*NBIVBN - 1		NBIVBN entries of form:
	0	X coordinate of point
	+1	Y coordinate of point
	+2	Force value for point

TABLE 30 Typical Real Bivariate Table Horizontal Information Entry (Lattice Case)

Relative Index	Description
KBIVXL through KBIVXL + NBIVX-1	X Values

TABLE 31 Typical Real Bivariate Table Vertical Information Entry (Lattice Case)

Relative Index	Description
KBIVYL through KBIVYL + NBIVY-1	Y Values

TABLE 32 Typical Real Bivariate Table Force Entry (Lattice Case)

Relative Index	Description
KBIVFL	Offset
KBIVFL + 1 through KBIVFL + NBIVF	Force Values ((Fij, i = 1, NBIVS), j = 1 NBIVY)

3.0 STRUCTURE OF PROGRAM

The HSRI Version of the CVS is organized into 133 subprograms. The following three sections provide information concerning the function, the linkage, and the communication among these subprograms.

3.1 Functional Breakdown

The CVS has been organized into subprograms to achieve efficiency of code and ease of understanding. Structured programming has not been employed in this development, but most of the logical principles involved have been generally followed. Table 33 lists the 133 subprograms and presents a short description of each subprogram.

Table 33 Subprogram Description Table (1 of 7)

Routine	Description
ADJUST	recomputes values of the parametric forms for state variables. Used to reconstruct time history when time increment is changed.
AIRBAG	for each airbag, controls interaction with panels and body segments, computes differential pressure and forces and torques on bag and segments.
AIRBGG	computes volume of intersection of airbag with body segments or panel.
AIRBG1	processes input cards and does initialization for airbags.
AIRBG3	calculates thermodynamic properties and updates linear and angular position and velocity of each airbag.
BELTG	computes tangent points, vectors from tangent points to anchor points and length of belt segments.
BELTRT	computes belt forces and torques.
BGG	computes volume of intersection of airbag with body segment or panel and force and torque per unit pressure on each.
BINPUT	processes input cards for occupant and initializes
BIVIN	processes input cards and initializes for bivariant polynomials, bivariant tables and G-R tables for materials
BLDEFL	determines penetration, location, and velocities for an ellipsoid against a planar panel in terms of the panel system.
BLKDTA	initializes various constants
BLOCK	determines next box of points for table interpolation search for nearest points
BOXSCN	searches box of points for nearest points to interpolation point
BXINFO	determines box parameter for box of points
CFACTT	computes matrix transpose of cofactors and determinant
CHAIN	computes linear positions and velocities for all segments from that of the first and of vehicle
CINPUT	processes input cards for materials and contacts
CMPUTE	controls the evaluation of acceleration for a given set of parametric forms for state variables and time

Table 33 Subprogram Description Table (continued) (2 of 7)

CONTCT	controls computation of forces and torques generated by body segments contacting panels or other body segments or belts or airbags
CROSS	computes vector cross product
CSOLID	computes proper scaling factor for edge effects
CUBRUT	computes cube root of a number
DAUX	evaluates system linear and angular accelerations after applying external forces and constraints
DAUX11	used by DUAX to compute sub-matrices C_{11} and R_1 in order to eliminate body accelerations
DAUX12	used by DAUX to compute sub-matrices C_{12} and C_{21} in order to eliminate body accelerations
DAUX22	used by DAUX to compute sub-matrices C_{22} and R_2 in order to eliminate body accelerations
DAUX31	used by DAUX to compute sub-matrices C_{13} and C_{31} in order to eliminate body accelerations
DAUX32	used by DAUX to compute sub-matrices C_{23} and C_{32} in order to eliminate body accelerations
DAUX33	used by DAUX to compute sub-matrices C_{33} and R_3 in order to eliminate body accelerations
DAUX44	used by DAUX to compute sub-matrices for flexible elements
DAUX55	used by DAUX to compute sub-matrices for singular elements
DEBUG	processes debug input into switch values
DHHPIN	sets up proper direction cosine matrix for pinned or unpinned joint
DINT	controls integration steps between print times
DOTT31	calculates matrix from two vectors; $A \times B^T$
DOTT33	performs matrix multiplication; $A \times B^T$
DOT31	performs matrix multiplication of matrix transpose times a vector
DOT33	performs matrix multiplication; $A^T \times B$

Table 33 Subprogram Description Table (continued) (3 of 7)

DRCYPR	sets up direction cosine matrix for rotation angles yaw, pitch and roll
DSETD	updates direction cosine matrix using an incremental angular motion and renormalizes it
DSETQ	computes new direction cosine matrix from original and incremental motion expressed in quaternion form
DSMSOL	solves as set of simultaneous linear algebraic equations
DZP	computes state variables from parametric forms and evaluates exponential weights
EDEPTH	determines depth of penetration for two ellipsoids
EFUNCT	computes non-linear spring torque for Euler joints
EJOINT	computes torques for Euler joints
ELONG	computes arc length on an ellipse
ELTIME	counts number of times some subroutines are used and accounts for computer times used by them
ENTCOL	enters a column of values into a matrix
ENTROW	enters a row of values into a matrix
ENTVAL	enters a single value into a matrix
EQUILB	adjusts initial input position values so that initial normal contact forces are equal to either supplied values or constraint force values
ERRMSG	prints proper fatal error message
EULRAD	computes procession, mutation and spin angles from direction cosine matrix
EVALFD	evalues derivative, value or integral of a function in the TAB array
FINPUT	processes input cards for allowed contacts
FLXSEG	does calculation for flexible segments
FOEVAL	computes contact force for single material only with unloading, saturation and breakdown

Table 33 Subprogram Description Table (continued) (4 of 7)

FRCDFL	evalues force-deflection function in the TAB array at a point
FSMSOL	solves a set of simultaneous equations, the coefficient matrix of which is stored as submatrices
GETGR	gets proper G and R values for the material for unloading
GLOBAL	does calculations for globalgraphic joints
HEDING	prints titles on output pages
HERRON	computes angle values for use in joint stops
IMPLS2	called by UPDATE when a joint locks to apply proper impulse
IMPULS	computes linear and angular accelerations from an impulse and modifies linear and angular velocities
INITAL	processes input cards for occupant initial position
INTERL	does a bivariant interpolation, first finding the four nearest points
INTERP	does the actual interpolation from INTERL
INTERS	determines intersection for two ellipsoids
IOVRLP	determines whether edge effects on a panel overlap
IREGN	determines in which part of a panel the contact occurs; for determination of edge effects
LOADSW	given loading type indices for two materials, determines composite interaction index
LOADTP	determines loading type index for a material
LODFEL	controls contact interaction calculation
LOKIDJ	checks that input card being read is one expected for non-unique cards
LOOKID	checks that input card being read is one expected for unique cards
LTIME	measures CPU elapsed time in units of .01 seconds
main	defines lengths of IQ and RQ storage arrays
MAINPG	control input, initialization, integration and output of program

Table 33 Subprogram Description Table (continued) (5 of 7)

MAT31	performs matrix multiplication of a matrix times a vector
MAT33	performs matrix multiplication of two matrices
NEARPT	determines the four closest points to a given point, for interpolation in a random table
NEWPAG	determines whether a new page is needed for neat printing of the input data
NORLOD	evaluates table or polynomial material force for given deflection and deflection rate
ORTHO	generates a set of right-handed orthonormal vectors from a given one
OUTPUT	controls final printed output
PANEL	sets up required panel parameters for airbag
PDAUX	interfaces between DINT and DAUX to set up system
PHITAB	fits a linear polynomial to a table and determines the valid range
PLANIN	does planar interpolation from three points, used in the random interpolation routines
PLELP	controls computation of forces and torques from body segments contacting panels
PLOTR1	writes initial and constant data for off-line plots
PLOTR2	writes time point data for off-line plots
PLSEGF	obtains force for segment-segment contact case and applies this force to segment force and moment arrays
PLTXYZ	stores plot characters into printer plot arrays
PRINT	prints selected variables from selected routines at each time point
PRIPLT	sets up printer plot arrays for Y-Z and X-Z plane views
PSOLID	computes proper reference point for edge effects
PUSHER	allots space in integer and real storage arrays for input data

Table 33 Subprogram Description Table (continued) (6 of 7)

QBUG	prints out contents of integer and real storage arrays for debugging purposes
QSET	used to recompute time history when time step is doubled
RCRT	computer radius of curvature of ellipsoid at point normal to a specified plane
RDT	computer rotation matrix for an angle about an axis
RSTART	controls reading and writing of program variables for restart capability of program and redefines new variables from input
SEARCH	finds new variables to be redefined
SEGSEG	controls computation of forces and torques from body segments contacting other body segments
SETACT	sets up the entries in the packing tables for interactions of the control of the computation of force
SETUP1	sets up initial values of certain arrays used in DAUX before contact routines
SETUP2	sets up initial values of certain arrays used in DAUX after contact routines
SHARED	computes contact force when both materials are functions of deflection only
SHAREG	computes contact force when both materials are general
SHAREL	computes contact force when both materials are linear in deflection and deflection rate
SHAREM	computes contact force based on the assumption of effective dependence upon deflection
SHARET	sets up coefficients to be used in SHARED and SHAREL
SINPUT	processes input cards for vehicle interior, belts, constraints, spring damper functions, tangential force functions and body symmetry options
SLVCBC	solves a cubic equation for a root in a specified range
SLVGEN	solves a general equation (4th to 6th order) for a root in a specified range
SPDAMP	computes forces and torques from spring dampers
TODAY	obtains the day's date from the computer

Table 33 Subprogram Description Table (continued) (7 of 7)

TRANBY	converts coordinates from any body segment system to the inertial system
TRIGFS	computes components of data parameters dependent upon time step
TURNPT	calculates exact material turnaround point; ie deflection for which deflection rate is zero
UPDATE	updates conditions before and after an integration step
UPDFDC	updates functions in the TAB array
VEHPOS	computes vehicle position and velocity components
VINPUT	processes input cards and initializes for vehicle motion
VISCOS	computes coulomb friction and viscous torques at joints
VISPR	computes viscous and spring torques at joints
XDY	performs matrix multiplication of vector times matrix times vector
YPRDEG	computes yaw, pitch, and roll angles in degrees from direction cosine matrix
ZUMARY	controls reading and printing of output data from binary file

3.2 Linkage Structure

The linkage between the 133 subprograms is too complex to be illustrated in a conventional flow diagram. Tables 34 and 35 have been developed to summarize the linkage structure in a simple but convenient way. Table 34 lists each subprogram and each routine that it calls. Table 35 is the inverse listing each subprogram and each routine that calls it. Both tables are useful depending which way you are following a chain of logic.

Table 34 LINKAGE CROSS REFERENCE--PART 1, CALLER-CALLED (1 of 6)

Caller	Used
ADJUST	
AIRBAG	AIRBGG, CROSS, DOT31, ELTIME, MAT31; DSQRT
AIRBGG	BGG, DOT31
AIRBG1	DOT31, DOT33, DRCYPR, LOKIDJ, MAT33, PANEL ; DSQRT, MOD
AIRBG3	AIRBGG, DOT31, ELTIME, MAT31, PANEL, YPRDEG
BELTG	CROSS, ELONG, MAT31; DABS, DATAN2, DMAX1, DMIN1, DSQRT
BELTRT	BELTG, CROSS, DOTT33, DOT31, ELTIME, FRCDFL, MAT31
BGG	CROSS, DOT31, EDEPTH, INTERS, MAT31, MAT33, ORTHO, RCRT; DARSIN, DSQRT
BINPUT	DRCYPR, ELTIME, LOKIDJ, LOOKID, NEWPAG, PUSHER; IABS
BIVIN	LOKIDJ, LOOKID, NEWPAG, PUSHER; DABS, DLOG, DMAX1
BLDEFL	CROSS, DOTT33, DOT33, MAT31; DMAX1, DMIN1, DSQRT
BLKDTA	DATAN2
BLOCK	MAXO, MINO, MOD
BOXSCN	
BXINFO	DMIN1, MAXO
CFACTT	
CHAIN	CROSS, DOT31, ELTIME; IABS
CINPUT	BIVIN, FINPUT, LOADTP, LOKIDJ, LOOKID, NEWPAG
CMPUTE	DZP, OUTPUT, PDAUX
CONTCT	AIRBAG, BELTRT, ELTIME, PLELP, SEGSEG, SETACT; IABS
CROSS	
CSOLID	DSQRT
CUBRUT	
DAUX	CHAIN, CONTCT, DAUX11, DAUX12, DAUX22, DAUX31, DAUX32, DAUX33, DAUX44, DAUX55, EJOINT, ELTIME, FLXSEG, FSMSOL, PRINT, SETUP1, SETUP2, SPDAMP, VEHPOS, VISPR; DABS, IABS

Table 34 LINKAGE CROSS-REFERENCE--PART 1, CALLER-CALLED (2 of 6)

Caller	Used
DAUX11	ELTIME; IABS
DAUX12	ELTIME; IABS
DAUX22	DOT31, ELTIME; IABS
DAUX31	ELTIME; IABS
DAUX32	ELTIME; IABS
DAUX33	ELTIME
DAUX44	ELTIME; IABS
DAUX55	ELTIME; IABS
DEBUG	LAND, SHFTR
DHHPIN	
DINT	ADJUST, CMPUTE, ELTIME, OUTPUT, PDAUX, QSET, TRIGFS, UPDATE; DEXP, DMIN1
DOTT31	
DOTT33	
DOT31	
DOT33	
DRCYPR	MAT33, ROT
DSETD	CFACTT; DABS, DCOS, DSIN, DSQRT
DSETQ	CFACTT; DABS
DSMSOL	DABS
DZP	ELTIME; DABS, DEXP
EDEPTH	DSMSOL, MAT33; DABS, DSQRT
EFUNCT	DABS, DSIGN

Table 34 LINKAGE CROSS-REFERENCE--PART 1, CALLER-CALLED (3 of 6)

Caller	Used
EJOINT	CROSS, DOT31, DOT33, EFUNCT, ELTIME, EULRAD, GLOBAL, MAT31, ROT, VISCOS; DABS, DSQRT, IABS
ELONG	DABS, DCOS, DSIN, DSQRT
ELTIME	LTIME; FLOAT
ENTCOL	
ENTROW	
ENTVAL	
EQUILB	CHAIN, DAUX, DOT31, DRCYPR, MAT31, OUTPUT, PRINT, XDY; DABS, DSQRT
ERRMSG	
EULRAD	DABS, DARCOS, DATAN2, DMOD, DSIGN
EVALFD	DABS, DMAX1, DMIN1
FINPUT	EVALFD, LOKIDJ, LOOKID, PUSHER; DABS, IABS
FLXSEG	CROSS, DOTT33, DOT31, DOT33, DRCYPR, ELTIME, MAT31, MAT33, XDY; DARSIN, DATAN2, DCOS, DSIN, DSQRT
FOEVAL	GETGR, NORLOD, TURNPT; DABS, IABS
FRCDFL	EVALFD
FSMSOL	ELTIME; IABS
GETGR	
GLOBAL	FRCDFL, HERRON; DABS, DARCOS, DSQRT
HEDING	FLOAT, IABS, MINO
HERRON	EVALFD; DATAN2, DSQRT
IMPLS2	DAUX, DOT31, DOT33, DSMSOL, ELTIME, PRINT, XDY
IMPULS	CROSS, DAUX, DOT31, EJOINT, ELTIME, MAT31, OUTPUT, PRINT, VISPR; IABS

Table 34 LINKAGE CROSS-REFERENCE--PART 1, CALLER-CALLED (4 of 6)

Caller	Used
INITAL	CHAIN, DOT31, DRCYPR, ELTIME, EQUILB, LOKIDJ, LOOKID, MAT31, VEHPOS; IABS
INTERL	INTERP, NEARPT, PLANIN; DEXP
INTERP	
INTERS	DSMSOL, MAT31; DABS, DSQRT
IOVRLP	
IREGN	DABS
LOADSW	MAXO, MINO
LOADTP	
LODFEL	FOEVAL, SHARED, SHAREG, SHAREL, SHAREM, SHARET; DMAX1, DMIN1, IABS
LOKIDJ	IABS
LOOKID	
LTIME	TIME
(main)	MAINPG
MAINPG	BINPUT, BLKDTA, CINPUT, DEBUG, DINT, ELTIME, ERRMSG, INITAL, LOOKID, NEWPAG, OUTPUT, PLOTR1, PLOTR2, PRINT, PRIPLT, QBUG, RSTART, SINPUT, TODAY, VINPUT, ZUMARY; DABS, MOD
MAT31	
MAT33	
NEARPT	BLOCK, BOXSCN, BXINFO
NEWPAG	
NORLOD	INTERL; DMAX1, DMIN1
ORTHO	DSQRT
OUTPUT	CROSS, DOTT33, DOT31, ELTIME, HEDING, LOKIDJ, LOOKID, MAT31, YPRDEG; DARCOS, DSQRT, IABS, MINO
PANEL	CROSS, DOT31, MAT31, MAT33
PDAUX	CROSS, DAUX, DSETQ, ELTIME, QBUG; DSQRT
PHITAB	NEARPT; DABS, DMAX1, DMIN1

Table 34 LINKAGE CROSS-REFERENCE--PART 1, CALLER-CALLED (5 of 6)

Caller	Used
PLANIN	DABS
PLELP	BLDEFL, CROSS, CSOLID, DOTT33, DOT31, DOT33, IOVRLP, LODFEL, MAT31, PSOLID, TRANBY; DABS, DMAX1, DMIN1, DSQRT
PLOTR1	
PLOTR2	
PLSEGF	CROSS, DOT31, LODFEL, MAT31; DMIN1, DSQRT
PLTXYZ	MAT31
PRINT	DOT31, YPRDEG; DSQRT
PRIPLT	DOT31, ELTIME, PLTXYZ; IABS, MOD
PSOLID	IREGN
PUSHER	
QBUG	IABS
QSET	DSQRT
RCRT	DSQRT
ROT	DABS, DCOS, DSIGN, DSIN
RSTART	ELTIME, OUTPUT, SEARCH; DABS, IABS
SEARCH	MAXO
SEGSEG	CROSS, DOTT33, DOT31, DOT33, DSMSOL, ELTIME, INTERS, MAT31, MAT33, PLSEGF, PUSHER, XDY; DSQRT, IABS
SETACT	LOADSW, PUSHER; DABS, IABS
SETUP1	CROSS, DOT31, ELTIME; IABS
SETUP2	CROSS, DHHPIN, DOTT31, DOTT33, DOT31, ELTIME, MAT33; DABS, DSQRT, IABS
SHARED	SLVCBC, SLVGEN; DABS, DMIN1, DSQRT, IABS
SHAREG	FOEVAL, SHARED; DABS, MAXO

Table 34 LINKAGE CROSS-REFERENCE--PART 1, CALLER-CALLED (6 of 6)

Caller	Used
SHAREL	DMIN1
SHAREM	FOEVAL; DABS, DMAX1, DMIN1, DSIGN
SHARET	PHITAB, SHARED, SHAREL; DMAX1, DMIN1
SINPUT	AIRBG1, DRCYPR, LOKIDJ, LOOKID, NEWPAG, PUSHER; DMIN1, MOD
SLVCBC	CUBRT; DARCOS, DCOS, DSQRT
SLVGEN	DABS
SPDAMP	CROSS, DOT31, ELTIME, MAT31; DABS, DSQRT
TODAY	TIME
TRANBY	CROSS, DOT31
TRIGFS	
TURNPT	DMAX1
UPDATE	AIRBG3, CROSS, DAUX, DOT31, ELTIME, IMPLS2, IMPULS, OUTPUT, PRINT, SETUP2, UPDFDC, XDY; DABS, DSQRT, IABS
UPDFDC	EVALFD, FRCDFL; DMAX1, DSQRT
VEHPOS	DFLOAT, DSIN
VINPUT	DOT31, DRCYPR, DSETD, LOKIDJ, LOOKID, NEWPAG, YPRDEG; DCOS, DFLOAT, DSIN, IABS, MOD
VISCOS	
VISPR	CROSS, DOT33, EFUNCT, ELTIME, GLOBAL, MAT31, VISCOS; DARCOS, DATAN2, DSQRT, IABS
XDY	
YPRDEG	DABS, DARSIN, DATAN2, DSIGN
ZUMARY	HEDING; MINO, MOD

Table 35 LINKAGE CROSS-REFERENCE--PART 2, CALLED-CALLER (1 of 6)

Called	Users
ADJUST	DINT
AIRBAG	CONTCT
AIRBGG	AIRBAG, AIRBG3
AIRBG1	SINPUT
AIRBG3	UPDATE
BELTG	BELTRT
BELTRT	CONTCT
BGG	AIRBGG
BINPUT	MAINPG
BIVIN	CINPUT
BLDEFL	PLELP
BLKDTA	MAINPG
BLOCK	NEARPT
BOXSCN	NEARPT
BXINFO	NEARPT
CFACTT	DSETD, DSETQ
CHAIN	DAUX, EQUILB, INITAL
CINPUT	MAINPG
CMPUTE	DINT
CONTCT	DAUX
CROSS	AIRBAG, BELTG, BELTRT, BGG, BLDEFL, CHAIN, EJOINT, FLXSEG, IMPULS, OUTPUT, PANEL, PDAUX, PLELP, PLSEGF, SEGSEG, SETUP1, SETUP2, SPDAMP, TRANBY, TRANVI, UPDATE, VISPR
CSOLID	PLELP
CUBRUT	SLVCBC
DAUX	EQUILB, IMPLS2, IMPULS, PDAUX, UPDATE

Table 35 LINKAGE CROSS-REFERENCE--PART 2, CALLED-CALLER (2 of 6)

Called	Users
DAUX11	DAUX
DAUX12	DAUX
DAUX22	DAUX
DAUX31	DAUX
DAUX32	DAUX
DAUX33	DAUX
DAUX44	DAUX
DAUX55	DAUX
DEBUG	MAINPG
DHHPIN	SETUP2
DINT	MAINPG
DOTT31	SETUP2
DOTT33	BELTRT, BLDEFL, FLXSEG, OUTPUT, PLELP, SEGSEG, SETUP2
DOT31	AIRBAG, AIRBGG, AIRBG1, AIRBG3, BELTRT, BGG, CHAIN, DAUX22, EJOINT, EQUILB, FLXSEG, IMPLS2, IMPULS, INITAL, OUTPUT, PANEL, PLELP, PLSEGF, PRINT, PRIPLT, SEGSEG, SETUP1, SETUP2, SPDAMP, TRANBY, UPDATE, VINPUT
DOT33	AIRBG1, BLDEFL, EJOINT, FLXSEG, IMPLS2, PLELP, SEGSEG, VISPR
DRCYPR	AIRBG1, BINPUT, EQUILB, FLXSEG, INITAL, SINPUT, VINPUT
DSETD	VINPUT
DSETQ	PDAUX
DSMSOL	EDEPTH, IMPLS2, INTERS, SEGSEG
DZP	CMPUTE
EDEPTH	BGG
EFUNCT	EJOINT, VISPR
EJOINT	DAUX, IMPULS
ELONG	BELTG

Table 35 LINKAGE CROSS-REFERENCE--PART 2, CALLED-CALLER (3 of 6)

Called	Users
ELTIME	AIRBAG, AIRBG3, BELTRT, BINPUT, CHAIN, CONTCT, DAUX, DAUX11, DAUX12, DAUX22, DAUX31, DAUX32, DAUX33, DAUX44, DAUX55, DINT, DZP, EJOINT, FLXSEG, FSMSOL, IMPLS2, IMPULS, INITAL, MAINPG, OUTPUT, PDAUX, PRIPLT, RSTART, SEGSEG, SETUP1, SETUP2, SPDAMP, UPDATE, VISPR
EQUILB	INITAL
ERRMSG	MAINPG
EULRAD	EJOINT
EVALFD	FINPUT, FRCDFL, HERRON, UPDFDC
FINPUT	CINPUT
FLXSEG	DAUX
FOEVAL	LODFEL, SHAREG, SHAREM
FRCDFL	BELTRT, GLOBAL, UPDFDC
FSMSOL	DAUX
GETGR	FOEVAL
GLOBAL	EJOINT, VISPR
HEDING	OUTPUT, ZUMARY
HERRON	GLOBAL
IMPLS2	UPDATE
IMPULS	UPDATE
INITAL	MAINPG
INTERL	NORLOD
INTERP	INTERL
INTERS	BGG, SEGSEG
IOVRLP	PLELP
IREGN	PSOLID

Table 35 LINKAGE CROSS-REFERENCE--PART 2, CALLED-CALLER (4 of 6)

Called	Users
LOADSW	SETACT
LOADTP	CINPUT
LODFEL	PLELP, PLSEGF
LOKIDJ	AIRBG1, BINPUT, BIVIN, CINPUT, FINPUT, INITAL, OUTPUT, SINPUT, VINPUT
LOOKID	BINPUT, BIVIN, CINPUT, FINPUT, INITAL, MAINPG, OUTPUT, SINPUT, VINPUT
LTIME	ELTIME
MAINPG	(main)
MAT31	AIRBAG, AIRBG3, BELTG, BELTRT, BGG, BLDEFL, EJOINT, EQUILB, FLXSEG, IMPULS, INITAL, INTERS, OUTPUT, PANEL, PLELP, PLSEGF, PLTXYZ, SEGSEG, SPDAMP, VISPR
MAT33	AIRBG1, BGG, DRCYPR, EDEPTH, FLXSEG, PANEL, SEGSEG, SETUP2
NEARPT	INTERL, PHITAB
NEWPAG	BINPUT, BIVIN, CINPUT, MAINPG, SINPUT, VINPUT
NORLOD	FOEVAL
ORTHO	BGG
OUTPUT	CMPUTE, DINT, EQUILB, IMPULS, MAINPG, RSTART, UPDATE
PANEL	AIRBG1, AIRBG3
PDAUX	CMPUTE, DINT
PHITAB	SHARET
PLANIN	INTERL
PLELP	CONTCT
PLOTR1	MAINPG
PLOTR2	MAINPG
PLSEGF	SEGSEG
PLTXYZ	PRIPLT
PRINT	DAUX, EQUILB, IMPLS2, IMPULS, MAINPG, UPDATE
PRIPLT	MAINPG

Table 35 LINKAGE CROSS-REFERENCE--PART 2, CALLED-CALLER (5 of 6)

Called	Users
PSOLID	PLELP
PUSHER	BINPUT, BIVIN, FINPUT, SEGSEG, SETACT, SINPUT
QBUG	MAINPG, DAUX
QSET	DINT
RCRT	BGG
ROT	DRCYPR, EJOINT
RSTART	MAINPG
SEARCH	RSTART
SEGSEG	CONTCT
SETACT	CONTCT
SETUP1	DAUX
SETUP2	DAUX, UPDATE
SHARED	LODFEL, SHAREG, SHARET
SHAREG	LODFEL
SHAREL	LODFEL, SHARET
SHAREM	LODFEL
SHARET	LODFEL
SINPUT	MAINPG
SLVCBC	SHARED
SLVGEN	SHARED
SPDAMP	DAUX
TODAY	MAINPG
TRANBY	PLELP
TRIGFS	DINT
TURNPT	FOEVAL

Table 35 LINKAGE CROSS-REFERENCE--PART 2, CALLED-CALLER (6 of 6)

Called	Users
UPDATE	DINT
UPDFDC	UPDATE
VEHPOS	DAUX, INITAL
VINPUT	MAINPG
VISCOS	EJOINT, VISPR
VISPR	DAUX, IMPULS
XDY	EQUILB, FLXSEG, IMPLS2, SEGSEG, UPDATE
YPRDEG	AIRBG3, OUTPUT, PRINT, VINPUT
ZUMARY	MAINPG

3.3 Internal Communication

The communication of information is handled by means of arguments and commons. Table 36 lists each subprogram which uses arguments together with the arguments. Table 37 lists each subprogram together with all the labelled commons which are used in it. Table 38 is the inverse listing each common together with all subprograms in which it appears. Both tables are useful depending on which way you are following an information chain. Table 39 is a Symbol Dictionary covering every quantity which appears in an argument list, a common, or is in a debug printout. At this writing, not all quantities have been defined in this table. The level of effort required was not within the scope of this contract. Some commons contain temporary storage and have different uses of the same physical storage in different parts of the model run. Redefinitions of this sort are specified in the Symbol Table by postscripting a number sign (#) and a number signifying which definition to the common name.

Table 36 ROUTINE ARGUMENT LISTS (1 of 5)

ROUTINE	No. of Arg.	Arguments
ADJUST	5	M, D1, N, X(240), DER(240)
AIRBGG	1	J
AIRBG3	1	IRESET
BELTG	5	D(3,3), BELT(20), ZG(3), BD(24), ZC(3)
BELTRT	5	I, II, MM, M, NT
BGG	19	A(3,3), ZA(3), DA(3,3), BFA(3), VA(3), WA(3), B(3,3), ZB(3), DB(3,3), BFB(3), VB(3), WB(3), VSCS, IFULL, TV(3), FRA(3), TORQ(3), TQB(3), VOL
BLDEFL	2	M, KELLPR
BLOCK	5	HOMBOX, RADIUS, BOXNUM, NUMROW, NUMCOL
BOXSCN	10	LINDEX, X, Y, BOX, XNEAR(10,2), FNEAR(10), MNRAD2, DIST(10), FARPTR, NCLOSE
BXINFO	9	LINDEX, X, Y, DELMIN, HOMBOX, NUMROW, NUMCOL, MAXBOX, MINRAD
CFACTT	3	A(3,3), B(3,3), D
CMPUTE	7	K, M, FT, T, N, X(240), DER(240)
CROSS	3	A(3), B(3), C(3)
CSOLID	11	XO, YO, ZO, X1, X2, Y2, XX1, YY1, Q, RBAR, IETASE
CUBRUT	1	ARG
DAUX	1	I1
DEBUG	2	J, IBUG(16)
DHHPIN	5	DD(3,3), BN(3), L, M, N
DINT	10	IN, N, DPTR, HO, HMAX, HMIN, T, X(240), DER(240), NDINT
DOTT31	3	A(3), B(3), C(3,3)
DOTT33	3	A(3,3), B(3,3), C(3,3)
DOT31	3	A(3,3), B(3), C(3)

Table 36 ROUTINE ARGUMENT LISTS (2 of 5)

ROUTINE	No. of Arg.	Arguments
DOT33	3	A(3,3), B(3,3), C(3,3)
DRCYPR	5	D(3,3), A(3), I1, I2, I3
DSETD	3	D(3,3), TH(3), T
DSETQ	5	E(3,3), TH(3), ES, EC, D(3,3)
DSMSOL	3	A(LL,1), KK, LL
DZP	6	N, X(1), GG(5,1), E(3,1), R, M
EDEPTH	9	A(3,3), B(3,3), XM(3), T, Y(3), XA(3), XB(3), XL, XU
EFUNCT	4	TH, THD, SPR(5), JSTOP
EJOINT	2	IJ, NJ
ELONG	5	A, B, C, D, E
ELTIME	2	L, N
ENTCOL	5	A(2), V(2), N, M, J
ENTROW	5	A(2), V(2), N, M, I
ENTVAL	6	A(2), V, N, M, I, J
EQUILB	1	YPR(3,22)
ERRMSG	1	IFATAL
EULRAD	3	D(3,3), A(3), IC
EVALFD	3	D, N, L
FOEVAL	2	K, IC
FRCDFL	3	D, M, N
FSMSOL	6	C(3,3,1), R(3,1), NN(JN,1), MX, MAXN, JN
GETGR	5	K, KMATL, DEL, G, R
GLOBAL	6	J, HD3(3), DH1(3,3), TQC, T9(3), ANGL(3)

Table 36 ROUTINE ARGUMENT LISTS (3 of 5)

ROUTINE	No. of Arg.	Arguments
HEDING	2	LINES, KATGRY
HERRON	4	HD3(3), NT1, THETO, THETOP
IMPLS2	3	MODE, J, H(3)
IMPULS	3	I1, I2, I3
INTERL	7	LINDEX, X, Y, F, PFD, PFDD, IER
INTERP	8	XCORNR(2,2), DELTA(2), X, Y, F, FNEAR(4), PFD, PFDD
INTERS	7	A(3,3), B(3,3), XM(3), T, X(3), V, AX(3)
IOVRLP	4	X1, Y2, Q, RBAR2
IREGN	3	D, R, IETAR
LOADSW	2	L1, L2
LOADTP	3	ND, NR, NC
LODFEL	4	KKACT, FN, FTS, FTF
LOKIDJ	5	I, J, K, M, N
LOOKID	3	I, J, K
LTIME	1	N
MAT31	3	A(3,3), B(3), C(3)
MAT33	3	A(3,3), B(3,3), C(3,3)
NEARPT	10	LINDEX, X, Y, XNEAR(10,2), FNEAR(10), DIST(10), MINBOX, MAXBOX, FARPTR, NCLOSE
NEWPAG	3	LINE, N, M
NORLOD	5	TDEL, TDELD, FOR, PFD, PFDD
ORTHO	3	P(L,3), X(3), L
OUTPUT	1	IJK
PANEL	3	DRR(3,3), ZR(3), JB
PDAUX	4	VAR(3,1), DER(3,1), NEQ, KDINT

Table 36 ROUTINE ARGUMENT LISTS (4 of 5)

ROUTINE	No. of ARG.	Arguments
PHITAB	9	NBIVTK, COEF(27), CZERO, D, R, BOTDT, TOPDT, BOTRT, TOPRT,
PLANIN	8	XN(3,2), FN(3), XV, YV, FV, PFD, PFDD, IER
PLELP	4	KELLP, KPAN, KACT, IPICP
PLOTR1	1	LDNELL
PLOTR2	1	LDNELL
PLSEGF	3	M, N, KACT
PLTXYZ	2	P(3), C
PRINT	1	SUB
PSOLID	13	X, Y, XOC, YOC, X1, X2, Y2, Q, RBAR, XX1, YY1, IETASE, IETAR
PUSHER	3	IDIR, IBEG, NUM
QSET	5	F(5,3,80), Y(5,3,80), X(3,80), DER(3,80), N
RCRT	4	A(3,3), PL(4,3), Z(3), IP
ROT	3	A(3,3), L, TH
RSTART	2	IF, IT
SEARCH	4	AVAR, INDEX, NCOM, ITEM
SEGSEG	3	KELLP, KELLP2, KACT
SETACT	6	KFP1, KFP2, NUMACT, KACSWT, KACT, KKK
SHARED	3	LSWT, LSUB, NCOUNT
SHAREL	1	NCOUNT
SLVCBC	7	U, V, W, BOT, TOP, X, IER
SLVGEN	11	Z, BOT, TOP, C0, C1, C2, C3, C4, C5, C6, IER
TODAY	3	I, J, DATE(3)
TRANBY	3	P(3), PD(3), NBODY

Table 36 ROUTINE ARGUMENT LISTS (5 of 5)

ROUTINE	No. of Arg.	Arguments
TURNPT	6	D, DP, DPP, R, RP, RPP
UPDATE	1	I
UPDFDC	1	M
VISCOS	3	ZD, VISC(5), HA
VISPR	2	IJ, NJ
XDY	3	X(3), D(3,3), Y(3)
YPRDEG	2	D(3,3), A(3)
ZUMARY	1	ISWT

Table 37 COMMON USAGE--PART 1, ROUTINE-COMMONS USED (1 of 6)

Routine	Commons Used
ADJUST	CDINT, CNSNTS, FLECK
AIRBAG	ABDATA, CNSNTS, CNTSRF, CONTROL, CYDATA, DESCRP, FORCES, IOCNTL, IRBASE, JBARTZ, SGMNTS, TEMPVS, VPOSTN
AIRBGG	ABDATA, CNSNTS, CNTSRF, CONTROL, CYDATA, FORCES, IRBASE, JBARTZ, SGMNTS, TEMPVS, VPOSTN
AIRBG1	ABDATA, CNSNTS, CNTSRF, CONTRL, CYDATA, DESCRP, ERRER, FORCES, INTEST, IOCNTL, IRBASE, SGMNTS, TEMPVS, TITLES
AIRBG3	ABDATA, CNSNTS, CNTSRF, CONTRL, CYDATA, FORCES, IOCNTL, IRBASE, JBARTZ, SGMNTS, TEMPVS, VPOSTN
BELTG	CNSNTS, CONTRL, IOCNTL, TEMPVS
BELTRT	CNTSRF, CONTRL, FORCES, SGMNTS, TABLES, TEMPVS, VPOSTN
BGG	CNSNTS, IRBASE, TEMPVS
BINPUT	CEULER, CNSNTS, CNTSRF, CONTRL, DESCRP, ERRER, FLXBLE, INTEG, INTEST, IOCNTL, IRBASE, TEMPVS, TITLES
BIVIN	CNSNTS, CNTRL2, ERRER, INTEG, IOCNTL, IRBASE, REAL
BLDEFL	CONTRL, DSTUFF, IOCNTL, REAL, SGMNTS
BLKDTA	CNSNTS, TEMPVS
BLOCK	
BOXSCN	INTEG, REAL
BXINFO	INTEG, REAL
CFACTT	
CHAIN	CONTRL, DESCRP, IOCNTL, SGMNTS, TEMPVS
CINPUT	ERRER, INTEG, IOCNTL, IRBASE, REAL, TABLES, TEMPVS
CMPUTE	CDINT, CONTRL, IRBASE
CONTCT	CONTRL, FORCES, INTEG, IRBASE, JBARTZ, TABLES
CROSS	
CSOLID	
CUBRUT	
DAUX	CMATRX, CNSNTS, CONTRL, CSTRNT, DESCRP, ERRER, FLXBLE, IOCNTL, IRBASE, SGMNTS, TEMPVS

Table 37 COMMON USAGE--PART 1, ROUTINE-COMMONS USED (2 of 6)

Routine	Commons Used
DAUX11	CMATRX, CONTRL, DESCRP, SGMNTS, TEMPVS
DAUX12	CMATRX, CONTRL, DESCRP, TEMPVS
DAUX22	CEULER, CMATRX, CONTRL, DESCRP, SGMNTS, TEMPVS
DAUX31	CMATRX, CONTRL, CSTRNT, DESCRP, TEMPVS
DAUX32	CMATRX, CONTRL, CSTRNT, DESCRP, TEMPVS
DAUX33	CMATRX, CONTRL, CSTRNT, DESCRP, SGMNTS, TEMPVS
DAUX44	CMATRX, CONTRL, CSTRNT, DESCRP, FLXBLE, SGMNTS, TEMPVS
DAUX55	CMATRX, CNSNTS, CONTRL, CSTRNT, DESCRP, FLXBLE, SGMNTS, TEMPVS
DEBUG	IOCNTL
DHHPIN	CEULER, DESCRP, SGMNTS
DINT	CDINT, CNSNTS, CONTRL, FLECK, INTEST, IOCNTL, IRBASE
DOTT31	
DOTT33	
DOT31	
DOT33	
DRCYPR	CNSNTS
DSETD	CNSNTS, IOCNTL
DSETQ	CNSNTS, IOCNTL
DSMSOL	IOCNTL, IRBASE
DZP	CNSNTS
EDEPTH	CNSNTS, CONTRL, IOCNTL, IRBASE
EFUNCT	
EJOINT	CEULER, CMATRX, CNSNTS, CONTRL, DESCRP, FORCES, SGMNTS, TEMPVI, TEMPVS
ELONG	
ELTIME	GBTIME, IOCNTL

Table 37 COMMON USAGE--PART 1, ROUTINE-COMMONS USED (3 of 6)

Routine	Commons Used
ENTCOL	
ENTROW	
ENTVAL	
EQUILB	CMATRX, CNSNTS, CNTSRF, CONTRL, CSTRNT, DESCRP, IOCNTL, IRBASE, JBARTZ, SGMNTS, TABLES, TEMPVS, TITLES
ERRMSG	ERRER, IOCNTL
EULRAD	CNSNTS
EVALFD	TABLES
FINPUT	CNSNTS, CONTRL, CSTRNT, DESCRP, ERRER, INTEG, IOCNTL, IRBASE, JBARTZ, TABLES, TEMPVS, TITLES
FLXSEG	CNSNTS, FLXBLE, SGMNTS, TEMPVS
FOEVAL	CONTRL, INTEG, IOCNTL, IRBASE, REAL, SHRCMA, SHRCMG, SHRCMH
FRCDFL	TABLES
FSMSOL	IOCNTL, IRBASE
GETGR	INTEG, REAL
GLOBAL	CNSNTS, DESCRP, TABLES, TEMPVI
HEDING	CNSNTS, COMAIN, CONTRL, FORCES, INTEG, IOCNTL, IRBASE, JBARTZ, OUTCTL, REAL, RSAVE, TEMPVS, TITLES, ZUMOUT
HERRON	CNSNTS, TABLES
IMPLS2	CMATRX, CONTRL, CSTRNT, DESCRP, FLXBLE, IRBASE, SGMNTS
IMPULS	CMATRX, CONTRL, CSTRNT, DESCRP, ERRER, FLXBLE, IOCNTL, IRBASE, JBARTZ, SGMNTS, TABLES, TEMPVI, VPOSTN
INITAL	CNSNTS, CONTRL, DESCRP, ERRER, IOCNTL, IRBASE, SGMNTS, TEMPVS, TITLES, VPOSTN
INTERL	BIVTAB, CONTRL, ERRER, INTEG, IOCNTL, MISCL, REAL
INTERP	
INTERS	CNSNTS, IOCNTL, IRBASE

Table 37 COMMON USAGE--PART 1, ROUTINE-COMMONS USED (4 of 6)

Routine	Commons Used
IOVRLP	
IREGN	
LOADSW	
LOADTP	
LODFEL	CONTRL, ERRER, INTEG, IOCNTL, IRBASE, MISCL, REAL, SHRCMA, SHRCMB, SHRCMC, SHRCMD, SHRCME, SHRCMF, SHRCMG, SHRCMH
LOKIDJ	ERRER
LOOKID	ERRER
LTIME	
(main)	INTEG, IRBASE, REAL
MAINPG	CNSNTS, CNTRL2, CNTSRF, COMAIN, CONTRL, ERRER, FORCES, INTEG, IOCNTL, IRBASE, MISCL, REAL, RSAVE, RSTUFF, SGMNTS, TITLES, VPOSTN
MAT31	
MAT33	
NEARPT	BIVTAB, INTEG
NEWPAG	IOCNTL
NORLOD	CONTRL, ERRER, IOCNTL, IRBASE, MISCL, REAL, SHRCMG
ORTHO	
OUTPUT	CNSNTS, COMAIN, CONTRL, CSTRNT, DAMPER, DESCRP, ERRER, FLXBLE, FORCES, INTEG, IOCNTL, IRBASE, JBARTZ, OUTCTL, REAL, RSAVE, RSTUFF, SGMNTS, TEMPVS, TITLES, VPOSTN, ZUMOUT
PANEL	CONTRL, SGMNTS
PDAUX	CONTRL, DESCRP, FLXBLE, INTEST, IRBASE, SGMNTS, TEMPVS
PHITAB	CNSNTS, CONTRL, ERRER, INTEG, IOCNTL, IRBASE, REAL
PLANIN	
PLELP	CNSNTS, CONTRL, DSTUFF, INTEG, IOCNTL, IRBASE, MISCL, PLSTR, REAL, SGMNTS, TEMPVS
PLOTR1	CNTSRF, CONTRL, INTEG, REAL, TITLES
PLOTR2	CNTSRF, CONTRL, INTEG, PLSTR, REAL, SGMNTS, VPOSTN

Table 37 COMMON USAGE--PART 1, ROUTINE-COMMONS USED (5 of 6)

Routine	Commons Used
PLSEGF	CSTRNT, INTEG, IRBASE, REAL, SGMNTS, TABLES, TEMPVI, TEMPVS
PLTXYZ	CONTRL, SGMNTS, TEMPVS, VPOSTN
PRINT	CMATRX, CNSNTS, CONTRL, CSTRNT, DESCRP, IOCNTL, SGMNTS, TITLES
PRIPLT	CNTSRF, CONTRL, DESCRP, IOCNTL, JBARTZ, SGMNTS, TEMPVS, TITLES, VPOSTN
PSOLID	
PUSHER	CONTRL, ERRER, INTEG, IOCNTL, IRBASE, REAL
QBUG	INTEG, IOCNTL, IRBASE, REAL
QSET	
RCRT	
ROT	CNSNTS
RSTART	ABDATA, CDINT, CEULER, CMATRX, CNSNTS, CNTRL2, CNTSRF, COMAIN, CONTRL, CSTRNT, CYDATA, DAMPER, DESCRP, FLXBLE, FORCES, INTEG, INTEST, IOCNTL, IRBASE, JBARTZ, MISCL, OUTCTL, REAL, RSAVE, RSTUFF, SGMNTS, TABLES, TEMPVI, TITLES, VPOSTN, ZUMOUT
SEARCH	
SEGSEG	CNTSRF, CSTRNT, FORCES, INTEG, IRBASE, REAL, SGMNTS, TABLES, TEMPVS
SETACT	CNTRL2, CONTRL, INTEG, IOCNTL, IRBASE, REAL
SETUP1	CMATRX, CONTRL, DESCRP, IOCNTL, SGMNTS, TEMPVS
SETUP2	CMATRX, CNSNTS, CONTRL, CSTRNT, DESCRP, SGMNTS, TEMPVS
SHARED	CONTRL, IOCNTL, MISCL, REAL, SHRCMA, SHRCMB, SHRCMD, SHRCME, VPOSTN
SHAREG	CNSNTS, CONTRL, IOCNTL, IRBASE, REAL, SHRCMA, SHRCMB, SHRCMC, VPOSTN
SHAREL	CONTRL, IOCNTL, MISCL, REAL, SHRCMA, SHRCMB, SHRCMD, SHRCME, SHRCMF
SHAREM	CONTRL, IOCNTL, IRBASE, REAL, SHRCMA, SHRCMB, SHRCMC
SHARET	CONTRL, IOCNTL, IRBASE, MISCL, REAL, SHRCMA, SHRCMB, SHRCMC, SHRCME, SHRCMF
SINPUT	CNSNTS, CNTRL2, CNTSRF, CONTRL, CSTRNT, DAMPER, ERRER, INTEG, IOCNTL, IRBASE, REAL, SGMNTS, TEMPVS, TITLES

Table 37 COMMON USAGE--PART 1, ROUTINE-COMMONS USED (6 of 6)

Routines	Commons Used
SLVCBC	
SLVGEN	CONTRL, IOCNTL
SPDAMP	DAMPER, SGMNTS, TEMPVS
TODAY	
TRANBY	SGMNTS
TRIGFS	CDINT, CNSNTS, FLECK
TURNPT	
UPDATE	CEULER, CMATRX, CONTRL, CSTRNT, DESCRP, FORCES, INTEG, IOCNTL, IRBASE, JBARTZ, SGMNTS, TABLES, TEMPVI
UPDFDC	TABLES
VEHPOS	CNSNTS, CONTRL, SGMNTS, VPOSTN
VINPUT	CNSNTS, CONTRL, DESCRP, ERRER, INTEST, IOCNTL, IRBASE, SGMNTS, TEMPVS, TITLES, VPOSTN
VISCOS	
VISPR	CEULER, CMATRX, CNSNTS, CONTRL, DESCRP, FORCES, IOCNTL, SGMNTS, TEMPVI, TEMPVS
XDY	
YPRDEG	CNSNTS
ZUMARY	CNSNTS, COMAIN, CONTRL, FORCES, INTEG, IOCNTL, IRBASE, JBARTZ, OUTCTL, REAL, RSAVE, TEMPVS, TITLES, ZUMOUT

Table 38 COMMON USAGE--PART 2, COMMON-ROUTINES USED IN (1 of 3)

Common	Routines
ABDATA	AIRBAG, AIRBGG, AIRBG1, AIRBG3, RSTART
BIVTAB	INTERL, NEARPT
CDINT	ADJUST, CMPUTE, DINT, RSTART, TRIGFS
CEULER	BINPUT, DAUX22, DHHPIN, EJOINT, RSTART, UPDATE, VISPR
CMATRIX	DAUX, DAUX11, DAUX12, DAUX22, DAUX31, DAUX32, DAUX33, DAUX44, DAUX55, EJOINT, EQUILB, IMPLS2, IMPULS, PRINT, RSTART, SETUP1, SETUP2, UPDATE, VISPR
CNSNTS	ADJUST, AIRBAG, AIRBGG, AIRBG1, AIRBG3, BELTG, BGG, BINPUT, BIVIN, BLKDTA, DAUX, DAUX55, DINT, DRCYPR, DSETD, DSETQ, DZP, EDEPTH, EJOINT, EQUILB, EULRAD, FINPUT, FLXSEG, GLOBAL, HEDING, HERRON, INITAL, INTERS, MAINPG, OUTPUT, PHITAB, PLELP, PRINT, ROT, RSTART, SETUP2, SHAREG, SINPUT, TRIGFS, VEHPOS, VINPUT, VISPR, YPRDEG, ZUMARY
CNTRL2	BIVIN, MAINPG, RSTART, SETACT, SINPUT
CNTSRF	AIRBAG, AIRBGG, AIRBG1, AIRBG3, BELTRT, BINPUT, EQUILB, MAINPG, PLOTR1, PLOTR2, PRIPLT, RSTART, SEGSEG, SINPUT
COMAIN	HEDING, MAINPG, OUTPUT, RSTART, ZUMARY
CONTRL	AIRBAG, AIRBGG, AIRBG1, AIRBG3, BELTG, BELTRT, BINPUT, BLDEFL, CHAIN, CMPUTE, CONTCT, DAUX, DAUX11, DAUX12, DAUX22, DAUX31, DAUX32, DAUX33, DAUX44, DAUX55, DINT, EDEPTH, EJOINT, EQUILB, FINPUT, FOEVAL, HEDING, IMPLS2, IMPULS, INITAL, INTERL, LODFEL, MAINPG, NORLOD, OUTPUT, PANEL, PDAUX, PHITAB, PLELP, PLOTR1, PLOTR2, PLTXYZ, PRINT, PRIPLT, PUSHER, RSTART, SETACT, SETUP1, SETUP2, SHARED, SHAREG, SHAREL, SHAREM, SHARET, SINPUT, SLVGEN, UPDATE, VEHPOS, VINPUT, VISPR, ZUMARY
CSTRNT	DAUX, DAUX31, DAUX32, DAUX33, DAUX44, DAUX55, EQUILB, FINPUT, IMPLS2, IMPULS, OUTPUT, PLSEGF, PRINT, RSTART, SEGSEG, SETUP2, SINPUT, UPDATE
CYDATA	AIRBAG, AIRBGG, AIRBG1, AIRBG3, RSTART
DAMPER	OUTPUT, RSTART, SINPUT, SPDAMP
DESCRP	AIRBAG, AIRBG1, BINPUT, CHAIN, DAUX, DAUX11, DAUX12, DAUX22, DAUX31, DAUX32, DAUX33, DAUX44, DAUX55, DHHPIN, EJOINT, EQUILB, FINPUT, GLOBAL, IMPLS2, IMPULS, INITAL, OUTPUT, PDAUX, PRINT, PRIPLT, RSTART, SETUP1, SETUP2, UPDATE, VINPUT, VISPR
DSTUFF	BLDEFL, PLELP
ERRER	AIRBG1, BINPUT, BIVIN, CINPUT, DAUX, ERRMSG, FINPUT, IMPULS, INITAL, INTERL, LODFEL, LOKIDJ, LOOKID, MAINPG, NORLOD, OUTPUT, PHITAB, PUSHER, SINPUT, VINPUT
FLECK	ADJUST, DINT, TRIGFS

Table 38 COMMON USAGE--PART 2, COMMON-ROUTINES USED IN (2 of 3)

Common	Routines
FLXBLE	BINPUT, DAUX, DAUX44, DAUX55, FLXSEG, IMPLS2, IMPULS, OUTPUT, PDAUX, RSTART
FORCES	AIRBAG, AIRBGG, AIRBG1, AIRBG3, BELTRT, CONTCT, EJOINT, HEDING, MAINPG, OUTPUT, RSTART, SEGSEG, UPDATE, VISPR, ZUMARY
GBTIME	ELTIME
INTEG	BINPUT, BIVIN, BOXSCN, BXINFO, CINPUT, CONTCT, FINPUT, FOEVAL, GETGR, HEDING, INTERL, LODFEL, (main), MAINPG, NEARPT, OUTPUT, PHITAB, PLELP, PLOTR1, PLOTR2, PLSEFG, PUSHER, QBUG, RSTART, SEGSEG, SETACT, SINPUT, UPDATE, ZUMARY
INTEST	AIRBG1, BINPUT, DINT, PDAUX, RSTART, VINPUT
IOCNTL	AIRBAG, AIRBG1, AIRBG3, BELTG, BINPUT, BIVIN, BLDEFL, CHAIN, CINPUT, DAUX, DEBUG, DINT, DSETD, DSETQ, DSMSOL, EDEPTH, ELTIME, EQUILB, ERRMSG, FINPUT, FOEVAL, FSMSOL, HEDING, IMPULS, INITAL, INTERL, INTERS, LODFEL, MAINPG, NEWPAG, NORLOD, OUTPUT, PHITAB, PLELP, PRINT, PRIPLT, PUSHER, QBUG, RSTART, SETACT, SETUP1, SHARED, SHAREG, SHAREL, SHAREM, SHARET, SINPUT, SLVGEN, UPDATE, VINPUT, VISPR, ZUMARY
IRBASE	AIRBAG, AIRBGG, AIRBG1, AIRBG3, BGG, BINPUT, BIVIN, CINPUT, CMPUTE, CONTCT, DAUX, DINT, DSMSOL, EDEPTH, EQUILB, FINPUT, FOEVAL, FSMSOL, HEDING, IMPLS2, IMPULS, INITAL, INTERS, LODFEL, (main), MAINPG, NORLOD, OUTPUT, PDAUX, PHITAB, PLELP, PLSEGF, PUSHER, QBUG, RSTART, SEGSEG, SETACT, SHAREG, SHAREM, SHARET, SINPUT, UPDATE, VINPUT, ZUMARY
JBARTZ	AIRBAG, AIRBGG, AIRBG3, CONTCT, EQUILB, FINPUT, HEDING, IMPULS, OUTPUT, PRIPLT, RSTART, UPDATE, ZUMARY
MISCL	INTERL, LODFEL, MAINPG, NORLOD, PLELP, RSTART, SHARED, SHAREL
OUTCTL	HEDING, OUTPUT, RSTART, ZUMARY
PLSTR	PLELP, PLOTR2
REAL	BIVIN, BLDEFL, BOXSCN, BXINFO, CINPUT, FOEVAL, GETGR, HEDING, INTERL, LODFEL, (main), MAINPG, NORLOD, OUTPUT, PHITAB, PLELP,PLOTR1, PLOTR2, PLSEGF,PUSHER, QBUG, RSTART, SEGSEG, SETACT, SHARED, SHAREG, SHAREL, SHAREM, SHARET, SINPUT, ZUMARY
RSAVE	HEDING, MAINPG, OUTPUT, RSTART, ZUMARY
RSTUFF	MAINPG, OUTPUT, RSTART
SHRCMA	FOEVAL, LODFEL, SHARED, SHAREG, SHAREL, SHAREM, SHARET
SHRCMB	LODFEL, SHARED, SHAREG, SHAREL, SHAREM, SHARET
SHRCMC	LODFEL, SHAREG, SHAREM, SHARET
SHRCMD	LODFEL, SHARED, SHAREL

Table 38 COMMON USAGE--PART 2, COMMON-ROUTINES USED IN (3 of 3)

Common	Routines
SHRCME	LODFEL, SHARED, SHAREL, SHARET
SHRCMF	LODFEL, SHAREL, SHARET
SHRCMG	FOEVAL, LODFEL, NORLOD
SHRCMH	FOEVAL, LODFEL
SGMNTS	AIRBAG, AIRBGG, AIRBG1, AIRBG3, BELTRT, BLDEFL, CHAIN, DAUX, DAUX11, DAUX22, DAUX33, DAUX44, DAUX55, DHHPIN, EJOINT, EQUILB, FLXSEG, IMPLS2, IMPULS, INITAL, MAINPG, OUTPUT, PNAEL, PDAUX, PLELP, PLOTR2, PLSEGF, PLTXYZ, PRINT, PRIPLT, RSTART, SEGSEG, SETUP1, SETUP2, SINPUT, SPDAMP, TRANBY, UPDATE, VEHPOS, VINPUT, VISPR
TABLES	BELTRT, CINPUT, CONTCT, EQUILB, EVALFD, FINPUT, FRCDFL, GLOBAL, HERRON, IMPULS, PLSEGF, RSTART, SEGSEG, UPDATE, UPDFDC
TEMPVI	EJOINT, GLOBAL, IMPULS, PLSEGF, RSTART, UPDATE, VISPR
TEMPVS	AIRBAG, AIRBGG, AIRBG1, AIRBG3, BELTG, BELTRT, BGG, BINPUT, BLKDTA, CHAIN, CINPUT, DAUX, DAUX11, DAUX12, DAUX22, DAUX31, DAUX32, DAUX33, DAUX44, DAUX55, EJOINT, EQUILB, FINPUT, FLXSEG, HEDING, INITAL, OUTPUT, PDAUX, PLELP, PLSEGF, PLTXYZ, PRIPLT, SEGSEG, SETUP1, SETUP2, SINPUT, SPDAMP, VINPUT, VISPR, ZUMARY
TITLES	AIRBG1, BINPUT, EQUILB, FINPUT, HEDING, INITAL, MAINPG, OUTPUT, PLOTR1, PRINT, PRIPLT, RSTART, SINPUT, VINPUT, ZUMARY
VPOSTN	AIRBAG, AIRBGG, AIRBG3, BELTRT, IMPULS, INITAL, MAINPG, OUTPUT, PLOTR2, PLTXYZ, PRIPLT, RSTART, SHARED, SHAREG, VEHPOS
ZUMOUT	HEDING, OUTPUT, RSTART, ZUMARY

Table 39 SYMBOL DICTIONARY (1 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
A		DSTUFF		square of AA
AA		DSTUFF		semiaxis of ellipsoid
AA	24		RSTART	new value of alphanumeric variable
AB(3,5)		ABDATA		semiaxis of airbags when fully inflated and undeformed
ACA(3)		TEMPVS#2	BELTG	vector from UVA to tangent point
ACB(3)		TEMPVS#2	BELTG	vector from UVB to tangent point
ACC(6,20)		TEMPVS#13	OUTPUT	holds output quantities for printing
AD(3)		TEMPVS#8	EJOINT	
ADT		VPOSTN		time interval for vehicle deceleration table points
ALPHA	7-1-1		IMPULS	
AMR		TEMPVS#15	SEGSEG	
ANG(3,21)		CEULER		angles for Euler joints.
ANGD(3,21)		CEULER		angular rates for Euler joints
ANGL(3)		TEMPVS#8	EJOINT	
ANGL(3)	10-1-1	TEMPVS#21	VISPR	
ANGLE(3)		TEMPVS#20	VINPUT	initial angles of the vehicle reference system axes with respect to the inertial system

Table 39 SYMBOL DICTIONARY (2 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
APA(3)	2-1-1	TEMPVS#2	BELTG, BELTRT	first tangent point for belt on body
APB(3)	2-1-1	TEMPVS#2	BELTG, BELTRT	second tangent point for belt on body
APSDM(3,20)		DAMPER		coordinates of attachment point of first end of spring-dampers
APSDN(3,20)		DAMPER		coordinates of attachment point of second end of spring-dampers
ASD(5,20)		DAMPER		coefficients of spring and viscous forces for spring-dampers
ATAB(15,100)		TEMPVS#20	VINPUT	vehicle deceleration table values
ATO		VPOSTN		first time point for vehicle deceleration table
AVAR	24		RSTART	name of variable to be redefined on re-start
AX(3)		TEMPVS#2	BELTG	partial result: last half of ellipsoid equation for belt anchor A
AX(3)		VPOSTN		unit vector is direction of deceleration impulse
AO		SHRCMD		constant term in shared deflection equation
A13(3,3,24)		CSTRNT		submatrix A_{13} in $M\ddot{x}+A_{11}f+A_{13}q=U_1$
A22(3,3,42)		CMATRX		submatrix A_{22} in $A_{21}f+A_{22}t+A_{23}q=U_2$
A23(3,3,24)		CSTRNT		submatrix A_{23} in $A_{21}f+A_{22}t+A_{23}q=U2$

Table 39 SYMBOL DICTIONARY (3 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
B		DSTUFF		square of BB
B(3)		TEMPVS#2	BELTG	coefficient of equation of belt plane ellipse
B(3,3)=TT(3,3)		TEMPVS#15	SEGSEG	
B(9,4,5)		ABDATA		semiaxes of panels for airbags
BA		TEMPVS#17	SETUP2	
BA(3,4)		TEMPVS#1	BGG	contact surface ellipsoid matrix and ellipsoid center in airbag system
BAGPV(5)	1-1-1	ABDATA		undistorted volume of airbags
BAGSF(3,20)		FORCES		computed output quantities for airbag-segment contacts
BAGTTL(5,6)		TITLES		descriptive titles for the possible airbags
BB		DSTUFF		semiaxis of ellipsoid
BD(24,25)		CNTSRF		ellipsoid information for belts and airbags
BDYTTL(5)		TITLES		descriptive title for the occupant
BELT(20)	2-1-1		BELTG	local name of BELT(20,8) in BELTG for current belt entry
BELT(20,8)		CNTSRF		coordinates of anchor points and body segment contact point and slack of belts
BFB(3,4,5)		ABDATA		coordinates of airbag contact ellipsoid centers with respect to airbag center of gravity

Table 39 SYMBOL DICTIONARY (4 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
BLTTTL(5,8)		TITLES		descriptive titles for the various belts
BN(3)		TEMPVS#7	DAUX22	
BOT	14-1-3		SHARED	lower value of the valid range for shared deflection
BOTD	14-21-1	SHRCME		lower value of the valid range for deflection for shared deflection
BOTR	14-2-1	SHRCME		lower value of the valid range in deflection rate for shared deflection
BSF(4,20)		FORCES		strain and force for both parts of each belt
BSN(2)		TEMPVS#16	PRIPLT	
BX(3)		TEMPVS#2	BELTG	partial result: last half of ellipsoid equation for belt anchor B
B12(3,3,42)		CMATRX		submatrix B_{12}
B31(3,3,24)		CSTRNT		submatrix B_{31} in constraint equations
B32(3,3,24)		CSTRNT		submatrix B_{32} in constraint equations
B42(3,3,24)		FLXBLE		submatrix B_{42} in constraints for flexible elements
C		DSTUFF		square of CC
C(3,3,400)	4-1-1	TEMPVS#7	DAUX, DAUX11→DAUX55	matrices for solution of a set of simultaneous equations
C(3,3,400)	23		FSMSOL	matrices for solution of a set of simultaneous euqations

Table 39 SYMBOL DICTIONARY (5 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
CBB(3)		TEMPVS#1	BGG	position of point of maximum penetration relative to contact surface
CC		DSTUFF		semiaxis of ellipsoid
CENTM(3)	12-2-1	DSTUFF		ellipsoid center in panel system
CEPSLN		MISCL		force tolerance for convergence test in shared deflection
CFQQ(12)	9-1-1	CSTRNT		coefficient of friction for each constraint
CGC(3,3)	10		FLXSEG	
CGS(24)		TITLES		plot symbols for teh segment centers of gravity
CJOINT(3,21)	3-1-1	TEMPVS#16	PRIPLT	
CK(5)		ABDATA		parameter to stabilize airbag integration
CMASS(5)		ABDATA		multiplier for mass of airbags for damping of integrated motion
CN(3,3)		TEMPVS#10	FLXSEG	
CN1(3,3)		TEMPVS#10	FLXSEG	
COMENT(36)		TITLES		overall descriptive title
CONST(3,21)		CEULER		
CONVF		CNSNTS		conversion constant for force units with respect to pounds
CONVL		CNSNTS		conversion constant for length units with respect to inches

Table 39 SYMBOL DICTIONARY (6 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
CONVT		CNSNTS		conversion constant for time unit with respect to seconds
CPA(3)		TEMPVS#1	BGG	point of maximum penetration for airbag ellipsoid
CPB(3)		TEMPVS#1	BGG	point of maximum penetration for contact surface ellipsoid
CREST	7-1-2	TEMPVI		function of classical coefficient of restitution
CS(3)		TEMPVS#8	EJOINT	
CSA	10-1-1	TEMPVS#21	VISPR	
CSB	10-1-1	TEMPVS#21	VISPR	
CV	10-1-1	TEMPVS#21	VISPR	
CV(3)		TEMPVS#8	EJOINT	
CYAT(5)		CYDATA		sonic throat area for airbags
CYAO(5)		CYDATA		exhaust orifice area for airbags
CYC(5)		CYDATA		air cylinder gas constant
CYCD(5)		CYDATA		sonic throat discharge coefficient for airbags
CYCDO(5)		CYDATA		exhaust orifice discharge coefficient for airbags
CYK(5)		CYDATA		ratio of specific heats of supply gas for airbags

Table 39 SYMBOL DICTIONARY (7 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
CYLO(5)		CYDATA		characteristic length
CYMIN(5)		CYDATA		mass flow into airbags
CYMOUT(5)	1-1-1	CYDATA		mass flow out of airbags
CYORFC(5)		CYDATA		air cylinder exhaust orifice constant
CYP(5)		CYDATA		pressure of contents of airbags
CYPA(5)		CYDATA		atmospheric pressure for airbags
CYPV(5)		CYDATA		vent pressure of the exhaust orifice
CYPO(5)		CYDATA		initial air cylinder gauge supply pressure
CYR(5)		CYDATA		specific gas constant for airbags
CYRHO(5)		CYDATA		density of contents of airbag
CYRHOO(5)		CYDATA		initial air cylinder density
CYSP(5)		CYDATA		initial gas supply pressure for airbags
CYSS(5)		CYDATA		speed of sound
CYT(5)		CYDATA		temperature of contents of airbags
CYTD(5)		CYDATA		gas supply actuator firing time for airbags
CYTO(5)		CYDATA		initial gas supply temperature for airbags
CYV(5)		CYDATA		volume of airbags
CYVMAX(5)		CYDATA		air cylinder maximum volume
CYVO(5)		CYDATA		gas supply reservoir volume for airbags

Table 39 SYMBOL DICTIONARY (8 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
C06	14-2-2	SHRCMD		constant used in shared deflection equation
C15	14-2-2	SHRCMD		constant used in shared deflection equation
C24		SHRCMD		constant used in shared deflection equation
C33		SHRCMD		constant used in shared deflection equation
C42		SHRCMD		constant used in shared deflection equation
C51		SHRCMD		constant used in shared deflection equation
C60		SHRCMD		constant used in shared deflection equation
D(6)	14-1-2,4,6,8, 10 14-2-3	SHRCMA		deflection in each force producer for the three possible evaluations in shared deflection
D(3,3,22)		SGMNTS		direction cosine matrices for body segments, vehicle, airbags and ground
DAB(3,3)		TEMPVS#1	BGG	direction cosine matrix for contact surface relative to airbag
DATE(3)		TITLES		calendar date as supplied by the data set input
DBR(3,3,5)		ABDATA		direction cosine matrices of airbag principle axes in vehicle reference
DD(3)		TEMPVS#19	SPDAMP	components of distance between the specified attachment points of a spring-damper
DD(6)	14-1-2,4,5,8, 10 14-2-3	SHRCMA		deflection rate in each force producer for the three possible evaluations in shared deflection

Table 39 SYMBOL DICTIONARY (9 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
DDATE(3)		TITLES		calendar date of run as supplied by the computer
DDP(2)		SHRCMC		previous value of deflection rate in each force producer in shared deflection
DDO		TEMPVS#19	SPDAMP	
DEL		TEMPVS#19	SPDAMP	magnitude of distance between attachment points of a spring-damper
DEL	15-1-1		FOEVAL	deflection value at which material force is to be evaluated
DELBAR	11-1-2	DSTUFF		distance moved along the planar panel surface since first contact
DELD	15-1-1		FOEVAL	deflection rate value at which material force is to be evaluated
DELDOT	11-1-2	DSTUFF	PLELP	derivative of deflection
DELF(3)		TEMPVS#1	AIRBAG	force acting on airbag due to linear spring function
DELFSP		MISCL		ramp length for full use of force rate terms
DELM(3)		TEMPVS#19	SPDAMP	components
DELN(3)		TEMPVS#19	SPDAMP	components
DELTA	11-1-2	DSTUFF		deflection
DELTA(2)	14-1-12		INTERL	dimensions of box for interpolation
DEPLOY(3,5)		ABDATA		location of deployment point

Table 39 SYMBOL DICTIONARY (10 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
DER(240)		COMAIN		derivative of integration variables
DERP	14-3-1		SLVGEN	present value of derivative of equation being solved
DFORE(3)	14-2-3	SHRCMC		force imbalance for shared deflection iteration
DH1(3,3)		TEMPVS#8	EJOINT	direction cosines of proximal side of joint w.r.t. inertial
DH1(3,3)	10-1-1	TEMPVS#21	VISPR	
DH4(3,3)		TEMPVS#8	EJOINT	direction cosines of distol side of joint w.r.t. inertial
DLGA	2-1-1	TEMPVS#2	BELTG,BELTRT	length of belt contact body segment from fixed body point to tangent A
DLGB	2-1-1	TEMPVS#2	BELTG,BELTRT	length of belt contact body segment from fixed body point to tangent B
DLPD(3)	14-2-3	SHRCMC		
DLPDD(3)		SHRCMC		
DMNT(3,3)	11-2-1	TEMPVS#15	PLELP,PLSEGF,SEGSEG	
DMNWN(3)		TEMPVS#15	PLSEGF,SEGSEG	
DMV		TEMPVS#19	SPDAMP	magnitude of relative velocity of a spring-damper
DN2N1(3,3)		TEMPVS#10	FLXSEG	
DOTBAR	11-1-2		PLELP	velocity of DELBAR

Table 39 SYMBOL DICTIONARY (11 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
DP(2)		SHRCMC		previous value of deflection in each force producer in shared deflection
DPTG(3,3)	21,11-2-3	DSTUFF		direction cosine matrix of panel system w.r.t. inertial system
DPTGD(3,3)	12-2-1	DSTUFF		time derivative of DPTG(3,3)
DPVCTR(3,5)		ABDATA		vector along which airbag c.g. lies during inflation
DRR(9,4,3)		ABDATA		direction cosine matrix of orientation of airbag panels in vehicle reference
DSTEPN		SHRCMC		minimum step in deflection in shared deflection
DSTEPX		SHRCMC		maximum step in deflection in shared deflection
DT		COMAIN		time interval for integration
DUNIT(3)		TEMPVS#19	SPDAMP	unit vector components of line of action of a spring-damper
DV(3)		TEMPVS#19	SPDAMP	components of relative velocity of a spring-damper
DV(3)	7-1-2		IMPULS	
DVEH(3,3)		TEMPVS#20	VINPUT	current direction cosine matrix for vehicle
DWR1(3)	7-1-2		IMPULS	
DWR2(3)	7-1-2		IMPULS	
DWR3(3)	7-1-2		IMPULS	

Table 39 SYMBOL DICTIONARY (12 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
DWR4(3)	7-1-2		IMPULS	
D1		DSTUFF		equivalent of DPTM(1,1)
D2		DSTUFF		equivalent of DPTM(2,1)
D3		DSTUFF		equivalent of DPTM(3,1)
D4		DSTUFF		equivalent of DPTM(1 ,2)
D5		DSTUFF		equivalent of DPTM(2,2)
D6		DSTUFF		equivalent of DPTM(3,2)
D7		DSTUFF		equivalent of DPTM(1,3)
D8		DSTUFF		equivalent of DPTM(2,3)
D9		DSTUFF		equivalent of DPTM(3,3)
E(3,240)		CDINT		expotential weights for integration
EDGE(8)	12-1-1		BLDEFL	deflection of four sides and corners of panels
ELCP(3)	11-2-3		PLELP	
EPS(24)		TEMPVS#4	BLKDTA	constants with values of ten to the negative power of the argument value
EPSLN		MISCL		tolerance for zero tests of panel system corner points
EPSLON		MISCL		relative tolerance for test on loss of significance in bivariate table interpolation
EPS1		CNSNTS		constant with a value of ten to the minus one

Table 39 SYMBOL DICTIONARY (13 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
EPS12		CNSNTS		constant with a value of ten to the minus twelve
EPS15		CNSNTS		constant with a value of ten to the minus fifteen
EPS20		CNSNTS		constant with a value of ten to the minus twenty
EPS24		CNSNTS		constant with a value of ten to the minus twenty-four
EPS4		CNSNTS		constant with a value of ten to the minus four
EPS6		CNSNTS		constant with a value of ten to the minus six
EPS8		CNSNTS		constant with a value of ten to the minus eight
ESG		CNSNTS		value of earth standard gravity acceleration
ETAE	11-1-1*	DSTUFF		switch: 0=above panel; 1=force producing; -1=below but no force
ETAR		DSTUFF		contact edge and corner control switch 0=isolated, 1= foce of solid
ETAS	11-1-1,1*	DSTUFF		contact control switch 0=no contact;1=contact from front; -1=behind
ETASB	11-1-1,1*	DSTUFF		contact corner switch, 0=normal contact; 1=panel is broken

Table 39 SYMBOL DICTIONARY (14 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
ETASE	11-1-1,1*	DSTUFF		contact edge switch, 0=normal contact; 1=corner contact on solid
F	14-1-12		INTERL	interpolated bivariant table value
F(27)	14-2-1	SHRCMB		polynomial coefficients of first force producer in shared deflection
F(3,21)		CMATRX		forces acting on joints
F(5,240)		CDINT		storage of intergration variables
FAIL	5-1-1		DINT	indicates whether any convergence test has been failed
FD		TEMPVS#19	SPDAMP	damping force of a spring-damper
FF	15-1-2		FOEVAL	evaluation of force for material
FF	14-1-4		SHARED	evaluation of force for shared deflection
FFM(3)	11-31	TEMPVS#15	PLELP,PLSEGF	
FFN(3)	11-3-1		PLELP	
FM		TEMPVS#15	PLSEGF	
FMAX	11-1-1*	DSTUFF		deflection of contact interaction
FM3		DSTUFF		square of radius vector of ellipsoid to point of maximum distance into planar panel
FN	13-1-2		LODFEL	normal force of a contact interaction
FN	11-1-2		PLELP	normal force of a contact interaction

Table 39 SYMBOL DICTIONARY (15 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
FNEAR(10)	14-1-12		INTERL	force values for the nearest interpolation points
FOR	15-2-1		NORLOD	evaluation of force
FOR(6)	14-1-2,6,8,10 14-2-3	SHRCMA		force values in each force producer for the three possible evaluations in shared deflection
FORCE(3)		TEMPVS#1	BGG	force on airbag for current airbag-segment
FORCE(3,5)	1-1-1	TEMPVS#1	AIRBAG, AIRBGG	total forces acting on airbag
FOREPS		SHRCMC		epsilon test value for force in shared deflection (same as CEPSLN)
FR(3)	11-2-4	TEMPVS#15	PLELP,PLSEGF	
FRA(4,5)	1-1-1	TEMPVS#1	AIRBAG,AIRBGG	components of force on airbag in inertial reference
FRB(3)		TEMPVS#1	BGG	airbag force components on reaction surface in its local reference system
FRB(3,10)	1-1-1	TEMPVS#1	AIRBAG,AIRBGG	components of force on airbag in inertial reference
FS		TEMPVS#19	SPDAMP	spring force of a spring-damper
FT	11-1-2		PLELP	total tangential force of a contact interaction
FTF	13-1-2		LODFEL	tangential force of a contact interaction due to friction
FTS	13-1-2		LODFEL	tangential force of a contact interaction due to snap back effect

Table 39 SYMBOL DICTIONARY (16 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
FX(10)		TEMPVS#9	EQUILB	
FX1(10)		TEMPVS#9	EQUILB	
FZERO	14-2-1	SHRCMB		constant force term for first force producer in shared deflection
F1	11-1-2	DSTUFF		normal ellipsoid-panel force before any edge scaling
F2	11-1-2	DSTUFF		tangential ellipsoid-panel force before any edge scaling
F3	11-1-2		PLELP	
G(27)	14-2-1	SHRCMB		polynomial coefficients of second force producer in shared deflection
GC(3,3)		TEMPVS#10	FLXSEG	
GF(3,4)		TEMPVS#10	FLXSEG	
GG(5,240)		CDINT		parametric form of state variables
GH(3,4)		FLECK		
GRAVITY(3)		CNSNTS		components of the acceleration of gravity
GZERO	14-2-1	SHRCMB		constant force term for second force producer in shared deflection
H	5-1-1	CDINT		current value of time step
HA(3,42)		DESCRP		even vectors are fraction of deviation from full on viscous torque for each angle. Odd vectors are torques for last reversal of locking.

Table 39 SYMBOL DICTIONARY (17 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
HAC	10-1-1		VISPR	
HAD		TEMPVS#21	VISPR	
HARDCF		MISCL		force deflection linear spring coefficient for rigid-rigid contact interaction
HARDLM		MISCL		force deflection force limit value for rigid-rigid contact interaction
HB(3,42)		DESCRP		direction cosines of axis about which locking takes place w.r.t. both proximal and digital systems
HDT(3,3)		TEMPVS#8	EJOINT	
HD3(3)		TEMPVS#8	EJOINT	components of vector defining ϕ (used to define angle of joint stop)
HD3(3)	10-1-1	TEMPVS#21	VISPR	components of vector defining ϕ(used to define angle of joint stop)
HEAD(20)		TEMPVS#11	HEDING	
HF(4,12,8)		FLXBLE		coefficients of quadratic form function defining orietation of interior segments of flexible elements
HH(3)		TEMPVS#17	SETUP2	
HH(3,3)		TEMPVS#7	DAUX22	
HHT(3,3,12)	9-1-1	CSTRNT		hh^T or $I-hh^T$ for each constraint
HIJ(3,3)		TEMPVS#8	EJOINT	
HIM(3,3)		TEMPVS#8	EJOINT	

Table 39 SYMBOL DICTIONARY (18 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
HIR(3,3,21)		CEULER		
HIT(3)	11-2-4		PLELP	
HITD(3)	11-2-4		PLELP	
HMAX		COMAIN		maximum integration time step size
HMIN		COMAIN		minimum integration time step size
HOMBOX		BIVTAB		index of the box containing the interpolation point for bivariate random tables
HPRINT	5-1-1	CDINT		time step value for printing
HQQ(3,12)	9-1-1	CSTRNT		reference vector at point of constraint
HS	5-1-1	CDINT		previous value of H when chaning size of time step
HT(3,3,42)		DESCRP		direction cosines of principal axes of all joints w.r.t. both proximal and distal systems
HO		COMAIN		initial integration time step size
H2(3,3)		TEMPVS#8	EJOINT	direction cosines for precession only around z.
I	14-3-1		SLVGEN	iteration index
IALFA		ERRER		first letter of expected ID of input cards; also carrier of information to ERRMSG
IALFB		ERRER		last letter of expected ID of input cards; also carrier of information to ERRMSG

Table 39 SYMBOL DICTIONARY (19 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
IAO	14-2-2	SHRCMB		initialization switch for shared deflection contacts; also indicates proportional materials
IBEG	16-1-3		PUSHER	beginning index in array of space to be allocated
IBUG(16)		CONTRL		debug switch values
IC	14-2-3		SHAREM	index of accepted evaluation for shared deflection
ICARD	26		EQUILB	card number for input error
ICNT	5-1-1		DINT	counter of well-behaved time step evaluations
ICT	14-1-8,10	SHRCMC		index in D, DD, FOR of accepted evaluation for shared deflection
ID(5)		ERRER		actual ID as read from input card
IDBL	5-1-1	CDINT	DINT	number of well-behaved time step evaluations needed to allow doubling of time step value
IDIR	10 16-1-3		PUSHER	indicator of which array is being extended (IQ or RQ)
IFATAL		IRBASE		index of fatal error tape
IFIT	14-1-4,6	SHRCME		switch to tell if shared deflection value is inside valid range
IFLAG		CDINT		control for integration
IFULL(6)		ABDATA		indication that airbag is fully inflated
IGLOB(21)		DESCRP		globalgraphic indicators for joints

Table 39 SYMBOL DICTIONARY (20 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
IHEX(9)		RSTUFF		debug switch settings in hex for nine time points
IHEXP		RSTUFF		index of next time at which debug switch settings will be changed
II	24		RSTART	new value of integer variable
II	5-2-1		DINT	integration variable number
IJ	4-1-1	TEMPVS#7	DAUX,DAUX11-55	
IJK(54,54)	4-1-1	TEMPVS#7	DAUX,DAUX11-55	
ILINES		RSTUFF		
ILSTEP		RSTUFF		
ILT		RSTUFF		
INACT	13-1-1		LODFEL	contact interaction type indicator
IND(40)		GBTIME		
INDEX(3)	24		RSTART	array indices of variable being redefined on restart
INUM		ERRER		numeral of expected ID of input card
INZ		RSTUFF		
IPICP	11-1-1		PLELP	index of panel in plot storage array
IPIN(21)		DESCRP		indicator of type and initial status of joints
IQ(15000)	14-2-4 16-1-2 16-2-1	INTEG		integer parking array

Table 39 SYMBOL DICTIONARY (21 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
IRSIN		COMAIN		logical unit number for restart input
IRSOUT		COMAIN		logical unit number for restart output
ISING(22)		DESCRP		indicator of segment singularity
ISTEP		COMAIN		current integration step number
ITEM	24		RSTART	index in its common of variable to be redefined
ITER	6-1-1		EDEPTH	iteration counter for convergence
ITRY		SHRCMB		indicator of which shared deflection routine is being tried
ITYPE	24		RSTART	type indicator for variable being redefined on restart
IUSEIQ		IRBASE		length of IQ in use
IUSERQ		IRBASE		length of RQ in use
I1	25		IMPULS	indicator for routine from which IMPULS is called
I2	25		IMPULS	index of contacting segment or joint axis
I3	25		IMPULS	index of plane, segment or joint axis
J	10-1-1		VISPR	
JCARD	26		EQUILB	second card number for input error
JJ	1,2,3,5		SINPUT	
JNT(21)		DESCRP		indicator of segment associated with each joint

Table 39 SYMBOL DICTIONARY (22 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
JOINT(21)		TITLES		names of the joints, abbreviated
JS(24)		TITLES		plot symbols for the joints
JSTOP(4,2,21)		TEMPVI		indicators to signify joint that joint stop is on
JTITLE(5,51)		TEMPVS#6	CINPUT,FINPUT	descriptive titles for the old material property functions
K	5-1-1		DINT	integration step number
KACSWT	16-1-1		SETACT	indicator of type of contact
KACT	16-1-1		SETACT	beginning index for contact interaction control entry
KACT	11-1-1,2 13-1-1,15-2-1	SHRCMG		beginning index for contact interaction control entry
KACTO		SHRCMA		beginning index of contact interaction current real work entry
KACTR		SHRCMA		beginning index of contact interaction previous real work entry
KALGOR	15-1-1,2 15-2-1	SHRCMG		algorithm indicator for force producer
KATIND(2,15)		OUTCTL		
KELLP	21, 11-1-1		PLELP	beginning index of ellipsoid control entry
KFPD1	13-1-1		LODFEL	beginning index of second force producer control entry
KFPD2	13-1-1		LODFEL	beginning index of first force producer control entry

Table 39 SYMBOL DICTIONARY (23 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
KFP1	16-1-1		SETACT	beginning index of second force producer control entry
KFP2	16-1-1		SETACT	beginning index of first force producer control entry
KI(2)		SHRCMH		index of current KALGOR for both force producers
KIP(2)		SHRCMH		index of previous KALGOR for both force producers
KKA(20)		TEMPVS#11	HEDING	
KKACT		OUTCTL		
KKELP		OUTCTL		
KKI	15-1-1		FOEVAL	index of current KALGOR
KKIP	15-1-1		FOEVAL	index of previous KALGOR
KKK	16-1-2		SETACT	index in IQ where KACT will be inserted in allowed contact tables of contents
KKR	15-1-1		FOEVAL	beginning index of current array for unloading parameters
KKRP	15-1-1		FOEVAL	beginning index of previous array for unloading parameters
KKU(2,20)		TEMPVS#11	HEDING	
KMATL	15-1-1			beginning index of material control entry for both force producers
KMAT(2)		SHRCMH		beginning index of material control entry for both force producers

Table 39 SYMBOL DICTIONARY (24 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
KMATL1	9		LODFEL	beginning index of material control entry for first force producer
KMATL2	9		LODFEL	beginning index of material control entry for second force producer
KMATR	15-2-1	SHRCMG		beginning index of material real information entry
KMATR1		SHRCMF		beginning index of material real information entry for first force producer
KMATR2		SHRCMF		beginning index of material real information entry for second force producer
KNEND	10,16-1-3		PUSHER	potential length of array after allocation
KNT(21)	7	TEMPVS#3	BINPUT	indices of interior segments for flexible elements in the order of the HF arrays to be supplied
KNTANG		CNTRL2		beginning index of tangential force specification table of contents
KNTLGR		CNTRL2		beginning index of G-R table table of contents
KNTLPR		IOCNTL		print time switch
KONTL		IRBASE		IQ array base index
KPAN	21, 11-1-1		PLELP	beginning index of planar panel control entry
KPOLTA	15-2-1	SHRCMG		polynomial-table switch
KQTYPE(12)	9-1-1	CSTRNT		constraint type control from card D.6
KQ1(12)	9-1-1	CSTRNT		segment indices for first points to be constrained

Table 39 SYMBOL DICTIONARY (25 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
KQ2(12)	9-1-1	CSTRNT		segment indices for second points to be constrained
KR(2)		SHRCMH		beginning index of current array for unloading parameters for both force producers
KRP(2)		SHRCMH		beginning index of previous array for unloading parameters for both force producers
KSHAR	13-1-1		LODFEL	shared deflection indicator
KSWT(2)	14-2-1	SHRCMF		polynomial table switch for both force producers
KTITLE(31)		TEMPVS#6	CINPUT,FINPUT	temporary storage for titles
KUSE	10,16-1-3		PUSHER	present length of array
K1	46		SETACT	beginning index of material control entry for first force producer
K2	46		SETACT	beginning index of material control entry for second force producer
L	14-1-11		PHITAB	
LASKAT		OUTCTL		
LASNRN		OUTCTL		
LDNCAR		IOCNTL		logical unit number for input
LDNELL		IOCNTL		logical unit number for special ellipsoid post processor
LDNHIC		IOCNTL		logical unit number for HIC output
LDNPLT		IOCNTL		logical unit number for printer-plot output

Table 39 SYMBOL DICTIONARY (26 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
LDNPRT		IOCNTL		logical unit number for printed output
LDNWRK		IOCNTL		logical unit number for binary output
LENIQ		IRBASE		maximum available length of IQ
LENRQ		IRBASE		maximum available length of RQ
LIMCNT	14-1-8,10	SHRCMC		maximum number of iterations for shared deflections
LIMIT	10,16-1-3		PUSHER	maximum length of array possible
LINDEX	37,14-2-4		INTERL	beginning index of bivariate table control entry
LOAD	44		CINPUT	beginning index of table control entry
LODSWT	14-1-1	SHRCMF		defines type of shared deflection considering forms of both force producers
LORDER	14-1-3		SHARED	order of equation describing force relation for shared deflection
LPP		ZUMOUT		
LSWT	14-1-3		SHARED	indicates whether independent variable of equation describing force relation for shared deflection is deflection or deflection rate
M	11-1-1		PLELP	index of body segment to which contact ellipsoid is attached
	4		SINPUT	contact ellipsoid number
MAXLIN		IOCNTL		maximum number of time points to be printed if printing every intergration

Table 39 SYMBOL DICTIONARY (27 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
MBAG(3,10,6)		JBARTZ		segment and ellipsoid indices allowed to contact each airbag
MBLT(3,5,8)		JBARTZ		segment of ellipsoid i.d. numbers for each belt-segment contact
MBOPL(20)		TEMPVS#11	HEDING,ZUMARY	
MBSF		ZUMOUT		
MCF		TEMPVS#15	PLSEGF,SEGSEG	
MEXP		ERRER		value of expected number of input card
MNBAG(6)		JBARTZ		number of segments to contact each airbag
MNBLT(8)		JBARTZ		number of body segments allowed to interact with each belt
MNELEL	16		FINPUT	total number of allowed contacts for body contact ellipsoid MNELPC
MNELPC	15,16,19		FINPUT	body contact ellipsoid index
MS(3)=NS(3)		TEMPVS#6	FINPUT	segment and ellipsoid indices associated with belts
MSDM(20)		DAMPER		indices of segment to which first end of spring-damper is attached
MSDN(20)		DAMPER		indices of segment to which second end of spring-damper is attached
MSG(20,7)		RSAVE		segment indices for points for the various types of time history output
MTIN(40)		GBTIME		

Table 39 SYMBOL DICTIONARY (28 of 53)

ITEM	IFATAL OR debug ID	COMMON	ROUTINE(S)	DEFINITION
MXTB1		TABLES		number of elements in TAB array used to define functions
MXTB2	17	TABLES		total number of elements in TAB array
N	11-1-1		PLELP	segment number (including vehicle and ground) to which planar panel is attached
NATAB		VPOSTN		number of time points for vehicle deceleration table
NBAG		CONTRL		number of airbags in use
NBGSF		FORCES		number to print for airbag-segment contacts
NBIVTC	14-1-11	IRBASE		beginning index of uni- or bivariate tables table of contents
NBIVTK	20		PHITAB	beginning index of material table control entry
NBLT		CONTRL		number of belts in use
NBOPL(20)		TEMPVS#11	HEDING,ZUMARY	
NBSF		FORCES		number of belt-segment contacts
NC(40)		GBTIME		
NCF		TEMPVS#15	PLSEGF,SEGSEG	
NCOM	24		RSTART	
NCOUNT	14-1-8		SHAREG	index of iteration
NCOUNT	14-1-10		SHAREM	index of iteration

Table 39 SYMBOL DICTIONARY (29 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
NCRD		ERRER		number of input card as read
NDINT		COMAIN		number of iterations for integration convergence test
NEDGE	12-1-1		BLDEFL	index of maximum deflection in EDGE(8)
NELP		CONTRL		number of body ellipsoids
NELSEG	4		SINPUT	number of body segment to which ellipsoid M is attached
NEQ		COMAIN		number of integration variables
NF(5)		TEMPVS#6	FINPUT	index of old material properly functions for belts and joints
NFLEX(3,8)		FLXBLE		identification numbers of reference, interior, and terminating segment for each interior segment
NFLX	14,28	FLXBLE		total number of interior segments for all flexible elements
NFX	11,14		BINPUT	number of segments for which HF arrays are to be supplied (must equal NFLX)
NGRND		CONTRL		index of ground (ie inertial reference system)
NIX		SHRCMF		defines order of shared deflection forms type
NJ	19		FINPUT	body contact ellipsoid index; belt index; joint index
NJNT	28	CONTRL		number of joints
NJ2	28, 4-1-1		DAUX	

Table 39 SYMBOL DICTIONARY (30 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
NN	23		FSMSOL	contains location in array of I, J elements for solution of a set of simultaneous equations
NPANEL(6)		FORCES		number of planar panels allowed to contact the airbags
NPL		CONTRL		number of planar panels
NPRT(11)		CONTRL		switch array for various optional diagnostic output
NPSF		FORCES		number of plane-segment contact interactions
NQ	28	CSTRNT		number of constraints to be supplied
NQ2S		TEMPVS#7	DAUX,DAUX11-33, DAUX55	
NRPCAT		OUTCTL		
NS	28	DESCRP		number of singular segments
NSD		DAMPER		number of spring-dampers to be supplied
NSEG		CONTRL		number of segments
NSG(7)		RSAVE		number of selected points for the various types of time history output
NSSF		FORCES		number of segment-segment contact interactions
NSTEPS		COMAIN		number of time steps to be integrated (defines program run time covered)
NSYM(22)		SGMENTS		segment symmetry option switches

Table 39 SYMBOL DICTIONARY (31 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
NT(40)		GBTIME		
NTAB(500)		TABLES		control array containing index pointers to TAB array function used by contacts
NTABL	40		BIVIN	index of table being processed
NTBLT(5,8)		JBARTZ		index of NTAB array for each belt-segment contact
NTI(50)		TABLES		control array containing index pointer to TAB for each function
NUM	10,16-1-3		PUSHER	length of block to be allocated in array
NUMACT	16-1-1		SETACT	index of this contact interaction in order of scanning of all interactions of this type
NUMGR		CNTRL2		number of G-R tables for materials
NUTANG		CNTRL2		number of tangential force relations for contacts
NVEH		CONTRL		index of vehicle
NX	18		FINPUT	
OMEGA		VPOSTN		frequency of half-sine wave deceleration
ONE		TEMPVS#4	BLKDTA	constant with a value of one
ONE80		TEMPVS#4	BLKDTA	constant with a value of one hundred eighty
P		TEMPVS#15	PLSEGF,SEGSEG	
P	14-3-1		SLVGEN	present value of equation being solved

Table 39 SYMBOL DICTIONARY (32 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
PCYMIN(5)		ABDATA		previous value of CYMIN(5) at last airbag integration step
PCYV(5)		ABDATA		previous value of CYV(5) at last airbag integration step
PD(5)		ABDATA		differential pressure for airbags
PFD	15-2-1		NORLOD	evaluation of partial derivative of force with respect to deflection
PFD(6)		SHRCMA		partial derivative of force with respect to deflection for each force producer for the three possible evaluations in shared deflection
PFDD	15-2-1		NORLOD	evaluation of partial derivative of force with respect to deflection rate
PFDD(6)		SHRCMA		partial derivative of force with respect to deflection rate for each force producer for the three evaluations in shared deflection
PFDDP(2)		SHRCMC		previous value of PFDD for each force producer in shared deflection
PFDP(2)		SHRCMC		previous value of PFD for each force producer in shared deflection
PHI(3,22)		DESCRP		components of segment principle moments of inertia
PI		CNSNTS		value of π
PL(3)	11-2-3	DSTUFF		coefficients of equation of plane of planar panel

Table 39 SYMBOL DICTIONARY (33 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
PLANE(4,3)		TEMPVS#1	BGG	equation of plane at maximum penetration point for airbags
PLD(3)	11-2-3	DSTUFF		time derivatives of PL(3)
PLOT1(120,60)		TEMPVS#16	PLTXYZ,PRIPLT	storage of plot image for Y-Z view
PLOT2(120,60)		TEMPVS#16	PLTXYZ,PRIPLT	storage of plot image for X-Z view
PLTPL(4,3,20)		PLSTR		planar panel corner point coordinates
PPFD	15-1-2		FOEVAL	evaluation of partial derivative of force with respect to deflection
PPFDD	15-1-2		FOEVAL	evaluation of partial derivative of force with respect to deflection rate
PP2(3)	21		PLELP	
PP3(3)	21		PLELP	
PREVT		ABDATA		value of TIME at previous airbag integration step
PRJNT(6,21)		FORCES		compute output quantities for joints
PTD(3)		TEMPVS#10	FLXSEG	
PVBAG(5)		ABDATA		previous values of VBAG(5) at last airbag integration step
PYMOUT(5)		ABDATA		previous values of CYMOUT(5) at last airbag integration step.
POD(3)	12-2-1		BLDEFL	ellipsoid center velocity vector relative panel

Table 39 SYMBOL DICTIONARY (34 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
P1(3)		TEMPVS#18	SINPUT	coordinates of first corner of planar panel; also semiaxes of contact ellipsoids
P1(3)	11-2-12	DSTUFF		coordinates of first corner of planar panel
P1D(3)	11-2-2	DSTUFF		components of velocity of first corner of planar panel
P2(3)		TEMPVS#18	SINPUT	coordinates of second corners of planar panel; also coordinates of centers of contact ellipsoids relative to segment centers of gravity
P2(3)	21, 11-2-2	DSTUFF		coordinates of second corner of planar panel
P2D(3)	11-2-2	DSTUFF		components of velocity of second corner of planar panel
P3(3)		TEMPVS#18	SINPUT	coordinates of third corner of planar panel; also orientation of contact ellipsoid
P3(3)	21,11-2-2	DSTUFF		coordinates of third corner of planar panel
P3D(3)	11-2-2	DSTUFF		components of velocity of third corner of planar panel
QN	9-1-1		UPDATE	
QQ(3,12)	9-1-1	CSTRNT		computer constraint force
R(3)		TEMPVS#15	SEGSEG	
R(3,)	23		FSMSOL	right hand side for solution of a set of simultaneous equations
RA	10-1-1		VISPR	
RADIAN		CNSNTS		conversion factor from degrees to radians

Table 39 SYMBOL DICTIONARY (35 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
RB	10-1-1		VISPR	
RBA(3)		TEMPVS#17	SETUP2	
RBAD(3)		TEMPVS#17	SETUP2	
RES(50)		TEMPVS#13	OUTPUT	
RHS(3,54)	4-1-1	TEMPVS#17	DAUX,DAUX11, 22, 33,44,55	
RHSN(3)		TEMPVS#10	FLXSEG	
RHS1(3)		TEMPVS#10	FLXSEG	
RHS2(3)		TEMPVS#10	FLXSEG	
RK1(3,12)	9-1-1	CSTRNT		coordinates of first point to be constrained
RK2(3,12)	9-1-1	CSTRNT		coordinates of second point to be constrained
RLM(3)		TEMPVS#15	PLSEGF,SEGSEG	
RLN(3)		TEMPVS#15	PLSEGF,SEGSEG	
RM(3)		TEMPVS#15	SEGSEG	
RM(3)		TEMPVS#17	SETUP2	
RMD(3)		TEMPVS#15	SEGSEG	
RMG(3)		TEMPVS#10	FLXSEG	
RM3		DSTUFF		distance for ellipsoid center to lowest point of ellipsoid

Table 39 SYMBOL DICTIONARY (36 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
RN(3)		TEMPVS#17	SETUP2	
RND(3)		TEMPVS#15	SEGSEG	
RPHI(3,22)		DESCRP		inverse of segment moments of inertia components
RQ(3000)	13-1-2 16-2-2	REAL		real packing array
RQQ(3,12)	9-1-1	CSTRNT		R dot term for each constraint
RR	24		RSTART	new value of real variable
RSTIME		COMAIN		restart time
RW(22)		DESCRP		inverse of segment masses
R1		DSTUFF		equivalent of DDPTM(1,1)
R1I(3)	7-1-1	TEMPVI		value of RK1 for current constraint or impulse
R2		DSTUFF		equivalent of DDPTM(2,1)
R2I(3)	7-1-1	TEMPVI		value of RK2 for current constraint or impulse
R3		DSTUFF		equivalent of DDPTM(3,1)
R4		DSTUFF		equivalent of DDPTM(1,2)
R5		DSTUFF		equivalent of DDPTM(2,2)
R6		DSTUFF		equivalent of DDPTM(3,2)
R7		DSTUFF		equivalent of DDPTM(1,3)

Table 39 SYMBOL DICTIONARY (37 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
R8		DSTUFF		equivalent of DDPTM(2,3)
R9		DSTUFF		equivalent of DDPTM(3,3)
S(3)		TEMPVS#17	SETUP1	
SCALE(5)		ABDATA		scale factor from geometric volume to airbag volume
SD1		DSTUFF		square of distance from point 1 to point 2 of panel
SD2		DSTUFF		distance from point 1 to point 2 of panel
SEG(22)		TITLES		names of the segments, abbreviated
SEGLA(3,22)		SGMNTS		components of segment acceleration
SEGLP(3,22)	3-2-1	SGMNTS		components of segment positions
SEGLV(3,22)	3-2-1	SGMNTS		components of segment velocities
SF1	11-1-2		PLELP	
SF2	11-1-2		PLELP	
SF3	11-1-2		PLELP	
SGTEST(3,4,22)		INTEST		segment covergence test parameters
SH(3)		TEMPVS#8	EJOINT	
SM(3,3)		TEMPVS#7	DAUX12,22	
SN(3,3)		TEMPVS#7	DAUX12,22	

Table 39 SYMBOL DICTIONARY (38 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
SPRING(5,63)		DESCRP		spring characteristics for joints
SPRK(5)		ABDATA		spring constant for airbag attachment relation
SQQ(12)	9-1-1	CSTRNT		R term for each constraint
SQS1		TEMPVS#17	SETUP2	
SR(3,42)		DESCRP		joint locations in local reference of adjacent segments from Card B.3
SS1		DSTUFF		square of normalization factor for panel
SS2		DSTUFF		time derivate of square of normalization factor for panel plane
SS3		DSTUFF		normalization factor for panel plane
SWITCH(5)		ABDATA		reciprocal density of airbag at time of initial full inflation
S1		TEMPVS#17	SETUP1,SETUP2	
S2		TEMPVS#17	SETUP1,SETUP2	
S3		TEMPVS#17	SETUP2	
S4		TEMPVS#17	SETUP2	
T(3)		TEMPVS#12	INITAL	
T(3)		TEMPVS#15	PLSEGF	
T(3)		TEMPVS#17	SETUP1,SETUP2	
T(5)		TEMPVS#9	EQUILB	

Table 39 SYMBOL DICTIONARY (39 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
TA(3)		TEMPVS#2	BELTG	vector to belt fixed point from belt anchor A
TAB(2000)		TABLES		main table storage array
TB(3)		TEMPVS#2	BELTG	vector to belt fixed point from belt anchor B
TC(3)		TEMPVS#2	BELTG	normalized vector of belt plane determined by anchor points and fixed point
TCUR	21 3-2-1,5-1-1 5-2-1,10-1-1 11-1-1,12-1-1	CONTRL		time of current evaluation
TDEL	13-1-1,14-1-1	SHRCMB		total deflection
TDELD	13-1-1,14-1-1	SHRCMB		total deflection rate
TDELDP		SHRCMC		previous value of total deflection rate
TDELP		SHRCMC		previous value of total deflection
TDV	7-1-1		IMPULS	
TE	5-2-1		DINT	sum of squares of absolute error
TEMP(3)		TEMPVS#5	CHAIN	
TEMP(3)		TEMPVS#9	EQUILB	
TEMP(3)		TEMPVS#16	PRIPLT	
TEMP(3,3)		TEMPVS#1	BGG	partial result in conversion of surface ellipsoid to airbag system
TEMP(3)		TEMPVS#15	SEGSEG	

Table 39 SYMBOL DICTIONARY (40 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
TEMP1(3)		TEMPVS#5	CHAIN	
TEMP1(3)		TEMPVS#16	PRIPLT	
TEMP2(3)		TEMPVS#5	CHAIN	
TEMP2(3)		TEMPVS#16	PRIPLT	
TEMP3(3)		TEMPVS#5	CHAIN	
TEN		TEMPVS#4	BLKDTA	constant with a value of ten
TF		TEMPVS#15	PLSEGF	
TH(3,3)		TEMPVS#8	EJOINT	direction cosines of distol side of joint from proximal side of joint
THA(3)		TEMPVS#10	FLXSEG	
THAD(3)		TEMPVS#10	FLXSEG	
THADEG(3)		TEMPVS#10	FLXSEG	
THET(3)		TEMPVS#20	VINPUT	incremental angular motion of vehicle motion
THEXL		RSTUFF		latest time at which debug switch settings have been changed
THIRD		CNSNTS		constant with a value of one third
THN(4)		TEMPVS#10	FLXSEG	
THND(4)		TEMPVS#10	FLXSEG	
THREE		TEMPVS#4	BLKDTA	constant with a value of three
TIME		VPOSTN		current simulated time in run

Table 39 SYMBOL DICTIONARY (41 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
TIMFIR		IRBASE		initial time of this run
TIMHEX(9)		RSTUFF		times at which debug switch settings are to be changed
TIMLAS		IRBASE		final time of this run in user's time units
TJ(3)		TEMPVS#8	EJOINT	
TM(3)		TEMPVS#8	EJOINT	
TM(3)	11-3-1	TEMPVS#15	PLELP,PLSEGF,SEGSEG	
TMP		SHRCMC		
TMP(9)		TEMPVS#1	AIRBAG,AIRBFF,AIRBG1, ARBG3	temporary storage in airbag calculation
TMP1(3)		TEMPVS#1	AIRBAG	temporary storage in airbag calculation
TMP1(3,3)		TEMPVS#3	BINPUT	temporary storage for joint direction cosine w.r.t. proximal
TMP2(3,3)		TEMPVS#3	BINPUT	temporary storage for joint direction cosine w.r.t. distol
TOP	14-1-3		SHARED	upper value of the valid interval in shared deflection
TOPD	14-2-1	SHRCME		upper value of the valid interval in shared deflection
TOPR	14-2-1	SHRCME		upper value of the valid interval in deflection rate in shared deflection
TORA(3,5)	1-1-1	TEMPVS#1	AIRBAG,AIRBGG	total torques acting on airbag

Table 39 SYMBOL DICTIONARY (42 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
TORQ(3)	1-1-1	TEMPVS#1	AIRBAG,AIRBGG	components of torque on airbag in airbag reference system
TOTF(3)		TEMPVS#19	SPDAMP	components of force of a spring-damper
TPRINT	5-1-1	CDINT		next time point value at which results will be printed
TPTS(6,8)		CNTSRF		belt tangent points coordinates in inertial reference
TQ(3,21)	10-1-1	CMATRX		torques acting on joints
TQB(3,0)	1-1-1	TEMPVS#1	AIRBAG,AIRBGG	components of torque on contact surface in its local preference system for airbags
TQC		TEMPVS#21	VISPR	
TQE(3,21)		CEULER		
TQM(3)	11-2-4	TEMPVS#15	PLELP,PLSEGF	
TQN(3)	11-2-4	TEMPVS#15	PLELP,PLSEGF	
TQNT(3)		TEMPVS#15	PLSEGF	
TQQ(3,12)	9-1-1	CSTRNT		normal vector at point of contact for each constraint
TSTART		CDINT		starting time
TT	5-2-1		DINT	sum of squares of rate of change
TT(3,3)		TEMPVS#10	FLXSEG	
TTI(3)	7-1-2	TEMPVI		value of U1 array for impulse

Table 39 SYMBOL DICTIONARY (43 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
TT1(3,3)		TEMPVS#17	SETUP2	
TT2(3,3)		TEMPVS#17	SETUP2	
TT4(3,4)		TEMPVS#15	SEGSEG	
TT5(3,4)		TEMPVS#15	SEGSEG	
TVREL	7-1-2		IMPULS	
TV1(3,4,5)		ABDATA		partial results for intersection/penetration for each vehicle panel-airbag combination
TV2(3,10,5)		ABDATA		partial results for intersection/penetration for each body contact-airbag combination
TY	5-2-1		DINT	sum of squares of relative error
T1(3)		TEMPVS#1	BGG	angular velocity component for airbag in airbag system
T1(3)		TEMPVS#13	OUTPUT	
T1(3)		TEMPVS#15	SEGSEG	
T1(3)		TEMPVS#17	SETUP2	
TL(3)		TEMPVS#19	SPDAMP	
T10(3)		TEMPVS#17	SETUP2	
T11(3)		TEMPVS#17	SETUP2	
T2(3)		TEMPVS#1	BGG	relative velocity between contact surface and airbag ellipsoid centers in airbag system

Table 39 SYMBOL DICTIONARY (44 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
T2(3)		TEMPVS#13	OUTPUT	
T2(3)		TEMPVS#15	SEGSEG	
T2(3)		TEMPVS#17	SETUP2	
T2(3)		TEMPVS#19	SPDAMP	
T3(3)		TEMPVS#1	BGG	angular velocity components for contact surface in contact surface system
T3(3)		TEMPVS#13	OUTPUT	
T3(3)		TEMPVS#15	SEGSEG	
T3(3)		TEMPVS#17	SETUP2	
T3(3)		TEMPVS#19	SPDAMP	
T3(3)		TEMPVS#21	VISPR	
T4(3)		TEMPVS#1	BGG	angular velocity components for contact surface in airbag system
T4(3)		TEMPVS#13	OUTPUT	
T4(3)		TEMPVS#15	SEGSEG	
T4(3)		TEMPVS#17	SETUP2	
T4(3)		TEMPVS#19	SPDAMP	
T5(3)		TEMPVS#1	BGG	
T5(3)		TEMPVS#17	SETUP2	
T5(3)		TEMPVS#19	SPDAMP	

Table 39 SYMBOL DICTIONARY (45 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
T6(3)		TEMPVS#1	BGG	
T6(3)		TEMPVS#17	SETUP2	
T6(3)		TEMPVS#19	SPDAMP	
T6(3)		TEMPVS#21	VISPR	
T7(3)		TEMPVS#17	SETUP2	
T7(3)		TEMPVS#19	SPDAMP	
T7(3)	10-1-1	TEMPVS#21	VISPR	
T8(3)		TEMPVS#17	SETUP2	
T8(3)		TEMPVS#19	SPDAMP	
T8(3)		TEMPVS#21	VISPR	
T9(3)		TEMPVS#8	EJOINT	
T9(3)		TEMPVS#17	SETUP2	
T9(3)		TEMPVS#21	VISPR	
U(5,240)		CDINT		integration variable storage
UAA	2-1-1	TEMPVS#2	BELTG,BELTRT	belt length from tangent point to first anchor point
UBB	2-1-1	TEMPVS#2	BELTG,BELTRT	belt length from tangent point to second anchor point
UC(3)		TEMPVS#2	BELTG	unit vector in direction of belt plane ellipse center from ellipsoid center

Table 39 SYMBOL DICTIONARY (46 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
UNITF		CNSNTS		user's unit of force
UNITL		CNSNTS		user's unit of length
UNITT		CNSNTS		user's unit of time
UP(3)		TEMPVS#2	BELTG	unit vector in belt plane at right angles to UC(3)
UU(4)		FLECK		
UVA(3)	2-1-1	TEMPVS#2	BELTG,BELTRT	unit vector from tangent point to first anchor point
UVB(3)	2-1-1	TEMPVS#2	BELTG,BELTRT	unit vector from tangent point to second anchor point
U1(3,22)		SGMNTS		total external forces on each segment
U2(3,22)	8-1-1	SGMNTS		total external torques on each segment
U7		DSTUFF		unit vector in panel z from ellipsoid x
U8		DSTUFF		unit vector in panel z from ellipsoid y
U9		DSTUFF		unit vector in panel z from ellipsoid z
VAR(240)		COMAIN		values of integration variables
VATAB(6,101)		VPOSTN		vehicle deceleration tables for six degrees of freedom
VBAG(5)		ABDATA		airbag volume
VBAGG(5)		ABDATA		geometric volume of fully inflated airbag
VIPS		TEMPVS#20	VINPUT	initial velocity of vehicle presumed in/sec

Table 39 SYMBOL DICTIONARY (47 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
VISC(7,63)		DESCRP		viscous characteristics for joints
VLM(3)		TEMPVS#1	BGG	estimates of volume based on radii of curvature and penetration
VMEG(3)		TEMPVS#20	VINPUT	current angular velocity of vehicle in vehicle reference
VMEGD(3)		TEMPVS#20	VINPUT	time derivative of VMEG(3) except w.r.t. inertial
VMN(3)		TEMPVS#15	PLSEGF	
VOL(10)	1-1-1	TEMPVS#1	AIRBAG,AIRBGG	volume of intersection of reaction panel ellipsoid and airbag
VOLBP(5)	1-1-1	ABDATA		total volume of intersection on airbag with contacting segments and panels
VOLP(4,5)	1-1-1	TEMPVS#1	AIRBAG,AIRBGG	volume of intersection of reaction panel ellipsoid and airbag
VPSTTL(18)		TITLES		descriptive title for the vehicle deceleration
VP2(3)	12-2-1		BLDEFL	panel point 2 velocity vector relative panel
VP3(3)	12-2-1		BLDEFL	panel point 3 velocity vector relative panel
VR(3)		TEMPVS#15	PLSEGF,SEGSEG	
VREL(3)		TEMPVS#15	PLSEGF,SEGSEG	
VREL(3)	7-1-2		IMPULS	
VRM		TEMPVS#15	PLSEGF,SEGSEG	
VRT		TEMPVS#15	PLSEGF	

Table 39 SYMBOL DICTIONARY (48 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
VRTEST		TEMPVS#15	PLSEGF	
VSCS(5)		ABDATA		coefficient of sliding friction for airbags
VTIME		VPOSTN		time duration of the deceleration impulse, for half sine-wave type
VXT(3)		TEMPVS#14	PDAUX	
VXO		DSTUFF		x component of ellipsoid center velocity in panel system
VYO		DSTUFF		y component of ellipsoid center velocity in panel system
VZO		DSTUFF		z component of ellipsoid center velocity in panel system
V1(3,21)	8-1-2	CMATRX		r.h.s. of $B_{11}\ddot{x}+B_{12}\dot{\omega}+B_{13}f=V_1$
V2(3,21)		CMATRX		r.h.s. of $B_{22}\ddot{x}+B_{24}t=V_2$
V3(3,12)		CMATRX		r.h.s. of $B_{31}\ddot{x}+B_{32}\dot{\omega}+B^{q}=V_3$
V4(3,8)		FLXBLE		components of torques from flexible segments
W(22)		DESCRP		masses of segments, vehicle and airbags
WCM(3)		TEMPVS#15	PLSEGF	
WCM(3)		TEMPVS#17	SETUP2	
WCN(3)		TEMPVS#15	PLSEGF	
WCN(3)		TEMPVS#17	SETUP2	

Table 39 SYMBOL DICTIONARY (49 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
WCRM(3)		TEMPVS#17	SETUP2	
WCRN(3)		TEMPVS#17	SETUP2	
WCSN(3)		TEMPVS#10	FLXSEG	
WIJ(3)	10-1-1	TEMPVS#21	VISPR	
WIJM		TEMPVS#21	VISPR	
WJ(21)		CMATRX		relative angular velocity for each joint
WMEG(3,22)		SGMNTS		segment angular velocity in local reference
WMEGD(3,22)		SGMNTS		segment angular acceleration in local reference
WMGDEG(3,22)		TEMPVS#12	INITAL	initial components of angular body velocity in degrees/sec.
WMJ(3)		TEMPVS#8	EJOINT	
WMN(3)		TEMPVS#15	PLSEGF,SEGSEG	
WNM1(3)		TEMPVS#10	FLXSEG	
WWCM(3)		TEMPVS#17	SETUP2	
WWCN(3)		TEMPVS#17	SETUP2	
WWM(3)		TEMPVS#17	SETUP2	
WWN(3)		TEMPVS#17	SETUP2	
X	14-1-12		INTERL	first variable value to interpolate bivariant table

Table 39 SYMBOL DICTIONARY (50 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
XA(3)	6-1-1		EDEPTH	coordinates of point of maximum penetration in local reference system of first ellipsoid
XACOMP(3)		TEMPVS#20	VINPUT	current linear acceleration of vehicle in inertial reference
XB(3)	6-1-1		EDEPTH	coordinates of point of maximum penetration in local reference system of second ellipsoid
XCORNR(2,2)	14-1-12		INTERL	coordinates of corner points of box for interpolation
XDELD		DSTUFF		time derivative of XDELTA
XDELTA		DSTUFF		x coordinate of contact point in panel system
XDOTO(3)		TEMPVS#20	VINPUT	components of initial vehicle velocity
XE(3)		TEMPVS#2	BELTG	center of belt plane ellipse
XL	6-1-1		EDEPTH	
XLMDA		DSTUFF		maximum of ellipsoid semiaxis lengths
XMM(3)		TEMPVS#15	SEGSEG	
XMN(3)		TEMPVS#15	SEGSEG	
XSG(3,20,3)		RSAVE		coordinates of points for the various types of time history output
XTEST(264) or (3,88)	5-2-1	INTEST		integration convergence test quantities

Table 39 SYMBOL DICTIONARY (51 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
XU	6-1-1		EDEPTH	
XXO	11-1-1,1*		PLELP	ellipsoid center x-coordinate in panel system at time of first contact
XY(3)	11-2-3		PLELP	X1, X2, Y2 respectively
XO	11-2-3	DSTUFF		x-coordinate of ellipsoid center in planar panel system
XO(3)		TEMPVS#20	VINPUT	initial coordinates of vehicle reference origin in inertial reference
X1	11-2-3	DSTUFF		x-coordinate of second corner point of planar panel
X1D		DSTUFF		velocity of X1
X2	11-2-3	DSTUFF		x-coordinate of third corner point of planar panel
Y	14-1-12		INTERL	second variable value to interpolate bivariant tables
Y(3)	11-3-1		PLELP	
Y(3)		TEMPVS#1	BGG	point of intersection between contact surface and airbag ellipsoids
Y(5,240)		CDINT		integration variable storage
YD(3)	11-3-1		PLELP	
YDELD		DSTUFF		time derivate of YDELTA
YDELTA		DSTUFF		y coordinate of contact point in panel system

Table 39 SYMBOL DICTIONARY (52 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
YDTM(3)	11-3-1		PLELP	
YFA(3)		TEMPVS#1	BGG	
YFB(3)		TEMPVS#1	BGG	
YM(3)	11-3-1		PLELP	
YN(3)	11-3-1		PLELP	
YPR1(3,21)		TEMPVS#3	BINPUT	angles specifying principle axes of joints in local reference system of proximal segment
YPR2(3,21)		TEMPVS#3	BINPUT	angles specifying princple axes of joints in local reference system of distal segment
YPR3(3,21)		TEMPVS#3	BINPUT	angles of center of symmetry, for euler joints only
YYO	11-1-1,1*		PLELP	ellipsoid center y-coordinate in panel system at time of first contact
YO	11-2-3	DSTUFF		y-coordinate of ellipsoid center in planar panel system
Y2	11-2-3	DSTUFF		y-coordinate of third point of planar panel
Y2D		DSTUFF		velocity of Y2
Z	14-3-1		SLVGEN	independent variable of equation being solved
ZA(3)		TEMPVS#2	BELTG	anchor point coordinates of first end of belt relative to ellipsoid center
ZB(3)		TEMPVS#2	BELTG	anchor point coordinates of second end of belt relative to ellipsoid center

Table 39 SYMBOL DICTIONARY (53 of 53)

ITEM	IFATAL or debug ID	COMMON	ROUTINE(S)	DEFINITION
ZBB(3)		TEMPVS#1	BGG	vector to maximum penetration relative to contact surface system
ZDELD		DSTUFF		time derivative of ZDELTA
ZDELTA		DSTUFF		z coordinate of contact point in panel system
ZDEP(3,5)		ABDATA		coordinates of airbag deployment point in reference system of first panel
ZERO		TEMPVS#4	BLKDTA	constant with a value of zero
ZPLT(3)		VPOSTN		plot coordinates of the vehicle reference origin
ZR(3,4,5)		ABDATA		coordinates of centers of gravity of panels for airbags
ZO	11-2-3	DSTUFF		z-coordinate of ellipsoid center in planar panel system

4.0 OUTPUT FROM CVS (DETAILED DESCRIPTION)

This section is somewhat parallel to Section 3.0 of Volume II and fills in the details which Volume II left out.

4.1 Debugging Printout and Error Messages

Debugging printout for the CVS is organized in terms of sixteen four-level switches. Each switch corresponds to a particular section of the program. The levels of a particular switch control the depth of detail of the debugging printout from the section of the program which the swtich covers. High levels of a switch include all the printout from lower levels from the switch.

The four levels are represented by integers zero through three. Zero represents no debugging printout, and higher levels are represented by larger integers as described in Table 40.

TABLE 40. DEBUG SWITCH DEFINITION

0	= summary output only
1	= primary debugging information such as forces
2	= secondary debugging information such as the contributions to the generalized force vector of each force component
3	= tertiary debugging information to allow a detailed inspection of the inner workings of the program

To avoid needless volume of printing, each of the sixteen switches is allowed to vary in level as a function of simulated time (at up to eight time points) during a run of the program. In order to avoid inputting sixteen separate tables of debug level versus effective time, advantage is taken of the binary characteristics of the IBM 370 computer. The four levels of a debugging switch can be represented by two binary bits. The possibilities for all sixteen switches can then be represented by thirty-two bits. Eight hexadecimal digits also represent thirty-two bits. Hence, debugging control is achieved by use of a table of eight hexadecimal digit control words versus effective time. When any or all of the switches are

to change level, a new control word in the table is needed. The switches correspond to groups of two bits from the left of the word, i.e., switch one is controlled by the left-most two bits, switch two by the next two, and so on. The switch will take on the specified level at the first time step equal to or greater than the effective time specified.

As an example setup of the hexadecimal debugging control word, consider the case where printout of the quantity "XY", the position of panel, is desired. This is specified under debug switch 11, debug level 3. As each digit* of the hexadecimal word covers two debug switches, this printout will be covered by the first two bits of the sixth digit. Because no special printout is desired from debug switch 12, the last two bits of the sixth hexadecimal digit must be "00". Because the desired debug level is 3, the first two bits of the sixth digit must be "11". Therefore, the sixth digit takes on the value "1100" or "C". Thus, the hexadecimal word will be "00000C00" at the effective time.

The table of effective times and control words is specified to the program by means of Cards A.6.A and A.6.B. The total span of simulated time for the run should be covered by effective times of control words if these cards are used at all.

The user is warned that the volume of printout can be startling huge and hence utmost discretion must be exercised in the use of this feature.

Table 41 contains a detailed list of the sixteen debug switches and the quantities which will be printed for each debug level of each switch. Table 41 should be used in conjunction with the Symbol Dictionary (see Section 3.3, Table 39) and in some cases the listing of the program.

Each line in Table 41 corresponds to one line in the printed output so this table can be used to identify individual quantities.

Under the column entitled "Contents" there appears a facsimile of each output line including the line identification and showing the Fortran name for each printed quantity. The name of the subroutine from which this printout is made is given in the column labeled "Routine".

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*Base 16 digits are 0 to 9 plus A to F.

These printouts are organized on ID Number which consists of debug switch, level, and number of printout at that level hyphenated.

Error messages produced by the CVS are shown in Table 42 which is self-explanatory.

Table 41 DEBUGGING PRINTOUT LAYOUT (1 of 8)

Debug ID	Routine	Contents
(1-1-1)	AIRBAG	FRB(1-3,1) TQB(1-3,1) ... FRB(1-3,KBAG) TQB(1-3,KBAG) Nine values to a line. FORCE(1-3,J) TORA(1-3,J) TORQ(1-3) FRA(1-3,1) VOLP(1,J) - FRA(1-3,KP) VOLP(KP,J) VOL(1-KBAG) VOLBP(J) CYMOUT(J) BAGPV(J) PD(J) for J=1-NBAG where KBAG=MNBAG(J) KP=NPANEL(J) and spacing depends on these values.
(2-1-1)	BELTG	APA(1-3) UVA(1-3) DLGA UAA APB(1-3) UVB(1-3) DLGB UBB BELT(12-17)
(3-1-1)	PRIPLT	CJOINT(1-3,1) - - - - - - - - CJOINT(1-3,3) CJOINT(1-3,4) - - - - - - - CJOINT(1-3,NJNT)
(3-2-1)	CHAIN	LINEAR POSITIONS AND VELOCITIES OF BODY SEGMENTS FROM CHAIN FOR TIME = TCUR SEGLP(1-3,1) - - - - - - - - - SEGLP(1-3,3) SEGLP(1-3,4) - - - - - - - - SEGLP(1-3,NSEG) SEGLV(1-3,1) - - - - - - - - - SEGLV(1-3,3) SEGLV(1-3,4) - - - - - - - - SEGLV(1-3,NSEG)

Table 41 DEBUGGING PRINTOUT LAYOUT (2 of 8)

Debug ID	Routine	Contents
(4-1-1)	DAUX	DAUX PRINT OF IJK MATRIX 1 2 3 - - - - - - - - - - - - - - NJ2 1 IJK(1,1) - - - - - - - - - - - - IJK(1,NJ2) ⋮ ⋮ ⋮ NJ2 IJK(NJ2,1) - - - - - - - - - - IJK(NJ2,NJ2) DAUX PRINT OF RHS ARRAY 1 RHS(1,1) RHS(2,1) - - - - - - - - ⋮ ⋮ NJ2 RHS(1,NJ2) RHS(3,NJ2) - - - - - - - - DAUX PRINT OF C ARRAY ELEMENTS 1 C(1,1,1) C(1,2,1) C(1,3,1)- - - C(3,1,1) C(3,2,1) C(3,3,1) ⋮ IJ C(1,1,IJ) - - - - - - - - - - C(3,3,IJ)
(5-1-1)	DINT	HALVE TCUR TPRINT HS H HPRINT FAIL K ICNT (when time step halved)
(5-1-2)	DINT	WHOLE } same when time step same or doubled DOUBL } ie ICNT ≥ IDBL

Table 41 DEBUGGING PRINTOUT LAYOUT (3 of 8)

Debug ID	Routine	Contents
(5-2-1)	DINT	DINT CONV. TEST TCUR II TT TE TY XTEST(II-II+2)
(6-1-1)	EDEPTH	ITER XL XU XA(1-3) XB(1-3)
(7-1-1)	IMPULS	CALL PRINT (6HPREIMP) R1I(1-3) R2I(1-3)
(7-1-2)	IMPULS	DWR1(1-3) DWR2(1-3) DWR3(1-3) DWR4(1-3) TTI(1-3) VREL(1-3) DV(1-3) TVREL TDV CREST ALPHA CALL OUTPUT(1)
(8-1-1)	SETUP1	U2(1-3,1) - - - - - - - - - - - - U2(1-3,3) U2(1-3,4) - - - - - - - - - - - U2(1-3,NSEG)
(8-1-2)	SETUP1	V1(1-3,1) - - - - - - - - - - - - V1(1-3,3) V1(1-3,4) - - - - - - - - - - - V1(1-3,NJNT)

Table 41 DEBUGGING PRINTOUT LAYOUT (4 of 8)

Debug ID	Routine	Contents
(9-1-1)	UPDATE	UPDATE ROLL-SLIDE TEST KQTYPE(K) KQ1(K) KQ2(K) RK1(1-3,K) RK2(1-3,K) HHT(1,1,K) HHT(1,2,K) - - - - - - - - HHT(3,3,K) QQ(1-3,K) TQQ(1-3,K) RQQ(1-3,K) HQQ(1-3,K) SQQ(K) CFQQ(K) QN for K=1, NQ where KQTYPE(K)=3 or 4 and CFQQ $\geq$ 0.
(10-1-1)	VISPR	VISPR COMPUTATIONS FOR TIME = TCUR J CV CSA CSB HAC RA RB WIJ(1-3) T7(1-3) TQ(1-3,J) ANGL(1-3) D+L1(1-3,1-3)HD3(1-3,1-3) for J=NJ if NJ≠0 1-NJNT if NJ=0
11-1-1	PLELP	TCUR KELLP KPAN KACT M N ETAS ETASB ETASE XXO YYO IPICP
11-1-2	PLELP	KACT DELTA DELDOT DELBAR DOTBAR SF1 SF2 SF3 F1 F2 F3 FN FT
11-2-1	PLELP	DMNT(1,1) - - - - - - - - - - - - DMNT(3,3)
11-2-2	PLELP	P1(1) P1D(1) P2(1) P2D(1) P3(1) P3D(1) P1(2) P1D(2) P2(2) P2D(2) P3(2) P3D(2) P1(3) P1D(3) P2(3) P2D(3) P3(3) P3D(3)
11-2-3	PLELP	X1= XY(1) PL(1) PLD(1) DPTG(1,1-3) ELCP(1)= XO X2= XY(2) PL(2) PLD(2) DPTG(2,1-3) ELCP(2)= YO Y2= XY(3) PL(3) PLD(3) DPTG(3,1-3) ELCP(3)= ZO

Table 41 DEBUGGING PRINTOUT LAYOUT (5 of 8)

Debug ID	Routine	Contents
11-2-4	PLELP	HIT(1) HITD(1) FR(1) TQM(1) TQN(1) HIT(2) HITD(2) FR(2) TQM(2) TQN(2) HIT(3) HITD(3) FR(3) TQM(3) TQN(3)
11-3-1	PLELP	Y(1) YD(1) TM(1) YDTM(1) YM(1) FFM(1) YN(1) FFN(1) Y(2) YD(2) TM(2) YDTM(2) YM(2) FFM(2) YN(2) FFN(2) Y(3) YD(3) TM(3) YDTM(3) YM(3) FFM(3) YN(3) FFN(3)
11-1-1*	PLELP	ETAE ETAS ETASB ETASE XXO yyO FMAX
12-1-1	BLDEFL	TCUR NEDGE EDGE(1-8)
12-2-1	BLDEFL	DPTGD(1,1-3) POD(1) CENT M(1) VP2(1) VP3(1) DPTGD(2,1-3) POD(2) CENT M(2) VP2(2) VP3(2) DPTGD(3,1-3) POD(3) CENT M(3) VP2(3) VP3(3)
13-1-1	LODFEL	TCUR KFPD1 KFPD2 KACT INACT KSHAR TDEL TDELD
13-1-2	LODFEL	RQ(KACTO→KACTO+3) FN FT FTF FTS

Table 41 DEBUGGING PRINTOUT LAYOUT (6 of 8)

Debug ID	Routine	Contents
14-1-1	SHARET	TCUR TDEL TDELD LODSWT
14-1-2	SHARET	D(1) DD(1) FOR(1)
14-1-3	SHARED	BOT TOP LORDER LSWT
14-1-4	SHARED	IFIT D(1) D(4) DD(1) DD(4) FF PFD(1) PFD(4) PFDD(1) PFDD(4)
14-1-5	SHAREL	KACTO KACTR TCUR TDEL TDELD
14-1-6	SHAREL	D(1) D(4) DD(1) DD(4) FOR(1) FORG DIFFOR
14-1-7	SHAREG	IAO TCUR TIME TMP PFDP TDELP TDELDP PFDDP
14-1-8	SHAREG	NCOUNT LIMCNT ICT D(ICT) DD(ICT) FOR(ICT)
14-1-9	SHAREM	(upon entry)
14-1-10	SHAREM	NCOUNT LIMCNT ICT D(ICT) DD(ICT) FOR(ICT)
14-1-11	PHITAB	TCUR NBIVTK L

Table 41 DEBUGGING PRINTOUT LAYOUT (7 of 8)

Debug ID	Routine	Contents
14-1-12	INTERL	XCORNR(1-2, 1-2) FNEAR(1-4) DELTA(1-2) X Y F FNEAR(1-4)
14-2-1	SHARET	K1 K2 FZERO GZERO F(1)..F(5) F(6).....F(13) F(14).....F(21) F(22).....F(27) G(1) G(2) G(3).....G(10) G(11).....G(18) G(12).....G(26) G(27) BOTD TOPD BOTR TOPR
14-2-2	SHAREG	NCOUNT IA IB IC DFORE(1-3) DLPD(1-3) DLPDD(1-2) DLPDD(3) D(1-6) DP(1) DP(2) DD(1-6) DDP(1) DDP(2)
14-2-3	SHAREM	IC D(1) DD(1) FOR(1) D(4) DD(4) FOR(4) DFORE(1) DLPD(1) *or* IC D(2) DD(2) FOR(2) D(5) DD(5) FOR(5) DFORE(2) DLPD(2) *or* IC D(IC) DD(IC) FOR(IC) D(JC) DD(JC) FOR(IC+3) DFORE(IC) DFORE(IIA) *or* IC D(IC) DD(IC) FOR(IC) D(JC) DD(JC) FOR(IC+3) DFORE(IC) DLPD(IC)
14-2-4	INTERL	LINDEX IQ(LINDEX→LINDEX+9)
14-2-5	PHITAB	KZ NBL KUZ KUF or KD1 KD2 KR1 KR3 KF1 KF2 KF3 KBD KBR KBF or X1 R1 F1 X2 R2 F2 X3 R3 F3 TSD

Table 41 DEBUGGING PRINTOUT LAYOUT (8 of 8)

Debug ID	Routine	Contents
14-3-1	SLVGEN	I P DERP Z
15-1-1	FOEVAL	KMATL KKI KKIP KKR KKRP KALGOR DEL DELD
15-1-2	FOEVAL	KALGOR FF PPFD PPFDD
15-2-1	NORLOD	KACT KALGOR KPOLTA KMATR FOR PFD PFDD
16-1-1	SETACT	TCUR KFP1 KFP2 NUMACT KACSWT
16-1-2	SETACT	KACT KKK IQ(KACT→KACT+11)
16-1-3	PUSHER	TCUR IDIR NUM IBEG KUSE KNEND LIMIT
16-2-1	PDAUX→QBUG	IQ(1-IUSEIQ)
16-2-2	PDAUX→QBUG	RQ(1-IUSERQ)

Table 42 ERROR MESSAGES (1 of 4)

IFATAL	Routine	Message
1	SINPUT	FATAL ERROR---DUPLICATE PANEL NUMBER_____ON CARD_____NUMBER_____
2	SINPUT	FATAL ERROR---TIME POINTS NOT IN SEQUENCE FOR PANEL_____ON CARD_____NUMBER_____
3	SINPUT	FATAL ERROR---TIME POINTS DO NOT SPAN RUN TIMES FOR PANEL_____ON CARD___NUMBER_____
4	SINPUT	FATAL ERROR---ELLIPSOIDS OUT OF SEQUENCE ON BODY SEGMENT FOR ELLIPSOID_____ _____ ON CARD_____NUMBER_____
5	SINPUT	FATAL ERROR---TWO TIME POINTS AT SAME TIME FOR PANEL_____ON CARD_____NUMBER
6	MAINPG	FATAL ERROR---ELLIPSE REFERENCES WRONG SEGMENT_____ _____
7	BINPUT	INPUT ERROR ON CARD B. 7. J, SEGMENT NO._____IS NOT AN INTERIOR SEGMENT OF A FLEXIBLE ELEMENT FROM DATA ON CARDS B.3. PROGRAM TERMINATED
8	BINPUT	ERROR IN DEFINING FLEXIBLE SEGMENTS, ONLY ONE NEGATIVE JNT IN STRING. PROGRAM TERMINATED
9	LODFEL	FATAL ERROR---SHARED DEFLECTION FAILS TO CONVERGE. _____ _____
10	PUSHER	FATAL ERROR---STORAGE ARRAY EXCEEDED _____ _____ _____ _____ _____
11	BINPUT	FATAL ERROR---TOO MANY INTERIOR SEGMENTS OF FLEXIBLE ELEMENTS = _____
12	AIRBG1, BINPUT, BIVIN, CINPUT, EQUILB, FINPUT, INITAL, MAINPG, OUTPUT, RSTART, SINPUT, VINPUT	HAVE CARD_____(NUMBER_____) EXPECTED CARD_____(NUMBER_____)

Table 42 ERROR MESSAGES (2 of 4)

IFATAL	Routine	Message
13	BIVIN	TOO MANY MATERIAL SPECIFICATIONS
14	BINPUT	INPUT ERROR ON CARD B.7.A, NFX = _____ BUT NFLX = _____ AS COMPUTED FROM CARDS B.3. PROGRAM TERMINATED
15	FINPUT	FATAL ERROR---ELLIPSOID_____HAS NOT BEEN DEFINED FROM CARD_____
16	FINPUT	FATAL ERROR---NUMBER OF ALLOWED CONTACTS NOT FOUND, _____, FOR ELLIPSOID_____ FROM CARD _____
17	FINPUT	ERROR IN SUBROUTINE CINPUT, SIZE OF TAB ARRAY = _____ PROGRAM TERMINATED.
18	FINPUT	FUNCTION NO. _____ HAS NOT BEEN DEFINED. PROGRAM TERMINATED.
19	FINPUT	FATAL ERROR---ELLIPSOID INDICES DO NOT MATCH. _____ _____ FROM CARD _____.
20	PHITAB	FATAL ERROR---RANDOM TABLE NOT DEFINITIVE _____.
21	PLELP	FATAL ERROR---BAD SYSTEM TRANSFORMATION ___ ____ ___ ___ ___ ____ ____ (7 lines of data)
22	DSMSOL	DSMSOL MATRIX SINGULAR, PROGRAM TERMINATED.
23	FSMSOL	MAXIMUM DIMENSION OF 400 ON C ARRAY HAS BEEN EXCEEDED IN SUBROUTINE FSMSOL. TO CORRECT PROBLEM, REDUCE NUMBER OF CONSTRAINTS OR INCREASE THE 400 DIMENSION ON C IN COMMON/TEMPVS/IN THE DAUX SUBROUTINES AND INCREASE CORE SIZE ACCORDINGLY. PROGRAM IS BEING TERMINATED. COMPLETE PRINT-OUT OF IJK, RHS AND C ARRAYS FOLLOW. FSMSOL PRINT OF IJK MATRIX (data) FSMSOL PRINT OF RHS ARRAY (data) FSMSOL PRINT OF C ARRAY ELEMENTS (data)

Table 42 ERROR MESSAGES (3 of 4)

IFATAL	Routine	Message
24	RSTART	SUBROUTINE RSTART INPUT ERROR AVAR=_____INDEX=_____NCOM=_____ITEM=_____ITYPE=____ RR=_____II=_____AA=_____ PROGRAM IS BEING TERMINATED.
25	IMPULS	IMPROPER ARGUMENTS TO SUBROUTINE IMPULSE ARGUMENTS=_____ PROGRAM TERMINATED
26	EQUILB	INPUT ERROR ON CARD G. _____._____. PROGRAM TERMINATED.
27	AIRBG3	ERROR IN SUBROUTINE AIRBG3 AT TIME _____
28	DAUX	NS=_____, NFLX=_____,NQ=_____,NJNT=_____, AND NJ2=_____ THE VALUE OF NJ2 EXCEEDS THE ARRAY SIZE FOR RHS AND IJK IN SUBROUTINE DAUX. PROGRAM TERMINATED.
29	DINT	PROGRAM TERMINTED, PDAUX NEG SQRT. H HMIN + EPS8.
30	EDEPTH	EDEPTH ITERATION DID NOT CONVERGE
31	VINPUT	FATAL ERROR--MORE THAN 99 POINTS ON C.3 CARDS FOR UNIDIRECTIONAL VEHICLE DECELERATION.
32	AIRBG1, BINPUT, BIVIN, CINPUT, EQUILB, FINPUT, INITAL MAINPG, OUTPUT, RSTART, SINPUT, VINPUT	CONVERSION ERROR READING CARD _____ NUMBER _____
33	AIRBG1, BINPUT, BIVIN, CINPUT, EQUILB, FINPUT, INITAL MAINPG, OUTPUT, RSTART, SINPUT, VINPUT	END OF FILE BEFORE INPUT COMPLETED.

Table 42 ERROR MESSAGES (4 of 4)

IFATAL	Routine	Message
34	FOEVAL	BILINEAR UNLOADING INFLECTION POINT WRONG
35	FOEVAL	BILINEAR UNLOADING SLOPE NEGATIVE
36	PLELP	YDTMAG IS ZERO BUT FT IS NOT IN PLELP.
37	NORLOD	FATAL ERROR---RANDOM TABLE NOT DEFINITIVE. (VIA INTERL)
38	BIVIN	SOME OF THE POINTS OF THE LAST TABLE PROCESSED WERE NOT ALLOCATED TO A BOX.
39	BIVIN	DUPLICATE POINT IN LAST TABLE PROCESSED.
40	BIVIN	TABLE NO. ___ IS SPECIFIED WITH NO DEPENDENCE ON EITHER DEFLECTION OR RATE.
41	SINPUT	SPACE ALLOCATION ERROR-INSUFFICIENT SPACE IN PANEL TABLE OF CONTENTS.
42	SINPUT	DUPLICATE MATERIAL NUMBER.
43	CINPUT	MATERIAL TABLE OF CONENTS NOT FILLED IN.
44	CINPUT	RANDOM TABLE NOT BIVARIATE. _____
45	SHAREM	FATAL ERROR IN SHARE FOR ISWTD.
46	SETACT	FATAL ERROR-IMPOSSIBLE LOADING CURVE. K1 K2

4.2 External Storage of Normal Output

The normal tabular output of the CVS model is stored in an external file during the course of a run and then upon completion is read back in and printed. This external file also serves as input to some postprocessors, particularly the Validation Command Language (VCL). Table 43 contains a record by record specification of this external file. The Symbol Dictionary (Table 39) should be used with this table.

Table 43 BINARY FILE LAYOUT (1 of 3)

Record Number	Contents
1	LINES[I] NT[I]
2	NPSF[I] MBSF[I] NSSF[I] NBAG[I] LPP[I] NRPCAT[I] DDATE(3)[A] DATE(3)[A] UNITL[A] UNITT[A] UNITF[A] LDNPRT[I] NJNT[I] NBLT[I] NPL[I] NSEG[I]
3	NSG(7)[I] BDYTTL(5)[A] MNBLT(8)[I]
4	COMENT(1-20)[A]
5	COMENT(21-40)[A]
6	VPSTTL(20)[A]
6+i;i=1,7	MSG(1-20,i)[I]
14	SEG(1-20)[A]
15	JOINT(1-20)[A]
16	MNSEG(1-20)[I]
16+k,k=i+3*j-3; i=1,3;j=1,5	MSEG(i,j,1-20)[I]
32	MSEG(1-2,1-5,21-22)[I]
33	MSEG(3,1-5,21-22)[I] SEG(21-22)[A] JOINT(21-21)[A]
33+k;k=i+3*j-3; i=1,3;j=1,3	XSG(i,1-10,j)[D]

Table 43 BINARY FILE LAYOUT (2 of 3)

Record Number	Contents
42+k;k=i+3*j-3; i=1,3;j=1,3	XSG(i,11-20,j)[D]
51+i;i=1,8	MBLT(1-3,1-5,i)[I]BLTITL(1-5,i)[A]
60	BAGTTL(1-5,1-4)[A]
61	BAGTTL(1-5,5-6)[A]PHED(5)[D]
61+i;i=1,6	MBAG(1-2,1-10,i)[I]
67+k;k=1,3	MBAG(3,1-10,2k-1-2k)[I]
71	NPANEL(1-6)[I] MNBAG(1-6)[I] LASNRN[I] LASKAT[I] NFLX[I] NATAB[I] NELP[I] NQ[I] NSD[I] KNLTPR[I]
72	KATIND(1,1-15)[I] {final page no. α_i;i=1,15}
73	KATIND(2,1-15)[I] {beg. record no. β_i;i=1,15}
74	NBOPL(1-20)[I]
75	MBOPL(1-20)[I]
76	CONVL[D] CONVF[D] CONVT[D] IUSEIQ[I] IUSERQ[I] KONTL[I] NBIVTC[I] KIACT[I] NLIQ[I] NLRQ[I] KBIQ[I] KBRQ[I]
76+i;i=1, α_o=[(IUSEIQ+19)/20]	IQ(20*i-19 - min(20*i, IUSEIQ))[I]

Table 43 BINARY FILE LAYOUT (3 of 3)

Record Number	Contents
$76+\alpha_o+i$; $i=1,{}^{o}\beta_o=[(IUSERQ+9)/10]$	RQ(10*i-9 - min(10*i,IUSERQ))[D]
$\beta_1=77+\alpha_o+\beta_o$ $\beta_{m_1}=\beta_m-1+NTIMES$ Where actual order of categories is n=1-7, 9, 11-15, 8, 10 m =1-7, 8, 9-13, 14, 15	Recorded in KATIND(2,n) in record 73 above.

Category n	Description
1	Segment Linear Acceleration in Local Coordinates
2	Segment Linear Velocity in Vehicle Coordinates
3	Segment Linear Displacement in Vehicle Coordinates
4	Segment Angular Acceleration in Local Coordinates
5	Segment Angular Velocity in Vehicle Coordinates
6	Segment Angular Displacement in Vehicle Coordinates
7	Joint
8	Plane-Segment Contact Forces
9	Belt Forces
10	Segment-Segment Contact Forces
11-15	Airbag Forces for Airbag 1-5