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MVMA TWO-DIMENSIONAL CRASH VICTIM SIMULATION, VERSION 6

VOLUME 3

The Programmer's Manual

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16. Abstract <p>Volume Three is intended primarily for the professional computer programmer who is responsible for program maintenance and improvements in the MVMA Two-Dimensional Crash Victim Simulator.</p> <p>This volume describes the organization of the computer program into four processors and their interactions. Description of program organization and flow, packing techniques, binary output formats, and auxiliary program output is presented for each of the four processors. Design information concerning certain special output subprocessors is provided. Conversion of the computer program for use on various computer systems is discussed. Little or no such conversion is needed for Version 6.</p> <p>Volume One presents the analytical formulation of the equations describing the crash dynamics. Volume Two presents a detailed description of the input data quantities required by the computer model and the normal output produced.</p> <p>NOTE: Volume 3 contains much obsolete information pertinent only to Version 4 of the MVMA 2-D model. Documentation here pertinent to Version 6, however, is complete in most regards.</p>		
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* PART 4. DETAILED PROGRAM INFORMATION

4.1 Overall Model Organization and Flow

The MVMA Two-Dimensional Crash Victim Simulator is a large and complex computer program which is designed to provide many features with great freedom of choice in election of options, of numbers, of placement, and of movement. This part of the report discusses the model as a computer program describing the concepts employed for organization and storage minimization, followed by a detailed examination of the realization of these concepts. The subsections of this section deal with the overall concepts. The remainder of this part of the report presents the details for each of the four processors into which the program is organized. Each processor is described in terms of program organization and flow, packing techniques, binary output formats, auxiliary program output, and, in some cases, additional sections.

First, a table called "Subprogram Specifications and Appearances" is provided for each of the processors (see Tables 13, 25, 54, 96, and 107). These tables contain a short description of each of the subprograms together with four columns of information about interactions and communication between them. The Flow Sequence is a series of statements about parts of a program which indicate the steps that are taken and in what order and can be considered a flow diagram that has been written out. A flow sequence can be as elaborate as the whole program given step by step in English or as simple as a general description of purpose. In order to facilitate identification of which parts of the program code correspond to each of the flow sequence statements, a "Statement Location" column has been provided. The statement location consists of a range of Fortran statement numbers which include the code which is being described. Often there will be no statement number bounding the code to be discussed. This problem is handled by appending a suffix of "B" or "F" (which means "before" or "following," respectively) to a nearby statement number. "END" designates the physical last statement of the subprogram ("SRT" the first).

The "Commons" column lists in alphabetical order all the labeled commons used for communication between this subprogram and others. The

*NOTE: Volume 3 contains much obsolete information pertinent only to Version 4 of the MVMA 2-D model. Documentation here pertinent to Version 6, however, is complete in most regards. 6/30/88

"Subprograms Called" column lists all the other subprograms in alphabetical order which this one uses, followed by a list of all the library functions used. "Subprograms Calling" lists all the subprograms which call upon this one. The last column lists all the auxiliary output which emanates from this subprogram. A prefix of "DB" (found only in "GO") indicates the debug block number found in Tables 89 to 92. A prefix of "E" indicates the number of the error message in the order found in the respective Error Message Tables (Tables 23, 51, 95, 103, and 119).

Tables are also provided which indicate each of the labeled commons, the subprograms which share it and an indication of the type of information which it contains (Tables 14, 26, 56, 97, and 109).

4.1.1 The Four Processors. The MVMA Two-Dimensional Crash Victim Simulator has been broken into four processors which must be executed in succession for each run. This type of organization was used to reduce the total computer region size required to run the model. Each processor carries out a definite functional step in the execution of the model and loads only the routines required in carrying out its step. Communication between the processors is handled through use of five external files or data sets. Table 12 lists the functions and the communications for each processor. Figure 135 illustrates the flow of information between the four processors and the use of external data sets.

4.1.2 Techniques for Efficient Use of Storage. Since the MVMA Two-Dimensional Model is a large program of over forty thousand source cards and since the storage needs for complicated simulations is possibly immense, it has been a matter of prime importance to minimize necessary storage without reduction of the usefulness of the model by needless constraints on the flexibility inherent in the model. In addition to the use of processors for discrete steps, use has been made of the techniques of "packing" of tables or arrays, dynamic dimensioning of critical arrays, transfer vector routines, and external storage. The remainder of this subsection treats each of these techniques in turn.

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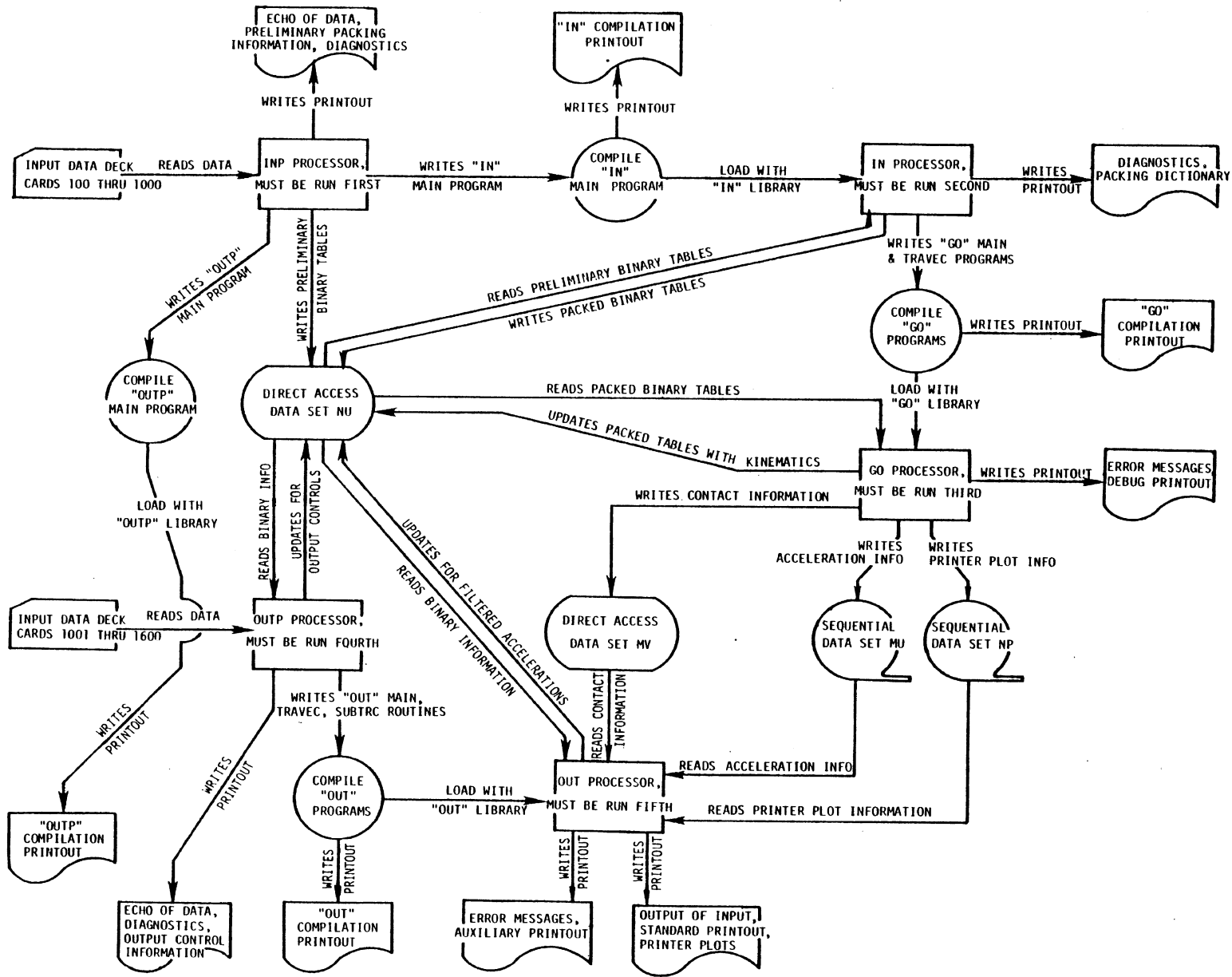
Table 12. The Four Processors

	Processor	General Function
* 1a.	Input Preprocessor (INP)	<ul style="list-style-type: none"> a. Reads data deck cards 100 thru 1000 #b. Makes preliminary counts of optional quantities #c. Writes preliminary binary tables #d. Generates main program for Input Processor
* 1b.	Input Processor (IN)	<ul style="list-style-type: none"> #a. Reads preliminary binary tables and counts b. Creates final counts and produces packed binary tables #c. Generates main program for the Dynamic Solution Processor #d. Generates "transfer vector" routine for the Dynamic Solution Processor e. Writes the packed binary tables
2.	Dynamic Solution Processor (GO)	<ul style="list-style-type: none"> a. Reads the packed binary tables b. Carries out the simulation specified in these tables c. Updates the binary tables for the solutions obtained
3.	Output Preprocessor (OUTP)	<ul style="list-style-type: none"> a. Reads data deck cards 1001 thru 1600 b. Updates binary tables for output controls c. Generates main program for Output Processor #d. Generates "transfer vector" routine for Output Processor
4.	Output Processor (OUT)	<ul style="list-style-type: none"> a. Reads binary tables with output controls b. Updates binary tables for acceleration-dependent quantities c. Writes specified formatted printout of both inputted and computed quantities d. Produces specified comparisons and printer plots

*# In Versions 5 and 6 of MVMA 2-D CVS, "INP" is obsolete. The current INP Processor "IN" has the combined functions of "INP" and "IN" in this table except that functions marked by # are obsolete.

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Figure 135 Overall Model Information Flow



It should be pointed out that the first and last of these techniques were employed in Version Three whereas the second and third are new with Version Four. The Version Four techniques are employed in a manner which is upwards compatible with Version Three. The Version Three user can use the same packing tables as the Version Four user but must ignore the tables describing the placement of the packing tables within the larger structure of Version Four. In the case of the external data sets, only one was modified in Version Four and this by addition of a new section at the front and another at the back of the data set. These changes will be detailed in Section 4.1.2.4. (Versions 5 and 6 are like Version 3.)

4.1.2.1 Packing techniques. The term "packing" is here used to describe a style of free format table organization in which the locations of information in the table(s) are successively stored in the table(s). Thus, such tables contain not only model information, but their own tables of contents as well. Let us begin discussion by defining a few additional terms which will be useful. Any part of any table which is distinguished from the rest of the table is called an "entry." Entries may either be of fixed length, called "fixed entries," or of length dictated by the circumstances, called "variable entries," or "free entries." If one entry contains location information about a second entry, it is referred to as the control section for the second entry. Location information will usually be in the form of the beginning index of the entry in the Fortran array which contains it and will always be so called. If one or more entries are positioned with specific beginning indices within a Fortran array, this group of entries is referred to as the standard area of the Fortran array.

In this model, each table or group of tables contains a standard area which includes control sections which serve as the first link in a chain of control sections which encompass all the information stored in the table or group of tables. This general approach is applied in several ways throughout the model. These applications will be discussed in detail in sections entitled "Packing Techniques" under each of the affected processors (see Sections 4.2.2, 4.3.2, 4.4.3, and 4.5.2).

Specific examples of the use of these descriptions will be found in Appendix A.

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4.1.2.2 Dynamic dimensioning.^{*} The technique discussed in the last section gave Version Three greater flexibility for a fixed amount of storage than would have been available with arrays dimensioned for a fixed number of ellipses, lines, etc. However, there are still two important weaknesses in the type of organization used for Version Three: occasionally, the total amount of storage was exceeded; and usually much of the storage available was unused. These difficulties were removed by the incorporation of a crude form of dynamic dimensioning in which a program is generated which contains the calculated correct dimensions for the case being run.

To simplify generating the program with correct dimensions in each of the affected processors, component arrays which can have lengths depending on the case being run are collected into two long arrays, one for integer information and one for real information. After the appropriate length of each of the component arrays has been determined, their beginning indices in the large arrays are calculated together with the total length of the two large arrays. Only the large arrays appear in the generated programs.

References to the component arrays within the target processors are made by explicit use of the Fortran linear addressing rule. This rule is stated as follows. If an array is dimensioned $A(L,M,N)$, then

$$\text{Loc}(A(I,J,K)) = \text{LOC}(A(1,1,1)) + (I-1) + L * (J-1) + L * M * (K-1)$$

where Loc is the location in word units of the indicated array element. The two-dimensional rule omits the last term and the one-dimensional rule omits the last two terms. For convenience, the constant portions of the above expression are collected together, precomputed, and given the name "offset beginning index" so that the functional rule becomes

$$\text{Loc}(A(I,J,K)) = (\text{Offset beginning of } A) + I + L * J + L * M * K$$

with the same simplifications for lower dimensions.

^{*} Obsolete in Versions 5 and 6.

In the sections which follow, the formulas used to calculate correct dimensions are discussed under the processor which generates the main program, and the layout of the large arrays is discussed under the processor which uses the arrays. In either case, the information is presented in the "Packing Techniques" section for each processor since the organization into large arrays can be considered another level of packing.

4.1.2.3 Use of "transfer vector" routines.* In some of the early computer systems, linkage between different subprograms was handled by storing the calling position in an index register and transferring to another section in the same subprogram called the "transfer vector." The transfer vector would be compiled with the name of each external routine in character code (e.g., BCD). During the loading process, each of these names would be replaced by an unconditional transfer to the loaded location of the routine in question. The effect of this was to simplify loading by requiring insertion of the correct location of each routine only within each transfer vector.

An adaptation of this same technique was used in the MVMA Two-Dimensional Model, but for a different reason. There are a number of subprograms in the GO and OUT processors which are needed only if certain model options are employed. If these options are not used, loading the corresponding subprograms is a useless waste of time and storage. It was noted that if the optional routines were called indirectly through a generated "transfer vector" routine which would contain the completing call only if the routine were really needed and if the loading of these two processors were handled out of libraries, then each routine would be loaded only if it were needed.

The specific applications of this simple idea are described under "Program Organization and Flow" for GO and OUT (see Sections 4.4.1 and 4.6.1).

* Obsolete in Versions 5 and 6.

4.1.2.4 Use of external storage. External storage is used to hold information too massive to be economically maintained in internal storage, for sorting information into required order, and for communication between processors. The external storage data sets are also useful as a record of the run and as input to post-processors.

The four external storage data sets used in the MVMA Two-Dimensional Model have been partially described in their communication functions in Table 12 and Figure 135. Details of the four data sets will be found in "Binary Output Formats" of the first four processors (see 4.2.3, 4.3.3, 4.4.3, and 4.5.3).

4.2 The Input Pre-Processor (INP)

4.2.1 Program Organization and Flow. Figure 136 shows a schematic of the calling structure of the Input Pre-Processor. Tables 13 and 14 are the Subprogram Specifications and Appearances for INP and the Labeled Common Descriptions for INP, respectively.

Table 15-1 gives the Fortran Name and a symbol for the quantities which will be used in the computation of array lengths needed for dynamic dimensioning of variable length arrays in IN. Table 15-2 gives the name of each component array of the two general arrays (respectively, RRQ and IIQ) in order of occurrence, the Fortran Name of the length of each such array, and the length relationship used for computing the length. The lengths of the two general arrays are the sum of the lengths of the components of each.

4.2.2 Packing Techniques. In the Input Pre-Processor, no real packing is accomplished, but preliminary tables are built up for later use in packing. As each input data card is ready, the contents are either placed in a special array for collection of data, called DATA, or written directly to external binary storage. This section will deal with the collection array, DATA, and the next section will deal with the external storage, NU.

DATA contains all the input information which specifies controls and other model parameters for which only one input card (the last read) is used whereas the input cards which may occur repeatedly for the specification of ellipses, materials, etc., are written to NU.

DATA is laid out as a two-dimensional array with the first subscript corresponding roughly to card field and the second subscript to relative card number. Table 16 presents the exact relationship between DATA and the various input cards. The IFAULT array is used to record the presence of certain explicit data cards to aid in providing defaults for missing cards. IFAULT is laid out similar to DATA and is specified in Table 17.

4.2.3 Binary Output Formats. The indexed binary file on logical device number NU is intended to be the main external data storage pool which all the processors use. It has three fixed length sections, the first of which is written mostly in INP, the second in IN, and the third in OUTP. In addition, there are two variable length sections. The first of these is used by INP to pass the input card data to IN and then re-used by IN to pass the revised and rearranged input data to GO and OUT. The second variable length section is used by OUTP to pass input data to OUT.

Tables 18 and 19 detail the contents of each record of file NU, which is written by INP. Table 18 deals with the first fixed length portion and Table 19 covers the first variable length portion, which contains the data from each "repeatable" input card in the order of occurrence in the input data deck. In Table 19, each record has the first three fields in common and only the other fields are described. Field 1 holds KODE, which determines what type of data follows. Field 2 holds LOOK, which usually determines whether this is the first or second section of the data. Field 3 holds KARDNO, which is a running count of the input cards used for making diagnostics specific.

4.2.4 Auxiliary Program Output. The Input Pre-Processor has no standard printout beyond a numbered echo of every card read, but it does have a debug switch. Debug level one will produce the printout of the two sections of the INP Packing Dictionary even if it is not otherwise requested. Debug level two adds a printout of the contents of each output record to file NU (see Table 19). This printout is interspersed within the card Echo Table as each card is read. Debug level three adds a printout of array DATA as it is formed.

Printout for INP consists of: (1) the automatic echoing of input cards as they are read (Table 20), (2) the automatic defaulted card summary listing (Table 21), (3) the optional Packing Dictionary (Table 22) and (4) the automatic error messages in case of specific problems (Table 23). The Echo Table adds a card number of the card in the data deck, moves the Card Identification Number to the left and presents the nine fields of eight on the card with contents of each field separated by columns of asterisks. This output format is thought to facilitate discovering and correcting alignment and other keypunching errors.

The Default Card List divides the input cards into two groups: those used successfully in the input data deck and those defaulted either because of some error in the card presented or because the card was absent. The groups are listed in parallel columns under appropriate headings.

The Packing Dictionary prints out a summary of the information stored in the packing tables used for communication between INP and IN. It can be used to check the correctness and completeness of the input data deck.

The error messages are intended to be self-explanatory and will appear as needed.

4.2.5 Programs Written by INP. The last function of the Input Pre-Processor (INP) is to write the main program for the Input Processor (IN), using the lengths as calculated in Section 4.2.1, to define the dimensions of the arrays in commons REAL and INTGR. An example main program is shown in Table 24.

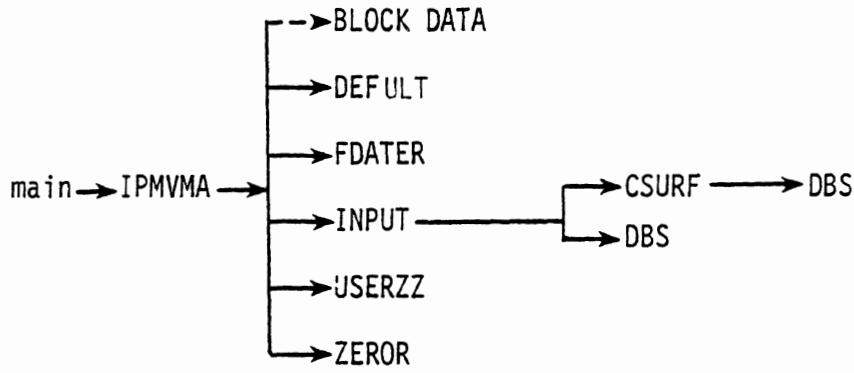


Figure 136. Calling Structure for the Input Pre-Processor (INP).

Table 13. Subprogram Specifications and Appearances for INP.

Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprograms Called	Subprograms Calling	Special Output
1	BLK DATA		Predefines input data card default values.	REAL	NONE	NONE	NONE
2	CSURF		Packs information on individual material property cards into preliminary binary tables.	COUNTS KARD	DBS		
3	DBS		Converts information in A-format into binary format for arithmetic use.	DUM LDNS	LAND* SIOC*	CSURF INPUT	NONE
4	DEFAULT		Checks inputted information and supplies specified values for missing cards.	COUNTS DATA KARD LDNS REAL REST	NONE	IPMVMA	NONE
5	FDATER		Obtains month, day, year, and time of current run.	NONE	TIME*	IPMVMA	NONE
6	INPUT		Reads input data deck and records into preliminary binary tables.	COUNTS DATA KARD LDNS MISC NAMES REST	CSURF DBS	IPMVMA	E1
7	IPMVMA		Overall control of Input Pre-Processor.	COUNTS DATA KARD LDNS MISC NAMES REST	DFULT FDATER USERZZ ZERO AMAX1	MAIN	E2-E7
8	MAIN		Calls IPMVMA and returns to system.	MISC	IPMVMA		NONE
9	USERZZ		Returns job name in EBCD.	NONE	NONE	IPMVMA	NONE
10	ZERO		Sets zero into a number of consecutive locations	NONE	NONE	IPMVMA	NONE

*This routine may require modification by local user. (See Section 4.8.1.)

Table 14. Labeled Common Descriptions for INP

Number	Common Name	Subprograms Which Use	Description
1	COUNTS	CSURF, DEFAULT, INPUT, IPMVMA	Counters of input information.
2	DATA	DEFAULT, INPUT, IPMVMA	Temporary storage for input quantities until put in their proper place.
3	DUM	DBS	Temporary storage.
4	KARD	CSURF, DEFAULT, INPUT, IPMVMA	Input "card image."
5	LDNS	DBS, DEFAULT, INPUT, IPMVMA	Control information for input and output.
6	MISC	INPUT, IPMVMA, main	Control information and more counters.
7	NAMES	INPUT, IPMVMA	Title storage and number of ellipses, line segments, and regions
8	REAL	BLOCK DATA, DEFAULT	Default values for input.
9	REST	DEFAULT, INPUT, IPMVMA	Option switches and more counters

Table 15-1. Array Dimension Symbols in INP for IN.

Name	Symbol	
NTSTIN	A	Number of tabular static and inertial curves, total.
NBLT	B	Number of belts used.
NGRP	D	Number of G and/or R input cards, total.
NELLPS	E	Number of ellipses attached to all segments.
NSTINP	F	Number of static and/or inertial spike input cards, total.
NLSEG	L	Number of line segments for all regions.
NMATL	M	Number of materials for all purposes.
NEEIN	N	Number of specified ellipse-ellipse interactions, allowed or disallowed.
NERIN	O	Number of specified ellipse-region interactions, allowed or disallowed.
NRGION	R	Number of regions total.
NCIRCL	S	Number of circles attached to all body segments.
NLPOSN	T	Number of position specifications cards for lines, total (number of line segment positions, total).
NMATLT	V	Number of material tables used, total.
NMATLP	W	Number of material table entries, total.
NBLTFS	X	Number of belts for which force-strain is specified.
NOYSST	Y	0 if no steer column, 1 if steer column.
NMTHFT	AA	Number of muscle tension and head force tables.
NMTHFP	AB	Number of muscle tension and head force table points.
NSHSPT	AC	Number of shoulder radial stiffness tables
NSHSPP	AD	Number of shoulder spring table points (linear, quadratic, and cubic).

Table 15-2. Array Dimensions in INP for IN.

Number	Array	Length Name	Length Relationship
1	KCON	NNKCON	$4B + 6M + 14R + 12L + 15E + 15S + 2(N+0) + 33 + 6NNMAT$
2	KACT	NNKACT	$5(E + S + R) + 4(M + D + F + L + N + 0 + T) + 24Y + 4(AB + AD) + 24 + 2B$
3	MSTOR	NUMTAB (KTBCSZ=6)	$V + AA + AC$
4	KREGNS, KREGNM	NREGNS	$R + B$
5	KELLM	NELLS	$E + S + B$
6	KCONAM	NLINES	L
*7	STOMAT	NNSMAT	$X + 7R + 30L + 5T + 28M - 6A + 12E + 7S + 28NNMAT$
8	STOR	NUMENT	$4(W + AB + AD) - 2(V + AA) - AC$
9	TACC, ACC	NNOACC or ITS	$KACCX + KACCZ + KACCTH$ (input counts)
10	HX11I, HTX11	NNSTRW	Input count
11	STOACT	NNSACT	$6(E + S) + 21M + 4D + 9(R + F) - 5A + 17L + 8(N + 0) + 5T + 44Y + 4(AB + AD) + 155$
12	MOOT, BTIM	NFLUXP	Input count
13	TEMPS, TTIM	NGASTM	Input count
14	PERM, DELTAP	NBAGPR	Input Count

* STOMAT length must accommodate $5 \text{ NBI} + 1$ additional values, where NBI is the number of user-specified unloading curves.

TABLE 16. DESCRIPTION OF DATA (I, K) IN INP

K	I	Unused Columns	MVMA Card, Fields
1	1 - 9		101, 1-9
2	1 - 9		102, 1-9
3	1 - 9		103, 1-9
4	1 - 9		104, 1-9
5	1 - 9		105, 1-9
6	1 - 9		201, 1-9
7	1 - 9		202, 1-9
8	1 - 9		203, 1-9
9	1 - 9		204, 1-9
10	1 - 9		205, 1-9
11	1 - 9		206, 1-9
12	1 - 9		207, 1-9
13	1 - 9		208, 1-9
14	1 - 9		209, 1-9
15	1 - 9		210, 1-9
16	1 - 9		211, 1-9
17	1 - 9		212, 1-9
18	1 - 9		217, 1-8; 604, 2
19	1 - 9	3	218, 1-9
20	1 - 9		301, 1-9
21	1 - 4	5-9	304, 1-4
22	1 - 9		303, 1-6; 605, 3-5
23	1 - 8	9	501, 1-8
24	1 - 9		601, 1-9
25	1 - 9		701, 1-8; 722, 1
26	1 - 9		722, 2-5; 702, 5-8; 722, 6

TABLE 16. DESCRIPTION OF DATA (I, K) IN INP.

(continued)

K	I	Unused Columns	MVMA Cards, Fields
27	1 - 8		801, 1-8; 113,4
28	1 - 8		802, 1-8; 113,5
29	1 - 9		803, 1-4; 726,1-5
30	1 - 6	7-9	(726, 6-7) ; 805, 3-6
31	1 - 9		901, 1-9
32	1 - 9		902, 1-9
33	1 - 9		903, 1-7; 725, 6-7
34	1 - 9		107, 1-9
35	1 - 9		108, 1-9
36	1 - 9		109, 1-9
37	1 - 9		110, 1-9
38	1 - 9	4	723, 1; 602, 2; 603, 2; *; 723, 2-6
39	1 - 8	9	907, 1-8
40	1 - 8	9	908, 1-8
41	1 - 9		909, 1-4; 111, 5-9
42	1 - 9		213, 1-4; 725, 1-5
43	1 - 9		214, 1-9
44	1 - 9		215, 1-9
45	1 - 9		216, 1-9
46	1 - 9		302, 1-9
47	1 - 9		111, 1-4; 710, 1-5
48	1 - 9		227, 1-4; 711, 1-5
49	1 - 9		228, 1-4; 712, 1-5
50	1 - 9		229, 1-4; 713, 1-5
51	1 - 9		230, 1-4; 714, 1-5
52	1 - 9		231, 1-4; 715, 1-5

TABLE 16. DESCRIPTION OF DATA (I,K) IN INP.
(continued)

K	I	Unused Columns	MVMA Card, Field
53	1 - 9		232, 1-4; 716, 1-5
54	1 - 9		233, 1-4; 717, 1-5
55	1 - 9		234, 1-4; 718, 1-5
56	1 - 9		235, 1-4; 719, 1-5
57	1 - 9		236, 1-4; 720, 1-5
58	1 - 9		237, 1-4; 721, 1-5
59	1 - 9		717, 6-7; 806, 3-9
60	1 - 9		719, 6-7; 807, 3-6; 720, 6-8
61	1 - 9	7	242, 1-2; 808, 3-6; 242, 3-4
62	1 - 9		809, 1-8; 721, 6

TABLE 17. Description of IFAULT (K) in INP.

K	MVMA Cards
1-37	Same as first Table 16 Entry for same K.
38	Unused
39-62	Same as first Table 16 Entry for same K
63	239
64	240
65	241
66	412
67	804
68	904
69	905
70	906
71-84	710-723
85	242

Table 18. Fixed Length Portion of Preliminary Indexed Binary Output Data Set on Logical Device Number NU in INP.

Record Number	Contents
1	NOCARD, INSX, NITEMS, LLKACT, LLMSTO, LLKCON, LLINF, LLSEGB, LLPRMT, LLKSA, LLBELN, LLELLN, LLCONM, LLREGN, LLREGS, LLSACT, LLSTOR, LLTACC, LLACC, LLHXII
2	LLHX11, LLSMAT, LLMDOT, LLBTIM, LLTEMP, LLTTIM, LLPERM, LLDelp, LLRGMU, LLALOK, LLBFLG, LLPLOK, LLREEL, LLSLAK, LLTLOK, LLVLOK, LLXEPS, LLYSEP, LLATTC, LLSTFG
3	LLANHR, LLRING, NKCON, NKACT, NKMIG, NIBCNT, NSTMAT, NSTACT, NCNOUT, LASNCR, NFLUXP, NGASTM, NBAGPR, NSTMIG, NADUM, NTSTIN, NBLT, NBLTSD, NGRP, LOPEN
4	NELLPS, NSTINP, NLSEG, NMATL, NEEIN, NERIN, NRGION, NCIRCL, NLPOSN, NMATLT, NMATLP, NBLTFS, NDYSST, NMTHFT, NMTHFP, NSHSPT, NSHSPP, KACCX, KACCZ, KACCTH
5	LOKCON, LOKACT, LOKMIG, LOKMUG, LOBCNT, KOTCNL, LOSMAT, LOSACT, LOCOUT, LOTACC, LOACC, LOMDOT, LOBTIM, LOTEMP, LOTTIM, LOPERM, LODELp, LOBAGL, LOSTHB, LOSMIG
6	LOSMUG, LOADUM, KOTRAL, NLCARD, NLOUT, LDNMN, NDMIRQ, NDMIQ, NNMREC, NNMLEN, NNSACT, NNMENT, LOHX11, LOHTX11, NNSTRW, KTBCSZ, NNKACT, NDMRRQ, NDMIIQ, INPDB
7	KROUTN(1-10), KSTOR(1-6), DATA(9, 59-62)
8	LKELLN, LKCONM, LKREGN, LKREGS, INTSCT, NPACK, NDMRQQ, NDMIQQ, NNMREC, NNMLEN, LOKCI, LOKOT, LOIDEL, LOKOTT, LOJOT, LOEDGE, LODD1, LODD2, LOSS, LOFF
9	DATA(1-9, 1-2), MUSNAM(1-2, 1)
10	DATA(1-9, 3-4), MUSNAM(1-2, 2)
11	DATA(1-9, 5-6), MUSNAM(1-2, 3)
12	DATA(1-9, 7-8), MUSNAM(1-2, 4)
13	DATA(1-9, 9-10), MUSNAM(1-2, 5)
14	DATA(1-9, 11-12), MUSNAM(1-2, 6)
15	DATA(1-9, 13-14), MUSNAM(1-2, 7)
16	DATA(1-9, 15-16), MUSNAM(1-2, 8)
17	DATA(1-9, 17-18), MUSNAM(1-2, 9)
18	DATA(1-9, 19-20), MUSNAM(1-2, 10)
19	DATA(1-9, 21-22), MUSNAM(1-2, 11)
20	DATA(1-9, 23-24), MUSNAM(1-2, 12)
21	DATA(1-9, 25-26), MUSNAM(1-2, 13)
22	DATA(1-9, 27-28), DATA(1-2, 59)
23	DATA(1-9, 29-30), DATA(3-4, 59)

Table 18. (Cont.)

Record Number	
24	DATA(1-9, 31-32), DATA(5-6, 59)
25	DATA(1-9, 33-34), DATA(7-8, 59)
26	DATA(1-9, 35-36), DATA(1-2, 60)
27	DATA(1-9, 37-38), DATA(3-4, 60)
28	DATA(1-9, 39-40), DATA(5-6, 60)
29	DATA(1-9, 41-42), DATA(7-8, 60)
30	DATA(1-9, 43-44), DATA(1-2, 61)
31	DATA(1-9, 45-46), DATA(3-4, 61)
32	DATA(1-9, 47-48), DATA(5-6, 61)
33	DATA(1-9, 49-50), DATA(7-8, 61)
34	DATA(1-9, 51-52), DATA(1-2, 62)
35	DATA(1-9, 53-54), DATA(3-4, 62)
36	DATA(1-9, 55-56), DATA(5-6, 62)
37	DATA(1-9, 57-58), DATA(7-8, 62)

Table 19. Variable Length Portion of Preliminary Indexed Binary Output Data Set on Logical Device Number NU in INP (Page 1 of 5)

KODE	LOOK	Field	Item	Input Card #	Field	
1	1	4-7	ellipsename	219	1-2	
		8-11	materialname	219	3-4	
		12	Body Segment Number	219	5	
		13	Friction Class Number	219	6	
	2	4-7	ellipsename	220	1-2	
		8,9	X_{em}, Z_{em}	220	3,4	
		10,11	a, c	220	5,6	
	2	1	4-7	materialname	221, 403, 704, 812	1-2
			8	δ_A	221, 403, 704, 812	3
9			δ_B	221, 403, 704, 812	4	
10			δ_C	221, 403, 704, 812	5	
11			δ_D	221, 403, 704, 812	6	
12			δ_F	221, 403, 704, 812	7	
13			F_{max}	221, 403, 704, 812	8	
14			β	221, 403, 704, 812	9	
2		4-7	materialname	222, 404, 705, 813	1-2	
		8	ϵ_p	222, 404, 705, 813	3	
		9	λ_1	222, 404, 705, 813	4	
		10	λ_2	222, 404, 705, 813	5	
		11	λ_3	222, 404, 705, 813	6	
		12-13	staticcurvename	222, 404, 705, 813	7	
		14-15	interialspikename	222, 404, 705, 813	8	
		16-17	G-Rrationame	222, 404, 705, 813	9	
3		4-5	G-Rrationame	223, 405, 706, 814	1	
		6	δ	223, 405, 706, 814	2	
		7	G	223, 405, 706, 814	3	

Table 19. (Cont.)

(Page 2 of 5)

KODE	LOOK	Field	Item	Input Card #	Field
4		4-5	staticcurvename	225, 407, 708, 816	1
		6	δ or negative number	225, 407, 708, 816	2
		7	F or C_1	225, 407, 708, 816	3
		8	C_2	225, 407, 708, 816	4
		9	C_3	225, 407, 708, 816	5
		10	C_4	225, 407, 708, 816	6
		11	C_5	225, 407, 708, 816	7
		12	C_6	225, 407, 708, 816	8
5		4-5	inertialspikename	226, 408, 709, 817	1
		6	δ or negative number	226, 408, 709, 817	2
		7	F or C_1	226, 408, 709, 817	3
		8	C_2	226, 408, 709, 817	4
		9	C_3	226, 408, 709, 817	5
		10	C_4	226, 408, 709, 817	6
		11	C_5	226, 408, 709, 817	7
		12	C_6	226, 408, 709, 817	8
6	1	4-7	linesegmentname	409	1-2
		8-11	regionname	409	3-4
		12	Penetration Limit	409	5
		13	Edge Constant	409	6
		14	Direction Factor	409	7
		15	Line Segment Index	409	8
	2	4-7	linesegmentname	410	1-2
		8	Number of Time Points	410	3
		9	Mass Compliance at Second Endpoint	410	4
		10	Bending Moment at Second Endpoint	410	5
		11	Mass Compliance at First Endpoint	410	6
		12	Bending Moment at First Endpoint	410	7

Table 19. (Cont.)

(Page 3 of 5)

KODE	LOOK	Field	Item	Input Card #	Field
7	1	4-7	regionname (Inertial)	401	1-2
		8-11	materialname	401	3-4
		12	IDEF	401	5
		13	ISCALE	401	6
		14	IAPP	401	7
		15	IMULTI	401	8
	2	4-7	regionname (Inertial)	402	1-2
		8	NSR	402	3
		9	Friction Class Index	402	4
		10	IMIG	402	5
		11	Input Coordinate Switch	402	6
		12	Output Coordinate Switch	402	7
8	1	4-7	ellipsename	106	1-2
		8-11	ellipsename or regionname	106	3-4
9		4-7	G-Rrationame	224, 406, 707, 815	1
		8	δ	224, 406, 707, 815	2
		9	R	224, 406, 707, 815	3
10		4-7	linesegmentname	411	1-2
		8	t	411	3
		9	X_j	411	4
		10	Z_j	411	5
		11	X_{j+1}	411	6
		12	Z_{j+1}	411	7
		13	II	411	8
11	1	4-7	regionname (Relative)	401	1-2
		8-11	materialname	401	3-4
		12	IDEF	401	5
		13	ISCALE	401	6
		14	IAPP	401	7
		15	IMULTI	401	8
	2	4-7	regionname (Relative)	402	1-2
		8	NSR	402	3
		9	Friction Class Index	402	4
		10	IMIG	402	5
		11	Input Coordinate Switch	402	6
		12	Output Coordinate Switch	402	7

Table 19. (Cont.)

(Page 4 of 5)

KODE	LOOK	Field	Item	Input Card #	Field
12	1	4-5	muscletensionname or headforcename	238, 606	1
		6	t	238, 606	2
		7	M , T or F_x, F_z	238, 606	3
13	1	4	θ_s	239	1
		5	KJI(10,1)	239	2
	2	4	θ_s	240	1
		5	KJI(10,2)	240	2
	3	4	θ_s	241	1
5		KJI(10,3)	241	2	
14	1	4-7	headmaterialname	805	1-2
	2	4-7	uppertorsomaterialname	806	1-2
	3	4-7	middletorsomaterialname	807	1-2
	4	4-7	lowertorsomaterialname	808	1-2
15	1	4-7	edgematerialname	810	1-2
		8-11	centermaterialname	810	3-4
		12-15	hubmaterialname	810	5-6
16	1	4-7	reaction#1materialname	811	1-2
		8-11	reaction#2materialname	811	3-4
		12-15	reaction#3materialname	811	5-6
		16-19	reaction#4materialname	811	7-8
17		4	I	412	1
		5	J	412	2
		6	CMU(I,J,1)	412	3
		7	CMU(I,J,2)	412	4
		8	CMU(I,J,3)	412	5
18	1,2, 3	4	Number of Pairs in This Record	602, 603, 604	et seq.
		5	Starting Index Within Table		
		6,8,10, 12	TACC		
		7,9,11, 13	ACC		
19		4	Number of Pairs in This Record	804	et Seq.
		5	Starting Index Within Table		
		6,8,10, 12	HTX11		
		7,9,11, 13	HX111		

Table 19. (Cont.)

(Page 5 of 5)

KODE	LOOK	Field	Item	Input Card #	Field
20	4,5, 6	4	Number of Pairs in This Record	904, 905, 906 et Seq.	
		5	Starting Index Within Table		
		6,8,10, 12	BTIM, TTIM, or DELTAP		
		7,9,11, 13	MDOT, TEMPS, or PERM		
21	1-7	4-7	belt#LOOKmaterialname	710-716	6-7
		8-11	bodymaterialname	710-716	8-9
		12	IBETN		
	8	4-7	lapbeltmaterialname	702	1-2
		8-11	bodymaterialname	702	3-4
	9	4-7	uppertorsobeltmaterialname	703	1-2
		8-11	bodymaterialname	703	3-4
		12-15	lowertorsobeltmaterialname	703	5-6
		16-19	bodymaterialname	703	7-8

```

1 100 * * * MVM*A 2-D TU*TORIAL E*XAMPLE #*1 * * *
2 -1 * * * * * * * * * * * * * * *
DEBGG SET 0* * * * * * * * * * * * * * *
3 400 * KNEE *BAR * * * * * * * * * * *
4 500 *200. COM*2. DISPL*. * * * * * * * * *
5 600 *30MPH FR*ONT BARR*IER * * * * * * * * *
6 700 * NO B*ELTS * * * * * * * * * * *
7 101 *1. *1. *32.174 *0. *0. *200. *1. *5. *10. *
8 102 *0. *0. *0. *0. *0. *0. *10. *1000001 *5. *
9 103 *2 *05 *100000. *15000. *20. *05 *10. *1. *1. *
10 104 *0. *00000000*70.1 *00000000*200. *00000000*201. *00000000*0. *
11 601 *0. *44. *0. *0. *0. *0. *0. *0. * * *
12 602 *23. *1. *1. * * * * * * * * *
13 TABLE* 0.0 * -1.70* 1.00* -1.40* 7.00* -33.50* 12.00* 2.80* 0.0 *
14 TABLE* 13.50* 3.90* 18.00* -21.20* 21.50* -12.40* 28.00* -9.20* 0.0 *
15 TABLE* 32.00* -24.00* 33.00* -24.00* 36.00* -9.90* 37.00* -9.90* 0.0 *
16 TABLE* 42.00* -26.90* 47.00* -31.30* 50.00* -25.90* 54.00* -27.20* 0.0 *
17 TABLE* 58.00* -32.20* 61.00* -29.00* 76.00* -6.90* 90.00* -1.40* 0.0 *
18 TABLE* 100.00* -1.40* 120.00* 0.0 * 300.00* 0.0 * 0.0 * 0.0 *
19 603 *2. *1. *1. * * * * * * * * *
20 TABLE* 0.0 * 0.0 * 300.00* 0.0 * 0.0 * 0.0 * 0.0 * 0.0 * 0.0 *
21 604 *2. *1. * * * * * * * * *
22 TABLE* 0.0 * 0.0 * 300.00* 0.0 * 0.0 * 0.0 * 0.0 * 0.0 * 0.0 *
23 200 *GM HYBRID II DUM*MY * * * * * * * * *
24 300 *(PRELIMINARY DATA) * * * * * * * * *
25 201 *1.1 *13.44 *3.4 *5. *15.8 * *10.3 *3.25 *-1.88 *
26 202 *2.75 *7. *1.7 *4.2 *8.2 *9.3 *5. *5.8 *.5 *
27 203 *.0259 *.0951 *.0052 *.0987 *.0932 *.0518 *.022 *.0256 *.007 *
28 204 *.198 *1.97 *.04 *1.53 *1.38 *2.82 *.18 *.62 * *
29 205 *10.8 *.58 *0. *.52 *17.4 *1. * *-25. *.35 *
30 206 *12.8 *.58 *0. *.52 *17.4 *1. * *-22. *.35 *
31 207 *70. *15. *0. *.66 *1000. *1. *-8. *-25.5 *.35 *
32 208 *102.5 *-7.824 *.1944 *.66 *1000. *1. *-33.999 *-34.001 *.35 *
33 209 *84.44 *-4.810 *.1053 *0. *850. *1. *-49.999 *-50.001 *.5 *
34 210 *0. *29.8 *0. *0. *204. *85. *135. *0. *.5 *
35 211 *0. *10. *0. *0. *222. *90. *28. *-197. *.5 *
36 212 *0. *10. *0. *0. *64. *30. *0. *-165. *.5 *
37 213 *751. *0. *757. *1.98 * * * * * *
38 214 *20. *230. *0. *0. * * * *2. * *.5 *
39 215 *38. *.58 *0. *.52 *0. *1. *-1. * *.16 *
40 216 *38. *.58 *0. *.52 *0. *1. *2. * *.16 *
41 242 *751. *0. *757. *1.98 * * * * * *
42 219 *HEAD * * * *1. *3. * * * *
43 219 *THORAX * *CHESTMAT*L *2. *1. * * * *
44 219 *HIP * *HIPMATL * *4. *1. * * * *
45 219 *THIGH * * * *5. *1. * * * *
46 219 *KNEE * * * *5. *1. * * * *
47 219 *SHANK * * * *6. *1. * * * *
48 219 *HEEL * * * *6. *2. * * * *
49 219 *TOE * * * *6. *2. * * * *
50 219 *ELBOW * * * *7. *1. * * * *
51 219 *HAND * * * *8. *3. * * * *
52 220 *HEAD * *0. *.5 *4. *4. * * * *
53 220 *THORAX * *-1.5 *-1.68 *5.52 *4.44 * * * *
54 220 *HIP * *-1.12 *0. *4.5 *4.5 * * * *
55 220 *THIGH * *-1.5 *-1.1 *7. *3. * * * *
56 220 *KNEE * *7. *-1.4 *2.25 *2.25 * * * *
57 220 *SHANK * *-7.54 *0. *3. *2.4 * * * *
58 220 *HEEL * *8.57 *0. *1.2 *1.2 * * * *

```

Table 20. Facsimile of Echo of Input Data Cards from INP

ALL OF THE CARDS LISTED BELOW ARE CARDS FOR WHICH DEFAULT VALUES WILL BE ASSIGNED IF THE CARD IS MISSING
 CARDS FOR WHICH DEFAULT VALUES HAVE BEEN ASSIGNED ARE LISTED IN THE COLUMN ON THE RIGHT

USER DEFINED	DEFAULTED
101	105
102	107
103	108
104	109
201	110
202	111
203	227
204	228
205	229
206	230
207	231
208	232
209	233
210	234
211	235
212	236
213	237
214	717
215	718
216	720
242	721
302	722
303	723
304	901
412	902
601	903
	904
	905
	906

Table 21. Facsimile of Defaulted Card Summary from INP

A. VARIABLE-LENGTH STORAGE LAYOUT

REAL ARRAYS

NAME	BEG. IND.	LENGTH	OFFSET	BEG.
STOACT	1605	1853	1604	
STOR	1133	418	1132	
TACC	1551	27	1550	
ACC	1578	27	1577	
HX11I	1605	0	1604	
HTX11	1605	0	1604	
STOMAT	1	1132	0	
MDOT	3458	0	3457	
BTIM	3458	0	3457	
TEMPS	3458	0	3457	
TTIM	3458	0	3457	
PERM	3458	0	3457	
DELTAP	3458	0	3457	
RINGMU	3458	0	3457	
ALOCK	3458	0	3457	
BFLAG	3458	0	3457	
PLOCK	3458	0	3457	
REEL	3458	0	3457	
SLAK	3458	0	3457	
TLOCK	3458	0	3457	
VLOCK	3458	0	3457	
XEPS	3458	0	3457	
YSEP	3458	0	3457	
ATTANC	3458	0	3451	
SETFLG	3458	0	3455	
ANCHOR	3458	0	3457	
RING	3458	0	3457	

INTEGER ARRAYS

NAME	BEG. IND.	LENGTH	OFFSET	BEG.
KACT	612	911	611	
MSTOR	1523	126	1516	
KCON	1	611	0	
INF	1523	0	1520	
ISEGB	1523	0	1522	
IPRNT	1523	0	1522	
KSA	1523	0	1522	
BELNAM-BELTMM	1523	0	1514	
KPEGNS	1649	45	1643	
KEILLNM	1694	80	1685	
KCONAM	1774	48	1769	
KREGNM	1822	72	1813	

B. SUMMARY OF COUNTS.

NIBCNT=	0	NADUM=	0	KACCY=	23	KAC CZ=	2				
KACCTH=	2	NFLUXP=	0	NGASTM=	0	NBAGPR=	0				
A=	8	B=	0	C=	0	D=	59	E=	4	F=	66
G=	8	L=	12	M=	12	N=	22	O=	0	R=	9
S=	6	T=	27	V=	21	W=	115	X=	0	Y=	0
AA=	0	AB=	0	AC=	0	AD=	0				
ELL1=	10	ELL2=	10	MAT1=	12	MAT2=	12				
RGN1=	9	RGN2=	9	LIN1=	12	LIN2=	12				
NLCARD=	5	NLOUT=	6	NU=	8	MU=	7	MV=	9	NP=	10
NOCARD=	322	INSX=	37	NCR=	71	NITEMS=	280	LASNCR=			
IIO DIMENSION=	1893			RRQ DIMENSION=	3458			NTACEN=	27		

Table 22. Facsimile of Packing Dictionary from INP

Table 23. Error Messages from INP.

Number	Message	Condition and Action Required	Routine
1	SKIPPED * * * * *...*	Warning, the preceding input data card has not been processed due to an error on the card.	INPUT
2	UNEQUAL NO. MATERIAL CARDS	Fatal, check data cards	IPMVMA
3	UNEQUAL NO. LINE CARDS	Fatal, check data cards	IPMVMA
4	UNEQUAL NO. REGION CARDS	Fatal, check data cards	IPMVMA
5	UNEQUAL NO. ELLIPSE CARDS	Fatal, check data cards	IPMVMA
6	CIRCLE BREAKDOWN WRONG	Fatal, check data cards	IPMVMA
7	FATAL ERROR---ERROR NO.	Fatal, result of one of the above fatal errors or as a result of an error in INPUT	IPMVMA

INP

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```
0001          COMMON/REAL/RRQ( 3458)
0002          COMMON/INTGR/IIQ( 1893)
           C   DEFINE FILE 8( 2000, 22,U,IUPONT)
0003          CALL INMVMA
0004          STOP
0005          END
```

Table 24. Main Program for IN

4.3 The Input Processor (IN)

4.3.1 Program Organization and Flow. Figure 137 shows a schematic of the calling structure of IN. Tables 25 and 26 are the Subprogram Specifications and Appearances for IN and the Labeled Common Descriptions for IN, respectively.

Table 27 gives the Fortran name and symbol for the quantities which will be used to determine the storage requirements for GO. Some of these are the same as in Table 15-1. Table 28 gives the name of each component array of the two overall packing arrays to be used in GO (namely, RQ and IQ), the Fortran name of the length of the variable part of each such array and the length relationship used. Some of these are also the same as in Table 15-2.

4.3.2 Packing Techniques. The Input Processor accomplishes all packing of input data and sets up packing for intermediate and final results. IN reads the input data from data set NU and packs most of it into KACT and STOACT. These two arrays are then used to produce the final input packing arrays KCON and STOMAT. All these arrays, together with others used to hold data, are arranged into two large arrays, RRQ for reals and IIQ for integers. Tables 29 and 30 show the layouts of RRQ and IIQ, respectively. This organization allows recovery of information under a large number of input card orderings and facilitates the packing procedure.

The remainder of this section deals with KACT and STOACT. KCON and STOMAT are discussed in Section 4.4.3. KACT and STOACT are used to temporarily hold the portions of the input data which must be correlated with other data and/or packed into KCON and STOMAT. The formats employed in KACT and STOACT are related to and a refinement of those employed in the preliminary use of data set NU described in Section 4.2.3.

The KACT array contains control information and is divided into two parts. The first part is fixed format, is described by Table 31, and is used to hold tables which aid the searching and matching of input items. The second part begins immediately after the first part. It consists of one four-element entry for each input item present in KACT and STOACT.

The term "input item" refers to a unit of information which contains data from one to four related input data cards. The typical entry of this part of KACT is described in Table 32. It should be noted that the ICODE of Table 32 is always the same as the KODE of Table 19 in the range one through sixteen. The rest of the typical entry of KACT contains control information about the sixteen different types of typical STOACT entries.

The STOACT array is divided into two parts. The first part is fixed format, described in Table 33, and used to hold friction coefficients for ellipse-region interactions. The second part begins immediately after the first, consists of the STOACT entries for sixteen types of input items, and is described in Tables 34 through 46.

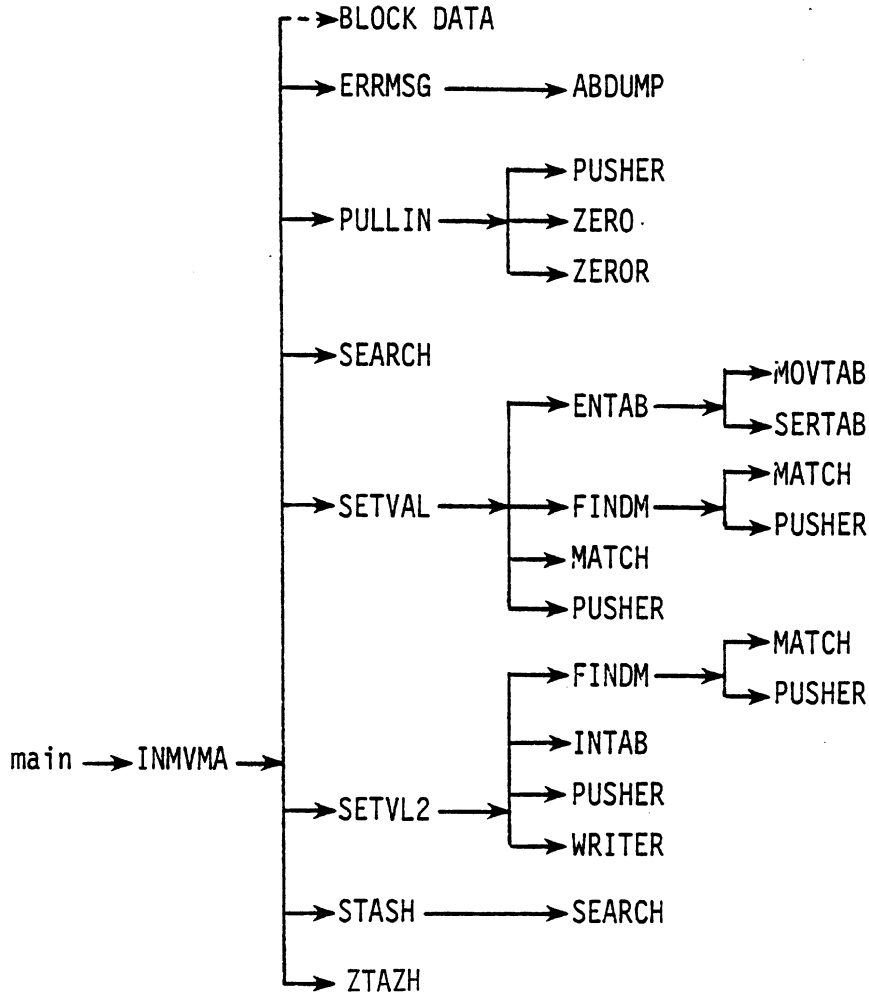


Figure 137. Calling Structure for the Input Processor (IN)

Table 25. Subprogram Specifications and Appearances for IN (Page 1 of 3)

Number	Subprogram Name	Statement Location	Flow Sequence or Descriptions	Commons	Subprograms Called	Subprograms Calling	Special Output
1	ABDUMP		Error return to system.	NONE	ERROR*	ERRMSG	NONE
2	BLOCK DATA		Predefines partial names for use in automatic creation of certain names.	STVAL	NONE	NONE	
3	ENTAB		Enters a single new point into a table.	BASE INTGR REAL RITE TAB ZERR	MOVTAB SERTAB MAXO	SETVAL	E1 E2
4	ERRMSG		Prints most of fatal error comments made for this model.	ENTRY RITE	ABDUMP	INMVMA	E3- E10
5	FINDM		Find or fill in material property storage given a name of a material.	INTGR	MATCH PUSHER	SETVAL	NONE
6	INMVMA		Overall control of input processor and writing of indexed binary file.	BASE DATA GOBASE INDIM INTGR NAMES PACK REAL REST RITE SRH TAB ZERR ZR	ERRMSG PULLIN SEARCH SETVAL SETVL2 SHRINK STASH ZTAZH	MAIN	E11- E17
7	INTAB		Sort material property tables into order and then compute slope and intercept for each of the linear segments of each table.	BASE INTGR REAL RITE TAB ZERR	NONE	SETVL2	E18

* Routine may require modification by local user. See Section 4.8.1.

Table 25. (Cont.) (Page 2 of 3)

Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprograms Called	Subprograms Calling	Special Output
8	MAIN		Calls INMVMA and returns to system.	INTGR REAL	INMVMA	NONE	NONE
9	MATCH		Match inputted name against names stored and return location if match is found.	BASE INTGR	NONE	FINDM SETVAL	NONE
10	MOVTAB		Move table entries around to make room for a new table entry.	BASE INTGR REAL RITE TAB	NONE	ENTAB	E19
11	PULLIN		Reads input data from preliminary binary file and stores in KACT and STOACT for later processing.	BASE DATA ENTRY GOBASE INDIM INTGR NAMES PACK	REAL REST RITE SRH TAB ZERR ZR	PUSHER ZERO ZEROR	INMVMA E20- E28
12	PUSHER		Adjusts stored indices to compensate for a new entry added in the middle of the packing table.	BASE INTGR PACK RITE	NONE	FINDM PULLIN SETVAL SETVL2	E29
13	SEARCH		Determines beginning and ending record number for next binary output record.	RITE SRH	MAXO	INMVMA STASH	E30
14	SERTAB		Searches for the table entry corresponding to a particular argument in tables.	BASE INTGR REAL TAB	NONE	ENTAB	NONE
15	SETVAL		Begins analysis of KACT and STOACT to build up packed tables for execution in KCON and STOMAT.	BASE DATA ENTRY INTGR NAMES PACK	REAL REST RITE STVAL ZERR ZR	ENTAB FINDM MATCH PUSHER AMAX1	INMVMA E31- E35

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Table 25. (Cont.) (Page 3 of 3)

Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprogram Called	Subprogram Calling	Special Output
16	SETVL2		Completes packed tables in KCON and STOMAT.	BASE DATA ENTRY GOBASE INDIM INTGR NAMES PACK	FINDM INTTAB PUSHER WRITER	INMVMA	E36- E39
17	SHRINK		Deletes unneeded data for unused options from KACT and STOACT arrays.	BASE ENTRY GOBASE INTGR	NONE NONE NONE NONE	INMVMA	NONE
18	STASH		Handles the writing of tables which require multiple records.	RITE SRH	SEARCH	INMVMA	E40
19	WRITER		Writes main program and transfer vector routine for GO.	RITE	NONE	SETVL2	NONE
20	ZERO		Zeros integer arrays.	NONE	NONE	PULLIN	NONE
21	ZEROR		Zeros real arrays.	NONE	NONE	PULLIN	NONE
22	ZTAZH		Same as STASH except for optional data on individual control basis.	RITE	NONE	INMVMA	NONE

Table 26. Labeled Common Descriptions for IN. (Page 1 of 2)

Number	Common Name	Subprograms Which Use	Description
1	BASE	ENTAB, INMVMA, INTAB, MATCH, MOVTAB, PULLIN, PUSHER, SERTAB, SETVAL, SETVL2, SHRINK	Packing information for input from INP.
2	DATA	INMVMA, SETVAL, SETVL2, PULLIN	Temporary storage for input quantities until put in their proper place.
3	ENTRY	ERRMSG, PULLIN, SETVAL, SETVL2, SHRINK	Input information.
4	GOBASE	INMVMA, PULLIN, SETVL2, SHRINK	Packing information for output to GO.
5	INDIM	INMVMA, PULLIN, SETVL2	Counters for array dimensions for GO.
6	INTGR	ENTAB, FINDM, INMVMA, INTAB, MATCH, main, MOVTAB, PULLIN, PUSHER, SERTAB, SETVAL, SETVL2, SHRINK	Storage for integer packing arrays
7	NAMES	INMVMA, PULLIN, SETVAL, SETVL2, SHRINK	Title storage and number of ellipses, regions, and line segments.
8	PACK	INMVMA, PULLIN, SETVAL, SETVL2, SHRINK	Packing array maximum lengths and current usage lengths.
9	REAL	ENTAB, INMVMA, INTAB, main, MOVTAB, PULLIN, SERTAB, SETVAL, SETVL2, SHRINK	Storage for real packing arrays.
10	REST	INMVMA, PULLIN, SETVAL, SETVL2	Control information used in packing and unpacking of various tables.
11	RITE	ENTAB, ERRMSG, INMVMA, INTAB, MOVTAB, PULLIN, PUSHER, SEARCH, SETVAL, SETVL2, STASH, WRITER, ZTAZH	Control information for input and output.
12	SRH	DEFAULT, INMVMA, SEARCH, STASH	Binary output file writing controls.

Table 26. (Cont.) (Page 2 of 2)

Number	Common Name	Subprograms Which Use	Description
13	STVAL	BLOCK DATA, SETVAL, SETVL2	Predefined titles and counters.
14	TAB	ENTAB, INMVMA, INTAB, MOVTAB, PULLIN, SERTAB, SETVL2	Table lengths and parameters.
15	ZERR	ENTAB, INMVMA, INTAB, PULLIN, SETVAL, SETVL2	Error switch.
16	ZR	INMVMA, PULLIN, SETVAL, SETVL2	Inhibition, joint, and material information.

Table 27. Array Dimension Symbols in IN for GO. (Page 1 of 2)

Name	Symbol	Description
NTSTIN	A	Number of tabular static and inertial curves, total
NBLT	B	Number of belts used
NBLTSD	C	Number of belts using shared deflection
NGRP	D	Number of G and/or R input cards, total
NELLPS	E	Number of ellipses attached to all segments
NSTINP	F	Number of static and/or inertial spike input cards, total
NSEGWE	G	Number of body segments which have ellipses or circles attached
NINTSD	H	Number of ellipse-line, ellipse-ellipse and steering column interactions to be shared deflection
NELINT	I	Number of ellipse-line and circle-line interactions total
NEEINT	J	Number of ellipse-ellipse, ellipse-circle, and circle-circle interactions total
NFORCX	K	Number of forces in operation on all line segments at one time
NLSEG	L	Number of line segments for all regions
NMATL	M	Number of materials for all purposes
NEEIN	N	Number of specified ellipse-ellipse interactions, allowed or disallowed
NERIN	O	Number of specified ellipse-region interactions, allowed or disallowed
NRGION	R	Number of regions total
NCIRCL	S	Number of circles attached to all body segments
NLPOSN	T	Number of position specifications cards for lines, total
NMATLT	V	Number of material tables used, total
NMATLP	W	Number of material table entries, total
NBLTFS	X	Number of belts for which force-strain is specified
NOYSST	Y	0 if no steer column, 1 if steer column
NINSTC	Z	Number of interactions between steering column and body

Table 27. (Cont.)

(Page 2 of 2)

Name	Symbol	Description
NMTHFT	AA	Number of muscle tension and head force tables
NMTHFP	AB	Number of muscle tension and head force table points
NSHSPT	AC	Number of shoulder radial stiffness tables
NSHSPP	AD	Number of shoulder radial stiffness table points
NLCONX	KK	Number of contact lines in contact at any one time

Table 28. Array Dimensions in IN for GO. (Page 1 of 2)

Number	Array	Length Name	Length Relationship
1	KCON	NKCON	$4B + 6M + 14R + 12L + G + 15E + 15S + 2N + 0 + 25 + 6 \cdot \text{NNMAT}$
2	KACT	NKACT	$21(I+J+B+Z+11) + 12(H+C) + 9R$
3	KMIG, KMUG	NKMIG	$4R + L + K + KK + 1$
4	BAGUL, IBCNT, STH	NIBCNT	121
5	MSTOR	NUMTAB	$V + AA + AC$ Note: KTBCSZ = 6
6	KELLM	NELLS	$E + S + B$
7	KCONAM	NLINES	L
8	KREGNM, KREGNS	NREGNS	$R + B$
9	KCI	NELPRG	0, not yet implemented
10	KOT, KOTT, IDELL, DD1, DD2, EDGE	NNITI, NNITJ	0, not yet implemented
11	STOMAT	NSTMAT	$X + 7R + 30L + 5T + 28M - 6A + 12E + 7S + 28 \text{ NNMAT}$
12	STOACT	NSTACT	$43(I + J + B + Z + 11) + 40(H + C)$
13	CONOUT	NCNOUT	$12I + 11J + 21R + 9B$
14	ACC, TACC	NNOACC	input count
15	MDOT, BTIM	NFLUXP	input count
16	TEMPS, TTIM	NGASTM	input count
17	PERM, DELTAP	NBAGPR	input count
18	STOMUG	NSTMUG	$\max[\text{NSTMIG}, 2(\text{NLINES} + \text{NREGNS})]$
19	STOMIG	NSTMIG	6K

Table 28. (Cont.) (Page 2 of 2)

Number	Array	Length Name	Length Relationship
20	ADUM	NADUM	0, not yet implemented
21	STOR	NUMENT	$4(W + AB + AD) - 2(V + AA + AC)$
22	HXIII, HTX11	NNSTRW	input count
23	SS, FF, PEN, JOT	NELPLN	0, not yet implemented

Table 29. Packing Array Layout for REALS in IN (RRQ).

	<u>Beginning Index</u>	<u>Array Name and Dimensions for RRQ</u>
1	LLSMAT (=1)	STOMAT(NNSMAT)
2	LLSTOR	STOR(NUMENT)
3	LLTACC	TACC(NNOACC)
4	LLACC	ACC(NNOACC)
5	LLHX1I	HX11I(NNSTRW)
6	LLHX11	HTX11(NNSTRW)
7	LLSACT	STOACT(NNSACT)
8	LLMDOT	MDOT(NFLUXP)
9	LLBTIM	BTIM(NFLUXP)
10	LLTEMP	TEMPS(NGASTM)
11	LLTTIM	TTIM(NGASTM)
12	LLPERM	PERM(NBAGPR)
13	LLDELP	DELTAP(NBAGPR)
14	LLRGMU	RINGMU(2)
15	LLREEL	REEL(3)
16	LLTLOK	TLOCK(3)
17	LLALOK	ALOCK(3)
18	LLPLOK	PLOCK(3)
19	LLVLOK	VLOCK(3)
20	LLBFLG	BFLAG(2)
21	LLSLAK	SLAK(7)
22	LLXEPS	XEPS(2)
23	LLYSEP	YSEP(2)
24	LLATTC	ATTANC(2,2,7)
25	LLSTFG	SETFLG(2,7)
26	LLANHR	ANCHOR(4)
27	LLRING	RING(2)

Table 30. Packing Array Layout for Integers in IN (IIQ).

	<u>Beginning Index</u>	<u>Array Name and Dimensions for IIQ</u>
1	LLKCON (=1)	KCON(NNKCON)
2	LLKACT	KACT(NNKACT)
3	LLMSTO	MSTOR(KTBCSZ, NUMTAB)
4	LLINF	INF(2,2)
5	LLSEGB	ISEGB(4)
6	LLPRMT	IPRMT(5)
7	LLKSA	KSA(7)
8	LLBELN	BELNAM(8,3) or KBELNM(8,3) BELTNM(8,7) or KBELTN(8,7)
9	LLREGS	KREGNS(5, NREGNS)
10	LLELLN	KELLM(8, NELLN)
11	LLCONM	KCONAM(4, NLINES)
12	LLREGN	KREGNM(8, NREGNS)

TABLE 31. THE STANDARD AREA IN THE KACT ARRAY FOR INPUT STORAGE

Index	Description
1 to NKIENT	Total number of entries in KACT for code type of same number as Index
NKIENT+1 to LSEGL=NKIENT+NSEG+LELLS	Total number of ellipses associated with reference segment system Index-NKIENT
LSEGL+1 to LELLAS=LSEGL+LELLS	Beginning index in KACT of ellipse KACT entry for entry in KELLNM at Index-LSEGL
LELLAS+1 to LREGAS=LELLAS+NSEG+LELLS	Total number of regions associated with reference system Index-LELLAS
LREGAS+1 to LREGL=LREGAS+LREGNS	Beginning index in KACT of region KACT entry for entry in KREGNM at Index-LREGAS
starting LREGL+1	KACT control entries

NOTE: NKIENT is the number of KACT Entry Types for Input, currently set to 17.

NSEG is the number of reference systems allowed, currently set to 10.

LELLS is the maximum number of ellipses and belts allowed for any one run, currently set to 27.

LREGNS is the maximum number of regions and belts allowed for any one run, currently set to 27.

NKIENT is base index for ellipses per segment count table

LSEGL is base index for ellipse internal/external correspondence table

LELLAS is base index for region per segment count table

LREGAS is base index for region internal/external correspondence table

LREGL is base index for control section

TABLE 32. THE TYPICAL KACT ENTRY FOR INPUT STORAGE

Relative Index	Description		
1 (ICODE)	Entry Type Code:		
	Code	Entry Type	STOACT Entry Length
	1	Ellipse	8 or 28
	2	Material	22 + 5 x unload curves
	3	G Ratio Table	4
	4	Static Curve	4 if table; 9 if poly
	5	Inert Spike	4 if table; 9 if poly
	6	Line	17
	7	(unused)	9
	8	Inhibition	8
	9	R Ratio Table	4
	10	Line Position Point	5
	11	Relative Region	9
	12	Head Force or Muscle	4
	13	Shoulder Stiffness Curves	2
	14	Body-Steer Properties	4
	15	Steering Wheel Material	12
16	Steering Col. Material or Joint Material	16	
17	Ellipse Attachment Table	4	
2 (IACT)	Beginning Index in STOACT for Input Storage Entry		
3 (ILOOK)	Supplementary Reference Indicator:		
	Code	Value	Description
	1	any	Beginning index in KELLNM
	10	any	KACT beginning index of line
	11	any	Beginning index in KREGNM
	13	1	Linear Coefficient
		2	Quadratic Coefficient
		3	Cubic Coefficient
	14	1-4	1=head, 2=upper torso, 3=middle torso, 4=lower torso
17	1	Radial Linear Coefficient	
	2	Radial Quadratic Coefficient	
	3	Radial Cubic Coefficient	
	4	Radial Damping Coefficient	
	5	Tangential Damping Coefficient	

NOTE: During creation of packed binary tables, certain entries are modified to mark processing progress. Field 1 is set zero when all info packed except codes 3, 4, 5, and 9 which are set -1 if not table and to table number if table and code 16 which is set to card number. Field 2 is set to beginning index in KCON for codes 1 and 11 during packing.

TABLE 33. THE STANDARD AREA IN STOACT FOR INPUT

Index	Description
1-5	Read in five quantities from card 412
6-155	Linearized storage for CMU (ellipse region coefficient) friction, friction, no. (3) class (5) class (10) Each entry 1-5 stored within 6-155

TABLE 34. THE TYPICAL ELLIPSE ENTRY IN STOACT FOR INPUT

Rel Index	Description	MVMA Input Card
1	Attachment Indicator (KSEG)	219-5
2	Friction Class (negative signals Card 249)	219-6
3	Ellipse center x value in link-fixed coordinate system (XEM)	220-3
4	Ellipse center z value in link-fixed coordinate system (ZEM)	220-4
5	Semi-axis length (a) (negative signals 305)	220-5
6	Semi-axis length (c) (nonzero signals 220)	220-6
7	Ellipse orientation angle in reference system (THEM)	220-7
8	Secondary attachment indicator (KSEGB) (nonzero when KSEG,KSEGB=4,5;5,4;5,6;6,5;7,8;8,7)	220-8
<p>If field 1 is positive, Ellipse is rigidly attached and entry ends here. Otherwise, Ellipse is primary ellipse for non-body link and fields 8-27 below are present.</p>		
9	Mass of non-body link	249-7
10	Moment of Inertia for non-body link	249-8
11	User segment number for non-body link	249-9
12-13	Table name for radial force coefficients	249-5
14-15	Table name for tangential damping coeff.	249-6
16-19	Torsion Material Name (16 characters)	249-3,4
20	Initial ellipse center x-coordinate (XEMO)	305-3
21	Initial ellipse center x velocity (XEMOD)	305-4
22	Initial ellipse center z-coordinate (ZEMO)	305-5
23	Initial ellipse center z velocity (ZEMOD)	305-6
24	Initial ellipse orientation angle (THEMO)	305-7
25	Initial ellipse angular velocity (THEMOD)	305-8
26	Equilibrium x of non-body link CG	219-7
27	Equilibrium z of non-body link CG	219-8
28	Equilibrium link angle orientation	219-9

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TABLE 35. THE TYPICAL G OR R TABLE ENTRY IN STOACT FOR INPUT

Relative Index	Description	Typical Material Input Card
1-2	G & R Table Name (8)	405 - 1 or 406 - 1
3	δ	405 - 2 or 406 - 2
4	G or R	405 - 3 or 406 - 3

TABLE 36. THE TYPICAL MATERIAL ENTRY IN STOACT FOR INPUT

Relative Index	Description	Typical Material
1-4	Material Name (16)	403 - 1,2
5	δ_A	403 - 3
6	δ_B	403 - 4
7	δ_C	403 - 5
8	δ_D	403 - 6
9	δ_F	403 - 7
10	F_{max}	403 - 8
11	β	403 - 9
12	ϵ_p	404 - 3
13	Viscous damping coeff., $\dot{\delta} > 0$	404 - 4
14	Viscous damping coeff., $\dot{\delta} < 0$	404 - 5
15	(not used)	404 - 6
16 - 17	Static Curve Name (8)	404 - 7
18 - 19	Inertial Spike Curve Name (8)	404 - 8
20 - 21	G & R Ratio Name (8)	404 - 9
22	Number of bilinear unloading curves, NBI	413 - 3
23	δ_1 for first unloading curve	
24	δ_2	
25	δ_3	
26	S_1	
27	S_2	
⋮		
⋮		
⋮		
⋮		
22+5 NBI	(unloading curve parameters for successive curves)	

TABLE 37. THE TYPICAL REGION CONTACT ENTRY IN STOACT FOR INPUT

Relative Index	Description	MVMA Input Card
1	Deformation type switch	401 - 5
2	Multiellipse force apportionment switch	401 - 6
3	Multisegment force apportionment switch	401 - 7
4	Cavity switch	401 - 8
5	NSR	402 - 3
6	Friction class (1 to 10)	402 - 4
7	Migration switch	402 - 5
8	Attachment Reference Indicator (KPATCH)	402 - 6
9	Output coordinate switch	402 - 7

TABLE 38. THE TYPICAL LINE SEGMENT CONTACT ENTRY IN STOACT FOR INPUT

Relative Index	Description	MVMA Input Card
1-4	Line Segment Name (16)	409 - 1,2
5-8	Region Name (16)	409 - 3,4
9	Penetration Limit	409 - 5
10	Edge Constant	409 - 6
11	Direction Factor	409 - 7
12	Line segment number in region	409 - 8
13	Number of time points to be specified	410 - 3
14	Mass compliance at 2	410 - 4
15	Bending constant at 2	410 - 5
16	Mass compliance at 1	410 - 6
17	Bending constant at 1	410 - 7

TABLE 39. THE TYPICAL ENTRY FOR STATIC CURVE OR INERTIAL SPIKE IN STOACT FOR INPUT

Relative Index	Description	MVMA Input Card	
		Static	Spike
1-2	Curve Name (Static or Spike)	407 - 1 or	408 - 1
3	δ if positive, table if negative, polynomial	407 - 2 or	408 - 2
4	If table, F; if polynomial, C_1 If table, entry ends here. If polynomial, five more lines.	407 - 3 or	408 - 3
5	C_2	407 - 4 or	408 - 4
6	C_3	407 - 5 or	408 - 5
7	C_4	407 - 6 or	408 - 6
8	C_5	407 - 7 or	408 - 7
9	C_6	407 - 8 or	408 - 8

TABLE 40. THE TYPICAL INHIBITION ENTRY IN STOACT FOR INPUT

Relative Index	Description	MVMA Input Card
1-4	Ellipse Name (16)	106 - 1,2
5-8	Ellipse or Region Name (16)	106 - 3,4

TABLE 41. THE TYPICAL TIME POINT ENTRY FOR LINE IN STOACT FOR INPUT

Relative Index	Description	MVMA Input Card
1	t	411 - 3
2	x_i	411 - 4
3	z_i	411 - 5
4	x_{i+1}	411 - 6
5	z_{i+1}	411 - 7

TABLE 42. THE TYPICAL MUSCLE TENSION OR HEAD FORCE TABLE ENTRY IN STOACT FOR INPUT

Relative Index	Description	MVMA Input Card	
1 - 2	Muscle Tension Table Name	238-1	or 606-1
3	Time	238-2	or 606-2
4	Muscle Contraction force or moment	238-3	or 606-3

TABLE 43. THE TYPICAL SHOULDER STIFFNESS COEFFICIENTS ENTRY IN STOACT FOR INPUT

Relative Index	Description	MVMA Input Card
1	Relative shoulder angle	238 + ILOOK*, 1
2	Radial shoulder stiffness coefficient.	238 + ILOOK*, 2

* ILOOK is from the corresponding KACT control entry (see Table 32) and also controls whether the coefficient is linear, quadratic, or cubic.

TABLE 44. THE TYPICAL STEERING COLUMN REACTION MATERIAL OR JOINT MATERIAL ENTRY IN STOACT FOR INPUT

Relative Index	Description	MVMA Input Card
1 - 4	Name assigned to body part material	804 + ILOOK*, 1-2

* ILOOK is from the corresponding KACT control entry (see Table 32) and also controls whether the body part is head, upper torso, middle torso, or lower torso.

TABLE 45. THE TYPICAL STEERING WHEEL MATERIAL ENTRY IN STOACT FOR INPUT

Relative Index	Description	MVMA Input Card
1-4	Steering Wheel Edge Material Name	810, 1-2
5-8	Steering Wheel Center Material Name	810, 3-4
9-12	Steering Wheel Hub Material Name	810, 5-6

TABLE 46. THE TYPICAL STEERING COLUMN REACTION MATERIAL ENTRY IN STOACT FOR INPUT

Relative Index	Description	MVMA Input Card
1-4	Reaction 1 Material Name (F_{A1})	811, 1-2
5-8	Reaction 2 Material Name (M_{J1})	811, 3-4
9-12	Reaction 3 Material Name (F_{A2})	811, 5-6
13-16	Reaction 4 Material Name (M_{J2})	811, 7-8

TABLE 46A THE TYPICAL ELLIPSE ATTACHMENT COEFFICIENT ENTRY IN STOACT FOR INPUT

Relative Index	Description	MVMA Input Card
1-2	Table Name	249 + ILOOK*, 1
3	Circumferential Angle	249 + ILOOK*, 2
4	Ellipse Attachment Coefficient	249 + ILOOK*, 3

* ILOOK is from the corresponding KACT control entry (see Table 32). ILOOK controls whether coefficient is linear, quadratic, or cubic radial stiffness, or a radial damping coefficient, or a tangential damping coefficient.

4.3.3 Binary Output Formats. The completed tables of input values are recorded back on direct access binary file NU. Table 47 shows the contents of the second fixed section and the variable section of this file line by line or section by section. Where there are parentheses separated from the Fortran name by a comma, the parentheses give the individual or range of values in the array DATA. This may be related to the corresponding MVMA Input Card by use of Table 16. The Fortran name shown is the name used in the Dynamic Solution Processor (GO). The values are laid out to show their corresponding position(s) in each binary record and no conclusions should be drawn from the number of values shown on any typewritten line or the number of typewritten lines per record description.

The Input Processor records all information described in Table 47 except the last three blocks of information. These blocks are supplied by GO and OUT. The length of each of these blocks is shown in Table 48. When IN is completed, the binary file produced contains the entire input for the model organized in such a manner that GO and OUT can use it. Two arrays produced before writing commences, LEAD and ICBEQ, act as a table of contents for the variable length and optional recording blocks.

LEAD contains the beginning record numbers of the blocks of information from the input data. ICBEQ usually contains the beginning record numbers for each output category from GO. In both cases, if the corresponding entry of the array is zero, the information block will not be written. Table 47 contains in the left margin an "Ln" or "In" where n is an integer to show which value of LEAD or ICBEQ, respectively, controls that information block.

4.3.4 Auxiliary Program Output. The Input Processor has no standard printout but does have the same debug switch as INP. Debug level one will produce the printout of the Packing Dictionary and Binary File Index Summary, as well as a printout of the loop counts from subroutine SETVAL. Debug level two adds a printout of each record written into file NU. Auxiliary printout for IN consists of three types: (1) the optional Packing Dictionary (Table 49), (2) the optional Binary File Index Summary (Table 50), and (3) the automatic error messages in case of trouble (Table 51).

The Packing Dictionary prints out a summary of the information stored in the packing tables when complete (see Section 4.4.3 for details). It is useful in two respects. First, a glance at the summary will confirm that the run configuration has been properly specified. Second, GO uses the KCON Beginning Index as an internal identification number for ellipses, regions, lines, and materials. The debugging information reflects these same internal numbers and the Packing Dictionary can be used to make the correspondence back to the original user-supplied names.

The Binary File Index Summary is a synopsis of the various controlling switches and of the array LEAD and ICBEQ in parts "C" and "D," respectively (for details see Section 4.3.3).

Captions in Table 50 merit some comments. Both the number of ellipses and the number of regions contain the number of belt segments used. Number of contact controls is the length of KCON and the number of contact values is the length of STOACT. Section C is the beginning record number for the belt section followed by the LEAD array, followed by the beginning record number of the INTACT array. Part D is a presentation of the ICBEQ array.

The error messages are self-explanatory and are printed only as needed.

4.3.5 Programs Written by IN. The last function of the Input Processor is to use the calculated dimensions for RQ and IQ and the option tabulation to write the main program and transfer vector routine for GO. Example programs are given in Tables 52 and 53, respectively. See Table 55 in the GO section of this volume for all possible routines called by TRAVEC.

TABLE 47. INDEXED BINARY OUTPUT DATA SET ON LOGICAL DEVICE NUMBER NU FROM IN
[8]

Record Number	Contents
INSX + 1	NBELT, (1,2) NBAG, (2,2) NELLS NLINES NREGNS -NTIMES NACTUL NINTAC ICBEG(1) ICBEG(12)
INSX + 2	ICBEG (13) ICBEG(32)
	NOTE: ICBEG(1) and (5) - (40): Beginning record number of category (γ_{n-1}) ICBEG(2): Logical device number for sequential accel. output (MU) ICBEG(3): Logical device number for direct access interaction output (MV) ICBEG(4): Beginning record number of INTACT table 1-4 is set negative if corresponding category not wanted; 5-40 is set 0 if corresponding category not wanted.
INSX + 3	HTITLE(1) . . . HTITLE(18) TTITLE(1) TTITLE(2)
INSX + 4	STITLE(1) . . . STITLE(20)
INSX + 5	STITLE(21) . . . STITLE(35) TTITLE(3) . . . TTITLE(7) Note: TTITLE(1)-(3): Date TTITLE(4)-(5): Time TTITLE(6)-(7): Job Name
INSX + 6	ICBEG(33) . . . ICBEG(40) MTIMES KPTIMS TB(5,1) TF (6,1) DT (7,1) PTINC (8,1) PLINC (9,1) NSTCOL (3,2) MKSSWT IUSEM IUSEK IPREP
INSX + 7	LHIB,(4,2) KHIB,(5,2) ILL,(6,2) EPSINV,(8,2) MX,(9,2) DSTEPX,(1,3) DSTEPN,(2,3) FORLIM,(3,3) HARDCN,(4,3) LIMCNT,(5,3) TPC,(6,3) EPSFAC,(7,3) BETELP,(8,3) GAMELP,(9,3) NUMTAB LIMTAB NUMENT LIMENT LENMAT LENKON
INSX + 8	EDEPS, XH,(1,22) XHD,(2,22) ZH,(3,22) ZHD,(4,22) ELN,(5,22) ELND,(6,22) XS,(1,21) XSD,(2, 21) ZS,(3, 21) ZSD,(4,21) THETA(1-9),(1-9,20)
INSX + 9	XV,(1,24) XVD,(2,28) ZV,(3,24) ZVD,(4,24) THV,(5,24) THVD,(6,24) AA,(7,24) C,(8,24) VM,(9,24) THDI(1-9), (1-9,46) AH,(1,19) AC,(2,19)
INSX + 10	HEAD.(1-3), (2-4,38) FLJI(2-8), (1-7,6) ASH, (8,6) FLI(1-8), (1-8,7) NP
INSX + 11	AMUS(1-11,1),(1,48-58) FMI(1-8), (1-8,8) EM9, (9,8)

Notes: 1. NU presently set to 8.
2. Record length for file NU is 80.

TABLE 30. INDEXED BINARY OUTPUT DATA SET ON LOGICAL DEVICE NUMBER NU (continued) IN

Record Number	Contents
INSX + 12	AMUS(1-11, 2), (2,48-58) FI(1-8), (1-8,9) ALF, (9,7)
INSX + 13	AMUS(1-11,3), (3,48-58) THROI(1-8), (1-8,18) BSH, (9,6)
INSX + 14	TMUS(1-11)(4,48-58) NPTS(1-3) NSTART(1-3) INTOP, (4,1) NNOACC FNU, (7,2)
INSX + 15	KJI(1-12,1), (1, 10-17; 42-45) KJI(1-8,2) (2,10-17)
INSX + 16	KJI(9-12,2), (2,42-45) KJI(1-12,3), (3,10-17; 42-45) CJI(1-4), (4,10-13)
INSX + 17	CJI(5-12), (4,14-17; 42-45) FJI(1-12), (5,10-17;42-45)
INSX + 18	VJI(1-12), (6,10-17;42-45) RJI(1-8), (9,10-17)
INSX + 19	RJI(9-12), (9,42-45) THSI(1-12,1), (7,10-17; 42-45) THSI(1-4,2), (8,10-13)
INSX + 20	THSI(5-12,2), (8,14-17; 42-45) G, (3,1) MUSNAM (3,1-11)
INSX + 21	CMU(1-5,1-4,1) or STOACT (6-25)
INSX + 22	CMU(1-5,5-8,1) or STOACT (26-45)
INSX + 23	CMU(1-5,9-10,1) and CMU(1-5,1-2,2) or STOACT(46-65)
INSX + 24	CMU(1-5,2-6,2) or STOACT(66-85)
INSX + 25	CMU(1-5,7-10,2) or STOACT(86-105)
INSX + 26	CMU(1-5,1-4,3) or STOACT (106-125)
INSX + 27	CMU(1-5,5-8,3) or STOACT(126-145)
INSX + 28	CMU(1-5,9-10,3) or STOACT(146-155) THEX(1-8), (1;3;5;7,4-5) HEX(1), (2,4) (19 long)
INSX + 29	<div style="display: flex; align-items: center;"> <div style="margin-right: 20px;"> <p>(4;6;8,4)</p> <p>HEX(2-8), (2;4;6;8,5)</p> </div> <div style="border-top: 1px solid black; padding-top: 5px;"> <p style="text-align: center;">LEAD(1-12)</p> <p style="text-align: center;"> $a_A a_B a_C a_D a_E a_F a_G a_H a_I a_{\alpha+1} a_{\beta+1} a_{\gamma+1}$ </p> </div> <div style="margin-left: 20px;"> <p>LACCEL</p> </div> </div>
INSX + 30	<p>KONSIS KTABSW(1-3) NUMACC HIC(1-2) KJI(13,1), (1,61)</p> <p>KJI(13,2), (2,61) KJI(13,3), (8,61) CJI(13) (9,61), NCR, FEMSOR, SKMASS, NBAGS ICBEG(61)...ICBEG(64) (19 long)</p>
INSX + 31	HICTA(1-2) HICTB(1-2) TMADC(1-16)
INSX + 32	<div style="display: flex; align-items: center;"> <div style="border-left: 1px solid black; border-right: 1px solid black; padding: 0 10px;"> <p>MUSNAM (3, 12-13)</p> <p>NFORCE(1-2)</p> </div> <div style="margin: 0 20px;"> <p>JFORCE, AF, CF, MJOINT(1-11), AHH, CONDYL, TRAD(9,18)</p> </div> <div style="text-align: right;"> <p>PLINCB</p> </div> </div>
INSX + 33	ICBEG(41)...ICBEG(60)

TABLE 30. INDEXED BINARY OUTPUT DATA SET ON LOGICAL DEVICE NUMBER NU (continued)

Record Number	Contents
INSX + 34	MATLJT (1-20)
INSX + 35	CVALUE (1-20)
INSX + 36	CVALUE (21-40)
INSX + 37	CVALUE (41-60)
INSX + 38	CVALUE (61-80)
INSX + 39	CVALUE (81-100)
INSX + 40	YDEL (1-7) (5-9, 42; 8-9, 33) BELTL (1-7) (5-9, 29; 1-2, 30)
INSX + 41	ITABV (1-12)
INSX + 42	KTABLT (1-7) FMAXRT (1-7)
INSX + 43	JFRELL (1-20,1)
INSX + 44	JFRELL (21-27,1) JFRELL (1-13,2)
INSX + 45	JFRELL (14-27,2) JFRELL (1-6,3)
INSX + 46	JFRELL (7-26,3)
INSX + 47	JFRELL (27,3) JFRELL (1-19,4)
INSX + 48	JFRELL (20-27,4) KFRELL (1-12,1)
INSX + 49	KFRELL (13-32,1)
INSX + 50	KFRELL (33-37,1) KFRELL (1-15,2)
INSX + 51	KFRELL (16-35,2)
INSX + 52	KFRELL (36,2) KFRELL (37,2) LVIELL LVIREG NSEG MAXSEG NOFRAT

TABLE 47. INDEXED BINARY OUTPUT DATA SET ON LOGICAL DEVICE NUMBER NU (continued)

Record Number	Contents
	if NBELT = 1 or 2
NCR	XVAI(1-4), (1;3;5;7,23) ZVAI(1-4), (2;4;6;8,23) CSIB1, (4,19) ZETAB1, (5,19) CSIB2,(6,19) ZETAB2, (7,19) CSIB3, (8,19) ZETAB3, (9,19) LBLO, (1,25) DELBL, (2,25) LBTUO, (3,25) DELBTU, (4,25) FBLMAX, (5,25) FBTMAX, (6,25) (Real)
NCR+1	LBTLO, (5,26) DELBTL, (6,26) LBTLA, (7,26) MUR, (8,25) DELTB, (7,25)
	if NBELT = 3
NCR	((ATTANC (I,K,J), K=1,2), I = 1,2), J = 1,5), (1-4,47-51)
NCR+1	((ATTANC (I,K,J), K = 1,2), I = 1,2), J = 6,7), (5-8,52-53) SLAK(1-7), (9,47-53) INFLNC, (5,54) MBELT, (6,54) LBTLA, (7,54) YSEP(1-2), (8-9,54)
NCR+2	IPRMT(2-3), (5-6,55) REPS, (7,55) XEPS(1) (8,55) XLAPAJ, (9,55) (1,59) (2,59) BMUK, (5,56) BMUS, (6,56) ZINFL (7,56) INF(1,2) (8,56) RFSAT, (9,56) AFSAT, (1,60) PERCNT, (2,60) ANCHOR(1-4), (5-8,57) RING(1-2), (9,57), (7,60)
NCR+3	RINGMU(1-2), (8-9,60) REEL(1-3), (5,58), (9,25), (1,38) TLOCK(1-3), (6,58), (1,26), (5,38) ALOCK(1-3), if webbing - (9,62), (9,26), (9,38); if vehicle (7,58), (2,26), (6,38) PLOCK(1-3), (8,58), (3,26), (7,38) VLOCK(1-3), (9,58), (4,26), (8,38) KSA(1-3)
NCR+4	SETFLG(1-2,1-7) KSA(4-7) BFLAG(1-2)

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TABLE 47. INDEXED BINARY OUTPUT DATA SET ON LOGICAL DEVICE NUMBER NU FROM IN

Record Number	Contents
NOTE:	$\text{if NBELT} = \begin{cases} 0 & \text{then } a_A = \text{NCR} \\ 1 \text{ or } 2 & \text{then } a_A = \text{NCR} + 2 \\ 3 & \text{then } a_A = \text{NCR} + 5 \end{cases}$ <p>NCR currently set to $\text{INSX} + 53$</p>
L1 a_A	SCMU(4,3), (4,30), (7,59), (4,60), (4,61), (5,30), (8,59), (5,60), (5,61), (6,30), (9,59), (6,60), (6,61) SZETA(1-4) (2,4,6,8;62) SCENTX, (3,59) SCENZ, (4,59) NNSTRW LHX111
$a_A + 1$	MATLSC(1-11) SZETAI(1-3), (6,59), (3,60), (3,61) HL, (1,27) HLD, (2,27) SCSI(1-4), (1,3,5,7;62) HAL1, (3,27)
$a_A + 2$	HALID, (4,27) HAL2, (5,27) HAL2D, (6,27) HH, (7,27) HHD, (8,27) HA(1,28) HRW(2,28) HLOC(3,28) HL1(4,28) HH1(5,28) HS1(6,28) HS2, (7,28) HS5, (8,28) HI1, (1,29) HI2, (2,29) HM1, (3,29) HM2, (4,29) RHOI(1-2), (3,30), (5,59)
$a_{A1} = a_A + 3 + \left[\frac{\text{NNSTRW} + 19}{20} \right]$	HTX11() 20 to a line
$a_A + 3$ to $a_{A1} - 1$	
$a_{A2} = a_{A1} + \left[\frac{\text{NNSTRW} + 19}{20} \right]$	HX111() 20 to a line
a_{A1} to $a_{A2} - 1$	
NOTE:	if steering column, $a_B = a_{A2}$; if not, $a_B = a_A$
L2 a_B	<p>(Real)</p> <p>if airbag</p> <p>NGLSW, (1,31)</p> <p>RLTHET, (2,31) WIDTH, (3,31) PRMTOL, (4,31) ITRTOP, (5,31)</p> <p>BPERIM, (6,31) BGPRSS, (7,31) ORFICE, (8,31) BGXCOR, (9,31)</p> <p>BGZCOR, (1,32) OCCWID(1-5), (3-7,32) RX, (1,33) PEX, (2,33)</p> <p>NFLUXP NGASTM NBAGPR LOMDOT</p>
$a_B + 1$	CSI(1-10), (1,3,5,7;39-41) ZETAI(1-10), (2,4,6,8;39-41)--Note: only 1st two used for 41.
$a_B + 2$	GAMMB, (3,33) TAU, (4,33) CP, (5,33) SPSI, (6,33) RHEAD, (7,33) IDPT, (1-2,1-6) LIBCNT
$a_{B1} = a_B + 3 + \left[\frac{\text{NFLUXP} + 19}{20} \right]$	BTIM() 20 to a line
$a_B + 3$ to $a_{B1} - 1$	
$a_{B2} = a_{B1} + \left[\frac{\text{NFLUXP} + 19}{20} \right]$	MDOT() 20 to a line
a_{B1} to $a_{B2} - 1$	

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IN

TABLE 47. INDEXED BINARY OUTPUT DATA SET ON LOGICAL DEVICE NUMBER NU FROM IN

Record Number	Contents
$a_{B3} = a_{B2} + \left[\frac{NGASTM + 19}{20} \right]$ a_{B2} to $a_{B3} - 1$	TTIM() 20 to a line
$a_{B4} = a_{B3} + \left[\frac{NGASTM + 19}{20} \right]$ a_{B3} to $a_{B4} - 1$	TEMPS() 20 to a line
$a_{B5} = a_{B4} + \left[\frac{NBAGPR + 19}{20} \right]$ a_{B4} to $a_{B5} - 1$	DELTAP() 20 to a line
$a_{B6} = a_{B5} + \left[\frac{NBAGPR + 19}{20} \right]$ a_{B5} to $a_{B6} - 1$	PERM() 20 to a line

TABLE 47. INDEXED BINARY OUTPUT DATA SET ON LOGICAL DEVICE NUMBER NU

Record Number	Contents
L2 a_B	NBAGS, (1,1) NENCV, (2,1) NABOVE, (3,1) RGAS, (1,2) MOLEWT, (2,2) GAMMG, (3,2) CPG, (4,2) PATM, (5,2) TATM, (6,2) RHEADG, (7,2) PEPS, (1,3) EPSM, (2,3) EP1, (3,3) EP2, (4,3) EP3, (5,3) EP4, (6,3) DMIN, (7,3) ITPMAX, (8,3) ITMMAX, (9,3)
<u>if advanced airbag</u>	
a_{B+1}	(CSI(I),ZETAI(I),I=1,4), (1-8,4) (CSI(J),ZETAI(J),J=5,8), (1-8,5) (CSI(K),ZETAI(K),K=9,10), (1-4,6)
a_{B+2}	IUSEKG, IUSESG, IUSEKC, (YIDTH(I), I=1,5),(5-9,6)
$a_{B1} = a_B + 3 + \left[\frac{IUSEKG + 19}{20} \right]$	KBAG() 20 to a line
$a_B + 3$ to $a_{B1} - 1$	
$a_{B2} = a_{B1} + \left[\frac{IUSESG + 19}{20} \right]$	STOBAG() 20 to a line
a_{B1} to $a_{B2} - 1$	
$a_{B3} = a_{B2} + \left[\frac{IUSEKC + 19}{20} \right]$	KENC() 20 to a line
a_{B2} to $a_{B3} - 1$	
$a_{B4} = a_{B3} + \left[\frac{NBAGS + 1}{2} \right]$	Airbag names, KBAGNM (8,20), 2 names to a line
a_{B3} to $a_{B4} - 1$	

TABLE 47 . INDEXED BINARY OUTPUT DATA SET ON LOGICAL DEVICE NUMBER NU

Record Number	Contents
NOTE: simple airbag if advanced airbag, neither	$a_B + 9$ $a_C = a_{B4}$ a_B
L3 $a_D = a_C + \left[\frac{IUSEK + 19}{20} \right]$ Records a_C to $a_D - 1$	KCON() 20 to a line
L4 $a_E = a_D + \left[\frac{IUSEM + 19}{20} \right]$ Records a_D to $a_E - 1$	STOMAT() 20 to a line
L5 $a_F = a_E + \left[\frac{NUMTAB + 3}{4} \right]$ Records a_E to $a_F - 1$	MSTOR(,5) 4 to a line stored on rows

TABLE 47. INDEXED BINARY OUTPUT DATA SET ON LOGICAL DEVICE NUMBER NU (continued)

Record Number	Contents
L6 $a_G = a_F + \left[\frac{\text{NUMENT} + 19}{5} \right]$ Records a_F to $a_G - 1$	STOR() 20 to a line
L7 $a_H = a_G + \left[\frac{2 * \text{ITS} + 9}{10} \right]$ Records a_G to $a_H - 1$	all TACC(), then all ACC() 20 to a line
L8 $a_I = a_H + \left[\frac{\text{NUMTAB} + 9}{10} \right]$ Records a_H to $a_I - 1$	NAMTAB (,2) 10 to a line stored on rows
L9 $\alpha = a_I + \left[\frac{\text{NELLS} + 1}{2} \right]$ Records a_I to $\alpha - 1$	Ellipse names [KELLM(8,27) or ELLNAM(8,27)]: Ellipse A Material A Ellipse B Material B
L10 $\beta = \alpha + \left[\frac{\text{NLINES} + 4}{5} \right]$ Records α to $\beta - 1$	Contact line names [KCONAM(4,50) or CONNAM(4,50)]: Line A Line B Line C Line D Line E
L11 $\gamma = \beta + \left[\frac{\text{NREGNS} + 1}{2} \right]$ Records β to $\gamma - 1$	Region names [KREGNM(8,27) or REGNAM(8,27)]: Region A Material A Region B Material B
L12 $\gamma_0 = \gamma + \left[\frac{\text{NREGNS} + 3}{4} \right]$ Records γ to $\gamma_0 - 1$	KREGNS(5,27): Region A Region B Region C Region D

TABLE 47. INDEXED BINARY OUTPUT DATA SET ON LOGICAL DEVICE NUMBER NU (continued)
(continued)

Record Number	Contents
I1	$\gamma_1 = \gamma_0 + \text{NTIMES}$: Entry for category 1 (NTIMES long) Records γ_0 to $\gamma_1 - 1$ [n=1]
I5 to I40	$\gamma_n = \gamma_{n-1} + \text{NTIMES}$: Entries are possible for categories 5-40 and 46-60 (each NTIMES long). n is incremented for each category actually entered. Records γ_{n-1} to $\gamma_n - 1$
I4	$p = n_{\text{max}} + 1$: INTACT table (NINTAC entries) Records γ_p to $\gamma_p + \text{NINTAC}$

TABLE 48. BINARY RECORD LENGTHS FOR OUTPUT CATEGORIES

Category	Record Length			Category	Record Length
1	10			36	12
2	9			37	10
3	12			38	11
4	1-12 E-L=14 (12 are printed)	13-23 E-E=11	24-31 B = 8	39	11
5	10			40	7 (5 are printed)
6	9			46	9
7	9			47	6
8	12			48	6
9	12			49	8
10	10			50	8
11	10			51	12
12	10			52	9
13	10			53	9
14	10			54	9
15	9			55	9
16	11			56	9
17	5			57	10
18	7			58	12
19	10			59	6
20	15			60	11
21	10			61	11
22	10			62	11
23	8			63	9
24	8			64	12
	Category 4 is special case			Category 40 is special case	
		Binary record			Binary record
	Printed Columns	word position		Printed Columns	word position
25	8	1	1	1	7
26	8	2	13	2	1
27	9	3	2	3	2
28	8	4	14	4	5
29	10	5	3	5	4
30	9	6	4		
31	9	7	5		
32	9	8	6		
33	12	9	7		
34	8	10	8		
35	12	11	9		
		12	10		

PACKING DICTIONARY

A. ELLIPSES

LINK NO.	NAME	KCON B.I.	STOMAT B.I.	MATL B.I.	NAME IN
1	HEAD	71	1	0	1
2	THORAX	88	8	106	2
4	HIP	111	20	128	3
5	THIGH	133	27	0	4
5	KNEE	149	39	0	5
6	SHANK	165	46	0	6
6	HEEL	181	58	0	7
6	TOE	198	65	0	8
7	ELBOW	214	72	0	9
8	HAND	228	79	0	10

B. CONTACT REGIONS AND SEGMENTS

NAME	KCON B.I.	STOMAT B.I.	MATL B.I.	NAME IND	W.R.T. SYSTEM
SEAT BACK	244	135	269	1	7
BACK LINE	258	150	269	1	
SEAT CUSHION	274	199	269	2	7
CUSHION LINE 1	289	222	269	2	
CUSHION LINE 2	300	244	269	3	
FLOOR	311	276	348	3	7
SEAT BOTTOM	326	299	348	4	
FLOORBOARD	337	321	348	5	
TOEPAN	353	353	348	4	7
TOEBOARD	367	368	348	6	
KNEE BAR	378	410	403	5	7
KNEEBAR LINE	392	425	403	7	
ROOFHEADER	408	489	433	6	7
LR	422	504	433	8	
WINDSHIELD	438	531	463	7	7
LW	452	546	463	9	
INSTRUMENT PANEL	468	573	505	8	7
MID IP	483	596	505	10	
LOWER IP	494	618	505	11	
DASH	510	680	535	9	7
DASHLINE	524	695	535	12	

C. BELTS---NO BELTS USED.

D. MATERIALS

NAME	KCON B.I.	STOMAT B.I.
CHESTMATL	106	91
HIPMATL	128	113
SEAT MATERIAL	269	177
FMATL	348	837
SHEET METAL	403	467
RMATL	433	759
WINDSHIELD GLASS	463	787
IPMAT	505	815
DASHMATL	535	737
6% WEBBING #1	540	859
6% WEBBING #2	545	881
NO STRENGTH	550	903
JOINT MATA	555	931
JOINT MATB	560	959
JOINT MATC	565	987
JOINT MATD	570	1015
JOINT MATE	575	1043

Table 49. Facsimile Packing Dictionary
from IN (page 1 of 3)

JOINT MATF 580 1071
 JOINT MATG 585 1099

IN

E. TABLES

NO.	NO.	PTS.	BEG. IND.	SCAN	TYPE	NAME
1	4		1	1		CGR
2	7		15	1		CSTAT
3	6		41	1		SSEAT
4	3		63	1		GRSHEET
5	7		73	1		GRSHEET
6	6		99	1		SSHEET
7	3		121	1		DGR
8	5		131	1		DGR
9	4		149	1		DSTAT
10	5		163	1		WGR
11	5		181	1		WGR
12	3		199	1		IPGR
13	5		209	1		IPGR
14	14		227	1		IPSTAT
15	2		281	1		FGR
16	2		287	1		FGR
17	12		293	1		FSTAT
18	5		339	1		GBELT1
19	5		357	1		GBELT1
20	6		375	1		SBELT1
21	6		397	1		SBELT2

F. CARD TYPES READ

TYPE NO.	TYPE NAME	NUMBER	TYPE NO.	TYPE NAME	NUMBER
1	ELLIPSE	10	9	F-TABLE	35
2	MATERIAL	12	10	TIME POINT	27
3	G-TABLE	24	11	REL REGION	9
4	STATIC CURVE	64	12	MUSCLE	0
5	INERT SPIKE	2	13	SHOULDER	0
6	LINE	12	14	STR WHL-BODY	0
7	INERTIAL REG	0	15	STEER WHEEL	0
8	INHIBITION	22	16	ST WHL REACT	0

G. SUMMARY OF COUNTS.

A= 8 B= 0 C= 0 D= 59 E= 4 F= 66
 G= 7 H= 10 I= 32 J= 1 K= 0 L= 12
 M= 12 N= 1 O= 21 R= 9 S= 6 T= 27
 V= 21 W= 115 X= 0 KK= 0 Y= 0 Z= 0
 AA= 0 AB= 0 AC= 0 AD= 0
 ACC X PTS= 23 ACC Z PTS= 2 ACC PITCH PTS= 2
 IQ DIMENSION= 2085 RQ DIMENSION= 4522
 NELPRG= 0 NNITI= 0 NNITJ= 0 NELPLN= 0

H. VARIABLE-LENGTH STORAGE LAYOUT

REAL ARRAYS

NAME	BEG. IND.,	LENGTH	OFFSET	BEG.
STOMAT	1	1132		0
STOACT	1133	2292		1132
COMOUT	3425	584		3424
TACC	4009	27		4008
ACC	4036	27		4035
MDOT	4063	0		4062
BTIM	4063	0		4062
TEMPS	4063	0		4062
TTIM	4063	0		4062

Table 49. Facsimile Packing Dictionary from IN (page 2 of 3)

IN

PERM	4063	0	4062
DELTAP	4063	0	4062
BAGUL	4063	0	4060
STH	4063	0	4062
STOMTG	4105	0	4104
STOMUG	4063	42	4062
ADUM	4105	0	4104
STOR	4105	418	4104
HX11I	4523	0	4522
HTX11	4523	0	4522
EDGE	4523	0	4522
DD1	4523	0	4522
DD2	4523	0	4522
SS	4523	0	4522
FF	4523	0	4522
PEN	4523	0	4522

INTEGER ARRAYS

NAME	BEG. IND.	LENGTH	OFFSET BEG.
KCON	1	589	0
KACT	590	1125	589
KMIG	1715	0	1714
KMUG	1715	0	1714
IECNT	1715	0	1714
MSTOR	1715	126	1708
KELLNM	1841	80	1832
KCONAM	1921	48	1916
KREGNM	1969	72	1960
KREGNS	2041	45	2035
KCI	2086	0	2085
KOT	2086	0	2085
IDELL	2086	0	2085
KOTT	2086	0	2085
JOT	2086	0	2085

I. OPTIONAL ROUTINE USAGE

NUMBER	ROUTINE NAME	STATUS
1	DELT	OMIT
2	BELT2	OMIT
3	STEER	OMIT
4	AIRDA	OMIT
5	INTSCT	OMIT
6	SETMIG	OMIT
7	ELLELL	USE
8	MIG	OMIT
9	MULTI	OMIT
10	PLTR	USE

Table 49. Facsimile Packing Dictionary from IN (page 3 of 3)

BINARY L.D.N. 8 INDEX SUMMARY

A. TITLE:

MVMA 2-D TUTORIAL EXAMPLE #1
 OCT 18, 1973 02:51:55 (7-77) GM HYBRID II DUMMY
 (PRELIMINARY DATA) KNEE BAR OCC. COMP. DISPL.
 30MPH FRONT BARRIER NO BELTS

B. OPTIONS:

BELT= 0, BAG= 0, STEER COL= 0, MKS= 1, ACCEL RECORD= 1
 NO. ELLPS= 10, NO. REGS= 9, NO. LINES= 12
 NO. TIME STEPS= 201, NO. PRINT TIMES= 41 NO. PLOT TIMES= 21
 NO. CNTCT CON= 589, NO. CNTCT VALS= 1126, NUM TAB= 21
 NUM TAB ENT= 418, NO. ACCEL ENT= 27

C. BEGINNING RECORD NUMBERS FOR VARIABLE POSITION SECTIONS:

BELT= 0, STEER COL= 0, BAG= 0, CNTCT CONTRL= 71, CNTCT VALS= 101
 TABLE CONTRL= 158, TABLE VALS= 163, ACCEL= 184, TABLE NAMES= 187
 ELLPS NAMES= 190, LINE NAMES= 195, REG. NAMES= 198, REG. CONTRLS= 203
 INTERACTION CONTROLS=1600

D. BEGINNING RECORD NUMBERS FOR OUTPUT CATEGORIES:

CATEGORY	RECORD NUMBER	CATEGORY	RECORD NUMBER
1	206	24	862
2	7	25	903
3	9	26	944
4	1600	27	985
5	0	28	1026
6	247	29	1067
7	288	30	1108
8	329	31	1149
9	370	32	1190
10	411	33	0
11	452	34	0
12	493	35	0
13	534	36	0
14	575	37	1231
15	616	38	1272
16	657	39	1313
17	698	40	1354
18	0	46	1395
19	0	47	1436
20	0	48	1477
21	739	49	1518
22	780	50	1559
23	821		

Table 50. Facsimile of Binary L.D.N. NU Index Summary from IN

TABLE 51. ERROR MESSAGES FROM IN (Page 1 of 5)

Number	Message	Condition and Action Required	Subroutine
1*	FATAL ERROR --- MORE THAN XXX TABLES REQUESTED.	Fatal, requested table is not set up and no entries for it are accepted.	ENTAB
2*	MORE THAN XXXX TABLE ENTRIES REQUESTED.	Fatal, the current entry replaces the last entry of the proper table.	ENTAB
3*	FATAL ERROR --- UNEXPECTED TYPE, IERR=XXX, CARD NO. XXXXX XXXXX XXXXX XXXXX .	Program or machine malfunction.	ERRMSG
4*	FATAL ERROR --- NO ROOM FOR BELT INTER-ACTION. CARD NO. XXXXX XXXXX XXXXX XXXXX .	Cut down ellipses and lines or redimension.	ERRMSG
5*	FATAL ERROR --- KCONAM SIZE EXCEEDED.	Cut down number of lines or redimension.	ERRMSG
6*	FATAL ERROR --- KELLNM SIZE EXCEEDED.	Cut down number of ellipses or redimension.	ERRMSG
7*	FATAL ERROR --- KREGNM SIZE EXCEEDED.	Cut down number of regions or redimension both KREGNM and KREGNS.	ERRMSG
8*	FATAL ERROR --- INPUT PACKING TABLES SIZE EXCEEDED.	Cut down volume of input or redimension KACT, STOACT, KCON and/or STOMAT.	ERRMSG
9	FATAL ERROR --- NOT AT LEAST TWO FRONTAL INTERIOR POINTS FOR AIRBAG CONTACT.	Turn off airbag switch (Card 102) or specify a sufficient number of points on 411-Cards.	ERRMSG
10	FATAL ERROR --- FRONTAL INTERIOR FOR AIRBAG CONTACT IS UPSIDE DOWN.	See Note 4 on Card 411.	ERRMSG
11	LAP BELT ATTACHMENT POINTS MUST BE COINCIDENT.	Fatal, error comment self-explanatory.	INMVMA
12	ANCHOR POINTS FOR BELTS 2 AND 3 MUST BE COINCIDENT.	Fatal, error comment self-explanatory.	INMVMA
13	FATAL ERROR --- ANCHOR(2) IS SPECIFIED ZERO, WHICH RESULTS IN ZERO BELT FORCES. SET NBELT EQUAL ZERO FOR INACTIVE BELTS SYSTEM OR SET ANCHOR(2) TO 1., 2., OR 3. FOR ACTIVE BELT SYSTEM.	Fatal, error comment self-explanatory.	INMVMA

TABLE 51. (CONT.) (Page 2 of 5)

Number	Message	Condition and Action Required	Subroutine
14	FATAL ERROR --- ERROR IN ADVANCED BELT SYSTEM SPECIFICATIONS ANCHOR(X) = X BUT BELT X IS --- PRESENT.	Self-explanatory	INMVMA
15	FATAL ERROR --- ERROR IN ADVANCED BELT SYSTEM SPECIFICATIONS. IF BELT 7 IS PRESENT AND BELT 6 IS NOT PRESENT THEN EITHER ANCHOR(1) MUST BE 3. OR RING(1) = 1. AND ANCHOR(3) = 3.	Self-explanatory	INMVMA
16	WARNING --- CONSTANT FRICTION FOR JOINT XX IS XXX AND VELOCITY THRESHOLD IS XXX DEG/SEC. THIS VELOCITY THRESHOLD MAY BE TOO SMALL FOR AN INTEGRATION TIME STEP OF XXX MSEC AND MAY LEAD TO BAD INTEGRATION. (CHECK PRINTOUT FOR BODY LINK ANGLE THETADOT NOT IN APPROXIMATION TO DELTA (THETADOT)/DELTA(TIME).) IT IS ESTIMATED THAT FOR 50TH-PERCENTILE VALUES FOR MASS, MOMENT OF INERTIA AND LINK LENGTHS AND AN INTEGRATION TIME STEP OF ONE MSEC THAT A THRESHOLD VELOCITY OF 300-400 DEG/SEC OR GREATER SHOULD BE USED FOR A JOINT WITH A CONSTANT FRICTION TORQUE OF 1000 IN-LB OR 113 N-M. THRESHOLD VELOCITY SHOULD BE IN PROPORTION TO CONSTANT FRICTION AND TIME STEP.	Self-explanatory	INMVMA
17	WARNING ALSO FOR JOINT XX: CONSTANT FRICTION = XXX AND VELOCITY THRESHOLD = XXX	See 16.	INMVMA

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Number	Message	Condition and Action Required	Subroutine
18	FATAL ERROR --- TWO TABLE ABCISSAS SAME FOR TABLE XXX, POINT NOS. XXXXX XXXXX AND VALUES ARE XXX XXX XXX XXX.	Check data cards.	INTAB
19*	NO ROOM FOR TABLE XXX EXPANSION AT XXXXXX.	Fatal, excess entries for material property tables deleted.	MOVTAB
20	WARNING --- FORCE APPORTIONMENT & MIGRATION ARE INOPERATIVE. SWITCH HAS BEEN TURNED OFF. CARD NO. XXXXX.	Self-explanatory	PULLIN
21*	KACT ARRAY EXCEEDED. XXX XXX XXX CHECK INPUT DATA DECK FOR IN- CONSISTENT SPELLING OF NAMES.	Self-explanatory	PULLIN
22*	STOACT ARRAY EXCEEDED. XXX XXX XXX CHECK INPUT DATA DECK FOR IN- CONSISTENT SPELLING OF NAMES.	Self-explanatory	PULLIN
23	ELLIPSE NAME INCONSISTENTLY SPELLED. XXX XXX XXX	Check data cards.	PULLIN
24	ILLEGAL RECORD CODE ASSIGNED. XXX XXX XXX	File NU has been tampered with between the running of IN and INP. Check your procedures.	PULLIN
25	AIRBAG FRONTAL INTERIOR OUTLINE SPEC ILLEGAL. XXX XXX XXX	See notes for 411-Cards.	PULLIN
26	REGION NAME INCONSISTENTLY SPELLED. XXX XXX XXX	Check data cards.	PULLIN
27	FRICITION CLASS ILLEGAL. XXX XXX XXX XXX	Ranges 1-5 for ellipses, 1-10 for regions.	PULLIN
28	ACCELERATION TABLE ERROR. XXX XXX XXX XXX XXX	Check data cards.	PULLIN
29	UNEXPECTED CALL TO PUSHER IDER ISIZE IBEG INSERT XXXX XXXX XXXX XXXX	Warning, PUSHER is called with directions to make space in an array which should not be used by the input processor. Program or machine error.	PUSHER

TABLE 51. (CONT.) (Page 4 of 5)

Number	Message	Condition and Action Required	Subroutine
30	WARNING --- ILLEGAL ZERO IN LEAD(13).	Warning, the LEAD array is not set up right or has been stored over. Program error or machine error.	SEARCH
31	WARNING. TABLE AAAAAAA IS NOT USED.	Incomplete or incompatible muscle tension table specification.	SETVAL
32	INHIBITION CARD SKIPPED: (card printed)	Warning, illegal name on inhibition card 106, check input. Card ignored.	SETVAL
33	FATAL ERROR --- MATERIAL SPECIFICATION INCOMPLETE FOR XXXX, CARD NO. XXX.	Self-explanatory	SETVAL
34	NOT ENOUGH TIME POINTS FOR LINE linename CORRECTED FROM XXXX TO XXXX.	Warning - Corrected value used. Check input for inconsistency between a card 410 and the corresponding 411's. Check input.	SETVAL
35	FATAL ERROR --- NOT ENOUGH SEGMENTS FOR REGION regionname HAVE XXX INSTEAD OF XXXX.	Inconsistency between card 402 and the corresponding 410's. Check input.	SETVAL
36	INHIBITION CARD SKIPPED: name name XXX XXX XXX XXX XXX	Warning.	SETVL2
37	ILLEGAL MATERIAL FOR BELT: Beltname VS. Bodyname, SET RIGID.	Warning, check input on 702, 703, or corresponding material cards.	SETLV2
38	FATAL ERROR --- INHIBITIONS INCONSISTENT XXX XXX XXX.	Check 106-Cards.	SETLV2
39	FATAL ERROR --- materialname MATERIAL IS NOT SPECIFIED.	Check data cards.	SETVL2

TABLE 51. (CONT.) (Page 5 of 5)

Number	Message	Condition and Action Required	Subroutine
40	WARNING --- VARIABLE POSITION SECTION PARAMETERS INCONSISTENT --- LEAD SEARCH RANGE PRE & POST IA IB II JJ XXXXX XXXXX XXXXX XXXXX CUR REC NO RANGE NCR MCR NPL NPN XXXXX XXXXX NO. GRP/LINE = XXXXX NO./GRP = XXXXX NUM I NO. GRP = XXXXX LAST REC NO. WROTE XXXXXX VAL IND RANGE JA JB CUR LINE = XXXXXX XXXXXX	Same as error 30.	STASH

*Error messages 1, 2, 3, 4, 5, 6, 7, 8, 19, 21, 22 can occur now only if
 INP and/or SHRINK have malfunctioned with the possible exceptions of
 21 and 22.

```

MICHIGAN TERMINAL SYSTEM FORTRAN G(21.8 TEST)          MAIN
0001          COMMON/REAL/RQ( 4522)
0002          COMMON/INTGR/IQ( 2085)
           C   DEFINE FILE  8( 2000, 22,U,IUPONT)
           C   DEFINE FILE  9( 2000, 32,U,JUPONT)
0003          CALL GOMVMA
0004          STOP
0005          END

```

Table 52. Main Program for G0 (obsolete)

```

MICHIGAN TERMINAL SYSTEM FORTRAN G(21.8 TEST)          TRAVEC
0001          SUBROUTINE TRAVEC(I,A,*)
0002          DIMENSION A(1),J(1)
0003          LOGICAL LOGSW
0004          GO TO(10,20,30,40,50,60,70,80,90,100),I
0005          10 RETURN
0006          20 RETURN
0007          30 RETURN
0008          40 RETURN
0009          50 RETURN
0010          60 RETURN
0011          70 CALL ELLELL(&1000)
0012          RETURN
0013          80 RETURN
0014          90 RETURN
0015          100 J(1) = A(1)
0016          CALL PLTR(J(1))
0017          A(1) = J(1)
0018          RETURN
0019          1000 RETURN 1
0020          END

```

Table 53. Transfer Vector Routine for G0 (obsolete)

6/30/88

IN

4.4 The Dynamics Solution Processor (GO)

4.4.1 Program Organization and Flow. Figure 138 shows the overall calling relationships. A letter "T" above a calling arrow indicates that the route is via the Transfer Vector Routine, TRAVEC (see Section 4.1.2.3 for the purpose of TRAVEC). Tables 54 and 56 provide the sub-program and common documentation (see Section 4.1 for details). Table 55 identifies the optional routines with their indices for calling via TRAVEC. [NOTE: The Transfer Vector Routine TRAVEC is not used in Versions 3, 5, and 6.]

4.4.2 Integration Techniques. This model offers the user a choice between the fixed step Runge-Kutta method or the fixed step Adams-Moulton predictor-corrector method. In either case the second order differential equations arising from the equations of motion are effectively reduced to twice as many first order equations and one application of the selected integration method is employed. The actual layout of information for this purpose is described in Tables 53-1 through 53-3 and accompanying notes.

It is felt that increased efficiency may be gained by an investigation of alternative procedures, e.g., variable step procedures. Regarding the currently implemented methods, the Adams-Moulton integration is sometimes less expensive than the Runge-Kutta in terms of computation time because it requires only two evaluations of derivatives, instead of four. The Adams-Moulton method does sometimes require a smaller integration time step, however.

6/30/88

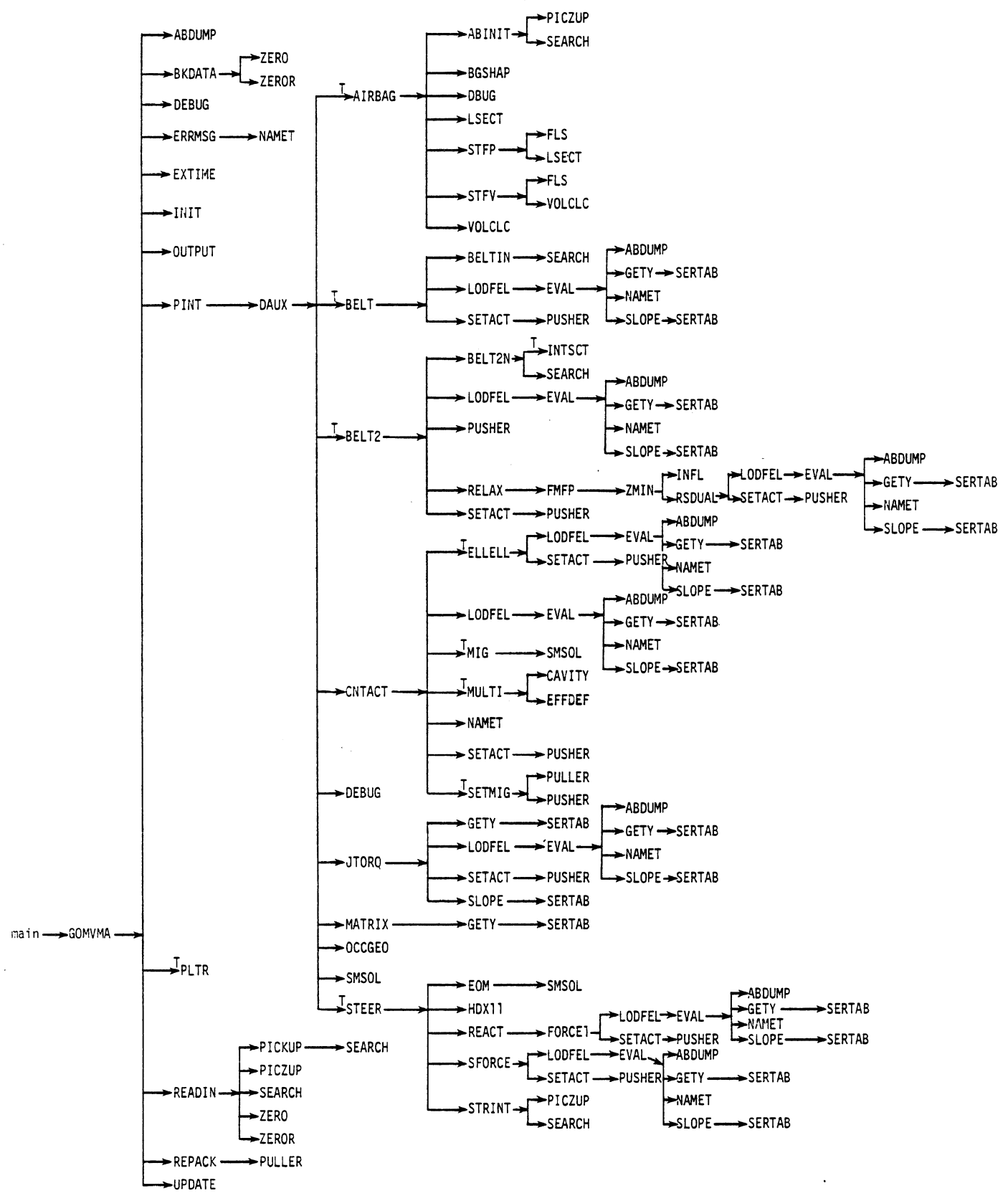


Figure 138. Calling Structure for the Dynamic Solution Processor (GO).

Table 53-1. LAYOUT OF INTEGRATION GROUP VARIABLES (COMMON/INTEG/)

Offset Beginning Index in RRQ Array	Integration Variables Group Description	Group Length in RRQ	Group Array Name	Typical Var. Name in /INTEG/	Sub-layout Reference Table
LSOD	Second Order Displacement	NESRRQ	THI	THI	53-2
LFOD	First Order Displacement	NEFRRQ	TMUS	TMUS	53-3
LSOV	Second Order Velocities	NESRRQ	THDI	THID	53-2
LSOVB	Second Order Velocities 2	NESRRQ	--	DTHI	53-2
LFOV	First Order Velocities	NEFRRQ	TMUSD	TMUSD	53-3
LSOA	Second Order Accelerations	NESRRQ	THDD	DTHID	--

LINYY = LSOD + 1 True Beginning of NEQRRQ Effective Displacements

LINYYP = LSOVB + 1 True Beginning of NEQRRQ Effective Velocities

NESRRQ = 3 * NFRELL + 22 <= 103

NESRRQ is the number of actual second order equations

NEFRRQ = 12

NEFRRQ is the number of actual first order equations

NEQRRQ = 2 * NESRRQ + NEFRRQ <= 218

NEQRRQ is the total number of effective first order equations

LENRRQ = 13 * NEQRRQ <= 2834

LENRRQ is the total space required to store and integrate

- Notes:
1. LSOD, LFOD, and LSOV groups form the LINYY group contiguously in specified order
 2. LSOVB, LFOV, and LSOA groups form the LINYYP group contiguously in specified order
 3. Integration is initialized by an evaluation of LFOV and LSOA from given LSOD, LFOD, and LSOV. LSOVB is copied from LSOV.
 4. A typical integration step begins with an estimation of LSOD, LFOD, and LSOV from previous LFOV and LSOA. Then LSOV is copied into LSOVB and LFOV and LSOA are evaluated from current LSOD, LFOD, and LSOV. This pattern is repeated one or more times basing the estimation on new LSOD, LFOD, and LSOV in a way depending on the integration method selected. When a step is completed, time is advanced and procedure is repeated.

Table 53-2. SUB-LAYOUT OF SECOND ORDER INTEGRATION VARIABLE GROUPS

A. Fixed Degrees of Freedom

RRQ	BS		
1	3	TH1	Head Angle
2	4	TH2	Upper Torso Angle
3	5	TH3	Middle Torso Angle
4	6	TH4	Lower Torso Angle
5	7	TH5	Upper Leg Angle
6	8	TH6	Lower Leg Angle
7	9	TH7	Upper Arm Angle
8	10	TH8	Lower Arm Angle
9	11	TH9	Neck Angle
10	12	XH	Upper Torso X
11	13	ZH	Upper Torso Z
12	14	XV	Vehicle X
13	15	ZV	Vehicle Z
14	16	THV	Vehicle Angle
15	17	HL	Steering Column Length
16	18	HAL1	Top Steering Column Angle
17	19	HAL2	Bottom Steering Column Angle
18	20	HH	Hub Length
19	21	ELN	Neck Length
20	22	XS	Shoulder Joint X
21	23	ZS	Shoulder Joint Z
22	24	XSLAP	Airbag Slap Displacement

B. Variable Degrees of Freedom

$3 * N + 20$	GSXN	General Segment N X-Coordinate
$3 * N + 21$	GSZN	General Segment N Z-Coordinate
$3 * N + 22$	GSTHN	General Segment N Angle

where N = 1 to NFRELL [NFRELL <= 27 is the number of User-specified Additional Segments]

Table 53-3. SUB-LAYOUT OF FIRST ORDER INTEGRATION VARIABLE GROUPS

1-11	TMUS	Maxwell Muscle Tension Variables
12	FFLUID	Airbag Fluid Component of Force

TABLE 54. SUBPROGRAM SPECIFICATIONS AND APPEARANCES FOR GO

Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprograms Called	Subprograms Calling	Special Output
1	ABDUMP		Makes error return to system with dump.	NONE	ERROR**	EVAL, GOMVMA	NONE
2	ABINIT		Determines location of surfaces that can be sensed by airbag. Initializes various constants. Solves gas thermodynamics equations. Reads airbag data from binary tables.	ABAGA ABAGB ABAGC ABAGD ABAGE ABAGF ABAGG BAGA BAGB BAGC BASE	CKOUT DUM INTEG INTGR IOCNL MSCON OCCC QV REAL THETA	PICZUP SEARCH ABS ATAN2 COS, SIN SQRT	AIRBAG E1
3	AIRBAG		Controls inflatable occupant restraint system submodel flow. Calls BGSHP if bag is neither full nor in contact with occupant. Calls STFP and VOLCLC if bag is both full and in contact, calls STFV if bag contacts occupant but is not full.	ABAGA ABAGB ABAGD ABAGE ABAGG BAGA BAGB BAGC	BASE CKOUT INTEG INTER IOCNL MSCON REAL	ABINIT BGSHP DBUG LSECT STFP STFV VOLCLC COS, SIN SQRT	DAUX via TRAVEC NONE
4	BELT	SRT-14 15-140 140-170F 170F-290 290F-370F	Determine belt anchor and reference point coordinates and velocities. Determine forces and moments due to lap belt. Determine geometry and deflection of torso belt straps. Determine forces and moments due to upper torso belt straps. Determine forces and moments due to lower torso belt.	BASE BELTA BELTB BELTC BELTD BELTE CKOUT INTEG	IOCNL MSCON OCCA OCCC OCCE REAL THETA	BELTIN LODFEL SETACT AMAX1 ATAN2 COS, SIN SQRT	DAUX via TRAVEC DB76- DB83 DB96 E2-E4

**This routine may require modification by local user. See Section 4.8.1.

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TABLE 54. (CONT.)

Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprograms Called	Subprograms Calling	Special Output
5	BELTIN		Reads input data for simple belts from binary file.	BASE BELTA BELTB BELTC BELTD	CKOUT DUM IOCNTL OCCE	SEARCH BELT	E5
6	BELT2	SRT-30 50F 50F-80 80F-160 170-210 220-450 220-280B 280-320B 320-350B	Initialize. If neither torso nor lap belt is potentially active, return. For belts 1-3, determine attachment points in vehicle coordinates, and calculate belt lengths. For belts 5-7, determine lengths and deflections. Set deflections and forces to zero for belts that are not potentially active. With endpoints of all belts in each "3-belt system" held fixed, determine the ring positions which balance belt forces at the ring in vehicle X and Z directions. If upper ring anchored to vehicle frame and belt combination 1-7 allowed to slip through the ring, then determine belt forces. If upper ring is at the end of a strap which leads either to an inertia reel or a vehicle anchor, determine ring position (and forces) for force balance. If torso belt is potentially active but lap belt is not and lower ring is at the end of a strap which leads to either an inertia reel or a vehicle anchor, determine ring position for force balance for belts 2 and 5.	BASE BELTB BP BQQ BRI BRIP BTWOA BTWOB CKOUT INTEG INTGR MSCON QV REAL THETA	BELT2N LODFEL PUSHER RELAX SETACT ABS ATAN2 COS IABS SIGN SIN SQRT	DAUX via TRAVEC	DB115- DB136 E6

(Continued next page)

TABLE 54. (CONT.)

Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprograms Called	Subprograms Calling	Special Output
6 (Continued)							
	BELT2	350-380B	If lap belt is potentially active but torso belt is not and lower ring is at the end of a strap which leads either to an inertia reel or a vehicle anchor, determine ring position for force balance for belts 3 and 5.				
		380-420B	If lower ring anchored to vehicle frame and belt combination 2-3 allowed to slip through the ring, then determine belt forces.				
		420-450	If lower ring is at the end of a strap which leads either to an inertia reel or a vehicle anchor, determine ring position for force balance for belts 2, 3, and 5.				
		450F-510	With ring positions as quasi-anchor points, determine belt lengths and lever arms for belts 1-4.				
		510F-560	Determine "free slipping" force-equalized belt tensions for the torso belt combination 1-2 and/or the lap belt combination 3-4.				
		560F-600	Determine belt forces for whichever of belts 1-4 are not members of a "free slipping" pair.				
		620-730B	If torso interbelt influence of friction type is chosen, compute new belt forces and skip to 810.				
		730-800	If torso interbelt influence of either force difference or percentage type is chosen, compute new belt forces.				
		810-820	Compute contributions to generalized forces.				
(Continued next page)							

TABLE 54. (CONT.)

Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprograms Called	Subprograms Calling	Special Output
6	(Continued)						
	BELT2	830-950	If integration time step is not complete, return. If complete, pack values to be used for printout and for the next time step.				
		840F-850	Determine whether vehicle sensitive inertia reel should be set in locked condition.				
		860-880F	Determine whether webbing sensitive inertia reel should be set in locked condition.				
		890-900	If a critical belt has broken, set torso and/or lap belt flag to indicate "inactive" condition.				
		910-910F	Calculate and store belt angles.				
		920B-950	Calculate and store belt force components and moments on body. Used for printout only.				
7	BELT2N		Reads input data for advanced belts from binary file.	BASE BELTD BP,BRIP BTWOA CKOUT	DUM INTGR IOCNTL MSCON QV THETA	INTSCT via TRAVEC SEARCH SQRT	BELT2 E7
8	BGSHAP		Determines coordinates of 120 points at three degree increments on the circular periphery of the expanding airbag before contact by the occupant.	ABAGA ABAGB ABAGD BAGA	BAGC BASE CKOUT REAL	ATAN2 COS, SIN SQRT	AIRBAG NONE

TABLE 54. (CONT.)

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Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprograms Called	Subprograms Calling	Special Output
9	BKDATA		Run initialization routine. Sets critical quantities to initialize values.	BAGA BAGB BAGC BELTB BELTD BELTE BQ BRIP BTWOA CKOUT	INTEG ILOCNTL MATRIX OCCF PACK OV STERF STERG STERH STERI	ZERO ZEROR GOMVMA	NONE
10	CAVITY		Determines cavity coefficients for the area of contact between an ellipse and a line segment.	CAV	AMAXI AMINI SQRT	MULTI	NONE
11	CONTACT	SRT-40 50-60B 60B-160F 190-1770 190-190F 240B-250 250F-260B 260-1580 260F-270B 270B-290B 290-360 370-400B	Initialization. Unpack contact ellipse information for each ellipse. Pack computed ellipse information for each ellipse. For each region, determine all forces, generalized forces, etc., resulting from all interacting ellipses. Unpack region controls. Initialization for force apportioning. Determine structural deformation. For each contact line, determine all forces, generalized forces, etc., resulting from all interacting ellipses. Unpack contact line controls. If line has more than one inputted position in time history, go to 290. For line with only one inputted position in time history, unpack end point coordinates, line length, etc. Go to 370. Determine end point positions and velocities interpolating if necessary. Correct inputted corner points for region migration.	BASE BQ CART CKOUT CON DUM INTGR ILOCNTL IT LCON MSCON QQ QV REAL SHDEFI THETA ZOUT	ELLELI* LODFEL, MIG* MULTI* NAMET SETACT SETMIG* ABS AMINI ATAN2, COS IABS SIGN SIN, SQRT *via TRAVEC	DAUX	DB39-DB51 DB54-DB62 DB70-DB75 E8-E10

(Continued next page)

TABLE 54. (CONT.)

Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprograms Called	Subprograms Calling	Special Output
11 (Continued)							
	CONTACT	420-460F 370-570B	Pack inertial corner point coordinates. Compute contact line coefficients and rates in inertial and vehicle coordinates.				
		570F-600B	Compute corner point positions and velocities relative to vehicle if the inputted time history is inertial.				
		610-720	Compute intermediate contact line quantities.				
		720F-760	At t=0, pack region anchor coordinates.				
		760F-770	Initialization for MULTI.				
		780-1500	Check all body segments for ellipses interacting with the line; compute deflections, forces, and lever arms.				
		790B-1490	Loop on ellipses for particular line and particular body segment. Nested inside 780-1500.				
		860-890F	Unpack ellipse information.				
		890-930B	Compute inertial coordinates of point of deepest penetration against line.				
		950-1060	Compute non-dimensional contact position and edge effectiveness factor.				
		1070-1090	Determine lever arms.				
		1100-1120	Determine deflection rate.				
		1120F	Determine normal contact force.				
		1130B-1200F	Bookkeeping for MULTI and force apportioning.				
		1200F-1210	Set up input to MULTI.				
		1210F-1220	Determine contributions to generalized force vector.				
		1220F-1240	Set up output quantities and do book-keeping for force apportioning.				
		1290F-1470	Tangential force loop for the line ellipse interaction.				
		1290F-1300B	Determine whether there will be a non-zero tangential force.				

(Continued on next page)

TABLE 54. (CONT.)

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Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprograms Called	Subprograms Calling	Special Output
15	EFFDEF		Determines effective deflection against a trapezoidal cavity.	CAV	NONE	MULTI	NONE
16	ELLELL	20B-860F	Loop for ellipse-ellipse interactions; outer most loops match body segment against body segment; inner-most loops match ellipses. If segment has no ellipses, consider next segment. Otherwise, unpack ellipse quantities. If opposing segment has no ellipses or if contact between the segments is inhibited, consider the next ellipse. Otherwise, unpack ellipse quantities. Ellipse loop for first compared body segment.	BASE BQ CKOUT DUM INTGR IT QQ QV REAL ZOUT	LODFEL SETACT ABS ATAN2 COS IABS ISIGN SIN SQRT	CNTACT via TRAVEC	DB63-DB69
		30B-50B	Compute lever arms for interacting circles or circle-like ellipses.				
		50-120B	Compute lever arms for ellipse interacting with circle or circle-like ellipse.				
		30F-850	Compute lever-arms for interacting ellipses.				
		50F-830	Define s and \bar{T} so as to resolve the degeneracy for the case of ellipses with parallel major axes.				
		140-220	Compute deflection rate, force, contributions to the generalized force vector, and output quantities.				
		230-350					
		360-510					
		410-450B					
		520-660B					

TABLE 54. (CONT.)

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Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprograms Called	Subprograms Calling	Special Output
17	EOM		Solves equations of motion of steering assembly.	BASE CKOUT INTEG IT MSCON	STERA STERC STERD STERF SMSOL	STEER via TRAVEC	DB112
18	ERRMSG		Prints most of fatal error comments made for this model.	BASE CKOUT DUM	NAMET FLOAT IABS	GOMVMA	E11-E28
19	EVAL		Compute the force produced given the material properties, deflection and deflection rate for a single interaction.	BASE,BTWOA CKOUT DUM INTGR IOCNTL LC LF,LP MSCON REAL	ABDUMP GETY NAMET SLOPE ABS AMAX1 AMIN1 SQRT	LODFEL	DB36-DB38 DB94 E29-E33
20	EXTIME		Returns elapsed CPU time after an initiating call.	NONE	TIME**	GOMVMA	NONE
21	FLS		Determines airbag shape and forces on the occupant if the bag is both full and in contact with the occupant.	ABAGA ABAGB ABAGD ABAGF BAGB BAGC BASE	CKOUT INTGR IOCNTL OCCC QV REAL THETAP LSECT ATAN2 COS, SIN SQRT	STFP STFV	NONE
22	FMFP		Determines local minimum of a function and corresponding independent variable values.	NONE	ZMIN ABS AMAX1 SQRT	RELAX	NONE

**This routine may require modification by local user. See Section 4.8.1.

TABLE 54. (CONT.)

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Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprogram Called	Subprograms Calling	Special Output
23	FORCE1		Compute the reaction forces of steering assembly.	BASE CKOUT	LODFEL SETACT ABS SIGN	REACT	E34
24	GETY		Determine correct piecewise linear interval for current deflection and material property table and interpolate to current deflection.	INTGR REAL TAB	SERTAB ABS AMOD IABS	EVAL JTORQ MATRIX	NONE
25	GOMVMA		Controls overall solution of the simulation problem.	BAGD BASE CKOUT INTEG MSCON ZQB	ABDUMP BKDATA DEBUG ERRMSG EXTIME INIT OUTPUT PINT PLTR via TRAVEC READIN REPACK UPDATE ABS	MAIN	DB22-DB25 E35-E36
26	HDX11		Determines the position and velocity of steering column gear box from a time dependent table.	BASE CKOUT REAL STERE STERF	NONE	STEER	DB114
27	INFL		Determine influence coefficients for x-force or z-force balance at ring. These are the two partial derivatives (for x and z) of $F_k(x)=0$.	BASE BRIP BTWOB CKOUT INTGR	NONE	ZMIN	DB142

TABLE 54. (CONT.)

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Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprogram Called	Subprogram Calling	Special Output
28	INIT		Put input quantities into units needed for execution of model.	BASE CON EL INTEG INTGR IOCNL JOINT LD MATRIX MATS MSCON	MUSCLE NECKON OCCA OCCB OCCF REAL TAB THETA ZP,ZQ ZR OCCC	ABS ATAN2 COS, SIN SQRT GOMVMA	NONE
29	INTSCT		Accepts center points and radii of two circles as input and returns intersection points.	NONE	SQRT	BELT2N via TRAVEC	NONE
30	JTORQ		Compute torques due to body joints.	BASE CKOUT EL INTEG IOCNL JOINT MUSCLE SHOLDR	ZR	DAUX	DB33-DB35
31	LODFEL		Carry out the unpacking of material properties for an interaction and manage the shared deflection iteration in any.	BASE BTWOA CKOUT INTGR IOCNL LC,LD LF,LP REAL SHDEFI	EVAL ABS AMAX1 AMINI IABS SIGN	BELT BELT2 CNTACT ELLELL FORCE1 JTORQ RSDUAL SFORCE	DB88-DB91

TABLE 54. (CONT.)

Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprograms Called	Subprograms Calling	Special Output
32	LSECT		Determines intersection, if any, of two line segments.	NONE	NONE	AIRBAG FLS STFP	NONE
33	MAIN		Calls GOMVMA and returns to system. Generated by IN with appropriate dimensions.	INTGR REAL	GOMVMA	NONE	NONE
34	MATRIX		Calculate coefficient matrix and right-hand side vector for system of 14 differential equations.	BASE BELTB BELTD BQ BQQ CKOUT DUM FORCE INTEG IOCNL ZP	JOINT MATRIX MSCON NECKON OCCA OV SHOLDR THETA ZOUT ZP	DAUX	DB26 DB143
35	MIG	70F-100B 120-160 160F-330 170-190 190F-320 220F-240 240F	Unpack values for region geometry and structural properties. Get line segment angles, with sines and cosines. Determine coefficient matrix and right-hand side vector for equations 193 and 196. Segment loop. Determine matrix coefficients that do not depend on segment angles. If there is a force on the segment, determine matrix coefficients that depend on segment angles and also the right-hand side vector. If more than one force on segment, get intermediate results for determining a resultant. Calculate position on segment of the single force and $(\Delta\delta_x, \Delta\delta_z)$ for permanent deformation at that point.	ADUM BASE CKOUT INTGR IT REAL	SMSOL ATAN2 COS, SIGN SIN	CNTACT via TRAVEC	DB9-DB21 E37

(Continued next page)

TABLE 54. (CONT.) Page 13 of 19

Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprograms Called	Subprograms Calling	Special Output
35	(Continued)						
	MIG	240F-270F	For outermost segments of region, reduce $(\Delta\delta_x, \Delta\delta_z)$ in proportion to distance of force from anchor.				
		280-280F	Calculate $(\Delta x, \Delta z)$ for the resultant force on the segment.				
		300B-310B	Get intermediate quantities for two-segment region with permanent deformation.				
		310-320	Calculate elements of coefficient matrix and right-hand side vector.				
		350-370B	Pack inertial migration increments for the interior juncture of a two-segment region.				
		370	Solve the system of linear algebraic equations.				
		410B-410	Find sines and cosines of the new angle.				
		410F-420	Find corner point positions from new angles.				
		420F-430	Adjust corner point positions by distributing the distance by which the second anchor was missed.				
		440B-440	Pack inertial components of migration increments for all corner points.				
		460-470	Pack sines and cosines.				
36	MULTI	40B-120	Put unordered input into an order on increasing s.	BASE CAV	CAVITY EFFDEF	CONTACT via TRAVEC	DB1-DB8
		120F-130	Establish a set of integer values which indicate which of the ordered ellipses have deflection equal to the maximum (normally only one member in the set).	CKOUT	ABS AMAX1 AMINI		
		140B-190	Determine cavities and effective deflections and forces to the "left" of the "leftmost" maximum deflection.				
		200-240	Determine cavities and effective deflections and forces to the "right" of the "rightmost" maximum deflection.				
		250-280	Determine cavities and effective deflections and forces between the outermost maximum deflections.				

(Continued next page)

TABLE 54. (CONT.)

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Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprograms Called	Subprograms Calling	Special Output
36 (Continued)	MULTI	290-300 310-END	Scale the forces so that they will add to F_{max} Rearrange ordered values to original order for return to CNTACT.				
37	NAMET		Obtain the name of a material, region, or segment given the KCON beginning index for the corresponding entry.	BASE INTER REAL	NONE	CNTACT ERRMSG EVAL	NONE
38	OCCGEO		Calculates joint positions, belt reference points, CG positions, rotation matrices, and lever arm factors.	BASE BELTD CKOUT DUM INTEG IOCNTL MSCON	NECKON OCCA OCCB OCCC QV SHOLDR THETA	ATAN2 SQRT	DAUX DB27, DB28 DB93
39	OUTPUT		Write the binary files on logical device numbers seven, eight, and nine for current computed quantities.	BAGA BAGB BAGC BASE BELTE CKOUT DUM FORCE INTEG INTGR IOCNTL JOINT KON LCON	MSCON NAMES NECKF OCCC OCCF OCCG PACK REAL SHOLDR STERF STERG STERH THETA ZP	AINT IABS GOMVMA	NONE
40	PICKUP		Reads a table from the binary data set on 'NU' which requires multiple records.	BASE IOCNTL	SEARCH	READIN	E38
41	PICZUP		Similar to PICKUP for individual arrays.	IOCNTL	NONE	ABINIT STRINT	NONE

TABLE 54. (CONT.)

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Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons		Subprograms Called	Subprograms Calling	Special Output	
42	PINT		Solves a system of real ordinary differential equations of the first order using a Runge-Kutta fourth-order method.	CKOUT		DAUX ABS AMAX1 AMIN1 SIGN	GOMVMA	NONE	
43	PLTR		Writes a record on binary data set on 'NP' containing plotting quantities.	BAGC BASE BRIP CKOUT INTEG INTGR IOCNL	MSCON OCCC OCCD QV REAL STERH THETA	NONE	GOMVMA via TRAVEC	NONE	
44	PULLER		Adjusts stored indices to compensate for an entry removed in the middle of the packing tables.	BASE INTGR PACK REAL		NONE	REPACK SETMIG	NONE	
45	PUSHER		Adjusts stored indices to compensate for a new entry added in the middle of the packing table.	BASE CKOUT INTGR PACK		IABS ISIGN	BELT2 SETACT SETMIG	DB95 E39	
46	REACT		Sets the final reaction forces for the steering assembly.	BASE CKOUT INTEG MSCON		STERA STERC STERD STERF	FORCE1 ABS SQRT	STEER	DB113

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TABLE 54. (CONT.)

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Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprograms Called	Subprograms Calling	Special Output
47	READIN		Controls the reading of the input data in binary form produced by "IN".	ADUM BAGD BASE CKOUT CON DUM EL INTEG INTGR IOCNTL IT JOINT KON LCON LD	MATS MSCON MUSCLE NAMES NECKON OCCA OCCB OCCF PACK REAL TAB ZP ZQ ZR	PICKUP ZERO ZEROR IABS	GOMVMA NONE
48	RELAX		Solves a set of N simultaneous non-linear equations of form $F_i(X)=0$ for the N unknowns, x_j .	ZQA	FMFP ZMIN	BELT2	NONE
49	REPACK		Update the time history entries in the packing tables in preparation for establishing the current time.	BASE CKOUT INTGR	PACK REAL PULLER IABS	GOMVMA	DB85-DB87 DB92
50	RSDUAL	SRT-20F 20F-180	Increment iteration counter. Set up belt number array and initialize residuals to zero. Determine residuals for x-force balance at ring. Also determine quantities necessary for calculation of influence coefficients in INFL. The loop is on belt index. Either two or three belt segments will contribute to residuals.	BASE BRI BRIP BTWOA BTWOB CKOUT INTGR REAL	LODFEL SETACT SQRT	ZMIN	DB137- DB141

(Continued next page)

TABLE 54. (CONT.)

Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprograms Called	Subprograms Calling	Special Output
50 (Continued)							
	RSDUAL	20F-30B	If belt is present, determine length for this iteration.				
		30-120B	Determine contributions to residuals from belt 6 (or 5) and, if "no slip" at ring, from belts 1 and 7 (or 2 and 3).				
		120-140B	Determine force adjustment from ring friction, if any.				
		140-160	Determine contributions to residuals from belts 1 and 7 (or 2 and 3) when slipping is allowed at the ring.				
		180-220	Store tentative output values from this iteration.				
51	SEARCH		Finds the read control parameters for the next record present on the binary data set in the variable section.	BASE IOCNL	NONE	ABINIT BELTIN,BELT2N PICKUP STRINT	E40
52	SERTAB		Search for the table entry corresponding to a particular argument in tables.	INTGR REAL TAB	ABS IABS ISIGN	GETY SLOPE	NONE
53	SETACT		Find or create the control entry in KACT for a given interaction.	BASE CKOUT INTGR PACK REAL STERI ZR	PUSHER IABS	BELT BELT2 CNTACT ELLELL FORCE1 JTORQ RSDUAL SFORCE	DB52- DB53
54	SETMIG		Enter the force and point of application in the KMUG and STOMUG arrays.	BASE CKOUT INTGR REAL	PULLER PUSHER	CNTACT via TRAVEC	DB84

TABLE 54. (CONT.)

Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprograms Called	Subprograms Calling	Special Output
55	SFORCE		Computes the normal and tangential forces due to the occupant contact with steering column.	BASE CKOUT STERE	LODFEL SETACT SIGN	STEER	E41
56	SLOPE		Look up the ramp slope in a material property table given a particular argument.	INTGR REAL TAB	SERTAB AMOD IABS	EVAL JTORQ	NONE
57	SMSOL		Solve matrix equation AX=B for X.	NONE	ABS	DAUX EOM, MIG	NONE
58	STEER		Controls overall flow of the steering assembly part. Also determines the position of body segment contact surfaces and the steering assembly contact points.	BASE CKOUT INTEG MSCON OCCC QV STERB	STERC STERD STERF STERG STERH THETA	EOM ATAN2 HDX11 COS REACT SIN SFORCE SQRT STRINT	DAUX via TRAVEC DB101- DB111
59	STFP		Determines bag shape if full and in contact with occupant by matching an inputted perimeter for a fully inflated bag.	ABAGA ABAGC ABAGD ABAGE BAGB BAGC	BASE CKOUT INTEG INTGR REAL THETA	FLS LSECT ABS COS SIN SQRT	AIRBAG NONE
60	STFV		Determines bag shape if in contact with occupant but not full by matching the volume with the volume of gas thus far supplied by the source.	ABAGA ABAGB ABAGC BAGA BAGB	BAGC BASE CKOUT INTEG	FLS VOLCLC ABS COS SIN	AIRBAG NONE
61	STRINT		Reads input data for steering column from binary file.	BASE CKOUT INTEG IOCNL MSCON REAL	STERA STERB STERD STERE STERF STERI	PICZUP SEARCH	STEER E42

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TABLE 54. (CONT.)

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Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprograms Called	Subprograms Calling	Special Output
62	TRAVEC		Transfer vector routine which calls appropriate optional routines. This routine is generated by IN.	NONE	AIRBAG BELT BELT2 ELLELL INTSCT STEER	MIG MULTI PLTR SETMIG STEER GOMVMA DAUX GOMVMA	NONE
63	UPDATE		Computes kinetic energies and head, chest, and hip Anterior-Posterior and Superior-Inferior accelerations.	FORCE INTEG JOINT MSCON MUSCLE NECKON NECKF OCCA	OCCB OCCC OCCF OCCG QV SHOLDR THETA	ABS GOMVMA	NONE
64	VOLCLC		Determines the volume of the deformed section of the airbag.	ABAGB BAGC BASE	CKOUT REAL	AIRBAG STFV	NONE
65	ZERO		Sets zero into a number of consecutive locations for integers.	NONE	NONE	BKDATA READIN	NONE
66	ZEROR		Sets zero into a number of consecutive locations for real numbers.	NONE	NONE	BKDATA READIN	NONE
67	ZMIN		Helper routine for FMFP.	ZQA	INFL RSDUAL ABS	FMFP	NONE

TABLE 55. SUBROUTINE/INDEX CORRESPONDENCE FOR CALLS TO TRAVEC (GO).

Index	Subroutine
<u>1</u>	<u>TRAVEC(I)</u>
1	BELT
2	BELT2
3	STEER
4	AIRBAG
5	INTSCT
6	SETMIG
7	ELLELL
8	MIG
9	MULTI
10	PLTR

TABLE 56. LABELED COMMON DESCRIPTIONS FOR GO.

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Number	Common Name	Subprograms Which Use	Description
1	ABAGA*	ABINIT,AIRBAG,BGSHAP,DBUG,FLS,STFP,STFV	Airbag bag contact quantities.
2	ABAGB*	ABINIT,AIRBAG,BGSHAP,FLS,STFV,VOLCLC	Airbag shape quantities.
3	ABAGC*	ABINIT,DBUG,STFP,STFV	Airbag volume quantities.
4	ABAGD*	ABINIT,AIRBAG,BGSHAP,DBUG,FLS,STFP	Airbag control quantities.
5	ABAGE*	ABINIT,AIRBAG,DBUG,STFP	Airbag bag perimeter quantities.
6	ABAGF*	ABINIT,FLS	Airbag occupant quantities.
7	ABAGG*	ABINIT,AIRBAG	Airbag position quantities.
8	ADUM	MIG,READIN	Temporary storage.
9	BAGA	ABINIT,AIRBAG,BGSHAP,BKDATA,DBUG,OUTPUT,STFV	Airbag thermodynamics quantities.
10	BAGB	ABINIT,AIRBAG,BKDATA,DAUX,FLS,OUTPUT,STFP,STFV	Airbag force and moment quantities.
11	BAGC	ABINIT,AIRBAG,BGSHAP,BKDATA,DBUG,FLS,OUTPUT,PLTR,STFP,STFV,VOLCLC	Airbag position quantities.
12	BAGD	DAUX,GOMVMA,READIN	Airbag control quantities.
13	BASE	ABINIT,AIRBAG,BELT,BELTIN,BELT2,BELT2N,BGSHAP,CNTACT,DAUX,DBUG,DEBUG,ELLELL,EOM,ERRMSG,EVAL,FLS,FORCE1,GOMVMA,HDX11,INFL,INIT,JTORQ,LODFEL,MATRIX,MIG,MULTI,NAMET,OCCGEO,OUTPUT,PICKUP,PLTR,PULLER,PUSHER,REACT,READIN,REPACK,RSDUAL,SEARCH,SETACT,SETMIG,SFORCE,STFP,STFV,STEER,STRINT,VOLCLC	Beginning addresses of individual arrays in general integer and real arrays.
14	BELTA**	BELT,BELTIN	Initial belt lengths, breaking tensions, and belt slacks.

*These commons present only if airbag option selected.

**These commons present only if simple belt option selected.

TABLE 56. (CONT.)

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Number	Common Name	Subprograms Which Use	Description
15	BELTB	BELT,BELT2,BKDATA,DAUX, MATRIX	Belt moments and force components.
16	BELTC**	BELT,BELTIN	Belt anchors in inertial and vehicle coordinates.
17	BELTD	BELT,BELTIN,BELT2N, BKDATA,DAUX,MATRIX	Belt control quantities.
18	BELTE	BELT,BKDATA,OUTPUT	Belt angles.
19	BP*	BELT2,BELT2N	Advanced belt system constants.
20	BQ	BKDATA,CNTACT,DAUX,ELLELL, MATRIX	Generalized forces for friction, line-ellipse forces, and ellipse-ellipse forces.
21	BQQ	BELT2,DAUX,MATRIX	Generalized forces from advanced belt system.
22	BRI*	BELT2,RSDUAL	Advanced belt system forces, deflections, and derivatives.
23	BRIP	BELT2,BELT2N,INFL,LODFEL, PLTR,RSDUAL	Attachment, anchor and ring positions and constants for advanced belt system.
24	BTWOA	BELT2,BELT2N,BKDATA,EVAL, LODFEL,RSDUAL	Switches for force-strain or force-deflection.
25	BTWOB*	BELT2,INFL,RSDUAL	Advanced belt partial derivatives, belt tensions.
26	CART	CNTACT,DAUX,MIG	Vehicle position, velocity, and acceleration.
27	CAV	CAVITY,EFFDEF,MULTI	Deflections, effective deflections, cavity coefficients, and line and ellipse dimensions.

*These commons present only if advanced belt option selected.

**These commons present only if simple belt option selected.

TABLE 56. (CONT.)

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Number	Common Name	Subprograms Which Use	Description
28	CKOUT	ABINIT,AIRBAG,BELT,BELTIN, BELT2,BELT2N,BGSHAP,BKDATA, CNTACT,DAUX,DBUG,ELLELL, EOM,ERRMSG,EVAL,FLS,FORCE1, GOMVMA,HDX11,INFL,JTORQ, LODFEL,MATRIX,MIG,MULTI, OCCGEO,OUTPUT,PINT,PLTR, PUSHER,REACT,READIN,REPACK, RSDUAL,SETACT,SETMIG,SFORCE, STEER,STFP,STFV,STRINT, VOLCLC	Time, auxiliary (debug) printout controls and error message controls.
29	CON	CNTACT,INIT,READIN	Tangential force friction coefficients and cutoff for relative velocity ramp.
30	DUM	ABINIT,BELTIN,BELT2N, CNTACT,ELLELL,ERRMSG,EVAL, MATRIX,OCCGEO,OUTPUT,READIN	Temporary storage.
31	EL	INIT,JTORQ,READIN	Neck and shoulder element location constants.
32	FORCE	DAUX,MATRIX,OUTPUT,READIN, UPDATE	Moments and force components at body segment C.G.'s due to airbag, steering column, belts, and contact forces.
33	INTEG	ABINIT,AIRBAG,BELT,BELT2, BELT2N,BKDATA,DAUX,EOM, GOMVMA,INIT,JTORQ,MATRIX, OCCGEO,OUTPUT,PLTR,REACT, READIN,STEER,STFP,STFV, STRINT,UPDATE	Generalized coordinates, velocities, and accelerations together with other integrated quantities.
34	INTGR	ABINIT,AIRBAG,BELT2,BELT2N, CNTACT,ELLELL,EOM,EVAL,FLS, GETY,INFL,INIT,LODFEL,MAIN, MIG,NAMET,OUTPUT,PLTR,PULLER, PUSHER,READIN,REPACK,RSDUAL, SERTAB,SETACT,SETMIG,SLOPE, STFP	General integer arrays.
35	IOCNTL	ABINIT,AIRBAG,BELT,BELTIN, BELT2N,BKDATA,CNTACT,DAUX, EVAL,FLS,INIT,JTORQ,LODFEL, MATRIX,OCCGEO,OUTPUT,PICKUP, PICZUP,PLTR,READIN,SEARCH, STRINT	Controls for binary file reading and writing together with a few program control constants.
36	IT	CNTACT,DAUX,ELLELL,EOM, MIG,READIN	Global constants.

TABLE 56. (CONT.)

Number	Common Name	Subprograms Which Use	Description
37	JOINT	INIT,JTORQ,MATRIX,OUTPUT,READIN,UPDATE	Joint parameters, relative joint angles and velocities, and torques.
38	KON	DAUX,OUTPUT,READIN	Controls and temporary storage for limiting debug output to the final evaluation at each time step.
39	LC	EVAL,LODFEL	Load deflection input constants.
40	LCON	CNTACT,OUTPUT,READIN	Beginning addresses of arrays for multi-segment and multi-circle contact options.
41	LD	INIT,LODFEL,READIN	Shared deflection input constants.
42	LF	EVAL,LODFEL	Tentative new values for load-deflection quantities.
43	LP	EVAL,LODFEL	Current values for load-deflection quantities.
44	MATRX	BKDATA,DAUX,INIT,MATRIX	Mass coefficient matrix and right-hand side, constants, and generalized forces.
45	MATS	INIT,READIN	Steering column material switches.
46	MSCON	ABINIT,AIRBAG,BELT,BELT2,BELT2N,CNTACT,DAUX,EOM,EVAL,GOMVMA,INIT,MATRIX,OUTPUT,PLTR,REACT,READIN,STEER,STRINT,UPDATE	Miscellaneous input constants.
47	MUSCLE	INIT,JTORQ,READIN,UPDATE	Muscle tension parameters.
48	NAMES	OUTPUT,READIN	Storage for names of ellipses, regions, and line segments.
49	NECKF	OUTPUT,UPDATE	Neck reaction force components.
50	NECKON	INIT,MATRIX,OCCGEO,READIN,UPDATE	Mass and inertia constants for neck element.
51	OCCA	BELT,INIT,MATRIX,OCCGEO,READIN,UPDATE	Body segment lengths.
52	OCCB	INIT,OCCGEO,READIN,UPDATE	Body segment masses and moments of inertia.

TABLE 56. (CONT.)

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Number	Common Name	Subprograms Which Use	Description
53	OCCC	ABINIT,BELT,FLS,INIT,OCCGEO,OUTPUT,PLTR,STEER,UPDATE	Joint positions and velocities.
54	OCCD	BELT,PLTR	Inertial position coordinates of belt attachment points.
55	OCCE	BELT,BELTIN	Position of belt attachment points in body segment coordinates.
56	OCCF	BKDATA,INIT,OUTPUT,READIN,UPDATE	Dissipated and absorbed energies for joints and accelerometer location coordinates.
57	OCCG	OUTPUT,UPDATE	Kinetic energies and components of head, chest, and hip accelerations.
58	PACK	BKDATA,DAUX,OUTPUT,PULLER,PUSHER,READIN,REPACK,SETACT	Packing array maximum lengths and current usage lengths.
59	QQ	CNTACT,DAUX,ELLELL	Generalized velocities.
60	QV	ABINIT,BELT2,BELT2N,BKDATA,CNTACT,ELLELL,FLS,MATRIX,OCCGEO,PLTR,STEER,UPDATE	Body segment CG positions and rotation matrices, with time derivatives and partials.
61	REAL	ABINIT,AIRBAG,BELT,BELT2,BGSHAP,CNTACT,DAUX,ELLELL,EVAL,FLS,GETY,HDX11,INIT,LODFEL,MAIN,MIG,NAMET,OUTPUT,PLTR,PULLER,READIN,REPACK,RSDUAL,SERTAB,SETACT,SETMIG,SLOPE,STFP,STRINT,VOLCLC	General real array.
62	SHDEFL	CNTACT,LODFEL	Component defl. and rates
63	SHOLDR	JTORQ,MATRIX,OCCGEO,OUTPUT,UPDATE	Polar coordinates and velocities for shoulder.
64	STERA*	EOM,REACT,STRINT	Steering column segment masses, moments of inertia and lengths.
65	STERB*	STEER,STRINT	Steering column angles.
66	STERC*	EOM,REACT,STEER	Steering column parameters.

*These commons present only if steering column option selected.

TABLE 56. (CONT.)

Number	Common Name	Subprograms Which Use	Description
67	STERD*	EOM,REACT,STEER,STRINT	Steering column constants.
68	STERE*	HDX11,SFORCE,STRINT	Steering column controls.
69	STERF	BKDATA,EOM,HDX11,OUTPUT,REACT,STEER,STRINT	Steering column forces, moments and reactions, internal.
70	STERG	BKDATA,DAUX,OUTPUT,STEER	Steering column forces and moments for output.
71	STERH	BKDATA,OUTPUT,PLTR,STEER	Steering column position quantities.
72	STERI	BKDATA,SETACT,STRINT	Steering column materials.
73	TAB	GETY,INIT,READIN,SERTAB,SLOPE	Storage for tables of static curves, inertial spike curves, G-ratios, R-ratios, muscle parameters, and stiffness coefficients.
74	THETA	ABINIT,BELT,BELT2,BELT2N,CNTACT,DAUX,INIT,MATRIX,OCCGEO,OUTPUT,PLTR,STEER,STFP,UPDATE	Sines and cosines of angles.
75	THETAP	DAUX,FLS	Sine and cosine of head angle.
76	ZOUT	CNTACT,DAUX,ELLELL,MATRIX	Force and moment components at body CG's from contacts.
77	ZP	INIT,MATRIX,OUTPUT,READIN	Head applied force components.
78	ZQ	INIT,READIN	Switch, vehicle angular acceleration in deg/sec ² or rad/sec ² .
79	ZQA**	RELAX,ZMIN	Miscellaneous advanced belt system controls.
80	ZQB	DAUX,GOMVMA	Debug printout parameters.
81	ZR	INIT,JTORQ,READIN,SETACT	Locations in KCON of beginning indices for the joint material properties entries in STOMAT.

*These commons present only if steering column option selected.

**These commons present only if advanced belt option selected.

4.4.3 Packing Techniques. Tables 27 and 28 give the dimensioning information for GO in IN. Tables 57 and 58 present the layout for the Real and Integer packing arrays (RQ and IQ, respectively).

The KCON array serves as the control section for the STOMAT, KREGNM, KREGNS, KELLNM, and KCONAM arrays, which hold the physical input data describing contacts, ellipses, belts, and materials. KCON itself has a control section and a free section. The control section is described in Table 59 and is the top level of a hierarchy which can extend four levels deep. Tables 60 through 65 describe the control entries which may appear in the free section of the KCON array and Tables 66 through 72 describe the information entries which may appear in the STOMAT array. The KREGNM, KREGNS, KELLNM, and KCONAM arrays contain the names of the contacts, ellipses, belts, and corresponding materials together with limited output control information for regions. KREGNM, KELLNM, and KCONAM all contain only names. KREGNS will be discussed in Section 4.4.4.

For regions which are undergoing migration, it is necessary to "remember" forces and points of application from the last established time until the process to establish a new time is complete. The dual set of arrays KMIG and STOMIG together with KMUG and STOMUG carry out this function. KMIG and KMUG have identical format, which is described in Table 73. KMIG contains the last established values. KMUG has the new values built up in it. STOMIG and STOMUG have a similar relationship and are described in Table 74.

During the model execution, KACT and STOACT arrays are reused to hold information concerning the interactions between force-producers. KACT contains both a control section described by Table 75 and a free section described by Table 76. The control section consists of nine element entries for each interaction of the run. The free data section follows immediately. The STOACT data entries are described in Table 77.

In addition to containing control information for STOACT, KACT also controls entries in the CONOUT array which contains computed forces, etc., to be outputted later. These entries are described in Tables 78 through 81.

Various tabular functions are stored in similar control and free format entries described in Tables 82 and 83. The total number of such tables used is NUMTAB.

4.4.4 Binary Output Formats. GO makes use of four external data sets—two direct access data sets and two sequential data sets. One of the direct access data sets (NU) has previously been described in Sections 4.2.3 and 4.3.3. In the process of execution, when each increment of the print time step control is reached, GO fills in the sections for computed results controlled by ICBEQ (see Table 47) and appends the INTACT array to the end of NU. The INTACT array controls the storage of computed results for belt interactions, ellipse-line interactions and ellipse-ellipse interactions in data set MV. This array is described in Table 84. In addition, GO continually updates both NACTUL, which is the number of print time points in record number $INSX + 1$, and the array KREGNS, which is stored under the control of the array LEAD (see Table 47). KREGNS controls the storage of region quantities and line position information on MV and is described in Table 85.

Acceleration information is recorded on sequential data set MU at every integration time step regardless of the print time step control. Table 86 presents the layout of sequential data set MU.

Table 87 describes the layout of data set MV into entries each of which is NTIMES records long and controlled by either INTACT or KREGNS.

The final data set employed is sequential data set NP, which stores the information needed for producing stick figure plots and is described in Table 88.

The information stored in these four data sets is read back in by the Output Processor in order to produce the standard printed output of the model. The data sets described in Tables 47, 86, 87, and 88 can be saved as a permanent record of the model run output. OUTP and OUT can be rerun any number of times to recover this information in different ways.

TABLE 57. PACKING ARRAY LAYOUT FOR REALS IN GO (RQ).

	<u>Beginning Index</u>	<u>Array Name and Dimensions for RQ</u>
1	LSMAT (=1)	STOMAT(NSTMAT)
2	LSACT	STOACT(NSTACT)
3	LCOUT	CONOUT(NCNOUT)
4	LTACC	TACC(NNOACC)
5	LACC	ACC(NNOACC)
6	LMDOT	MDOT(NFLUXP)
7	LBTIM	BTIM(NFLUXP)
8	LTEMPS	TEMPS(NGASTM)
9	LTTIM	TTIM(NGASTM)
10	LPERM	PERM(NBAGPR)
11	LDELTP	DELTAP(NBAGPR)
12	LBAGUL	BAGUL(2, NIBCNT)
13	LSTHB	STH(NIBCNT)
14	LSTMUG	STOMUG(NSTMUG)
15	LSTMIG	STOMIG(NSTMIG)
16	LADUM	ADUM(NADUM)
17	KTBRAL	STOR(NUMENT)
18	LHX11I	HX11I(NNSTRW)
19	LHTX11	HTX11(NNSTRW)
20	LEDGE	EDGE(NNITI, NNITJ)
21	LDD1	DD1(NNITI, NNITJ)
22	LDD2	DD2(NNITI, NNITJ)
23	LSS	SS(NELPLN)
24	LFF	FF(NELPLN)
25	LPEN	PEN(NELPLN)

TABLE 58. PACKING ARRAY LAYOUT FOR INTEGERS IN GO (IQ).

	<u>Beginning Index</u>	<u>Array Name and Dimensions for IQ</u>
1	LKCON (=1)	KCON(NKCON)
2	LKACT	KACT(NKACT)
3	LKMIG	KMIG(NKMIG)
4	LKMUG	KMUG(NKMIG)
5	LIBCNT	IBCNT(NIBCNT)
6	KTBCNL	MSTOR(KTBCSZ,NUMTAB)
7	LKELLN	KELLM(8, NELLE)
8	LKCONM	KCONAM(4, NLINES)
9	LKRGNM	KREGNM(8, NREGNS)
10	LKRGNS	KREGNS(5, NREGNS)
11	LKCI	KCI(NELPRG)
12	LKOT	KOT(NNITI,NNITJ)
13	LIDELL	IDELL(NNITI,NNITJ)
14	LKOTT	KOTT(NNITI,NNITJ)
15	LJOT	JOT(NELPLN)

Note: KTBCSZ = 6

TABLE 59. THE STANDARD AREA OF THE KCON ARRAY

Index	Description
1-8	Beginning index in KCON of segment entry for ellipses referencing all body links, zero if no ellipses refer to link. (KSEGEL)
$2*IBELT+7$	Beginning index in KCON of belt control entry for belt number IBELT, zero if none. (IBELT=1,7 for inboard lap belt, upper torso belt, lower torso belt, outboard lap belt, lower ring strap, upper ring strap, or torso belt extension.)
$2*IBELT+8$	Beginning index in KCON of belt material control entry for belt number IBELT
23	Number of regions (NREGON)
24	Number of additional segments (NFRELL)
25	Number of materials (NMATLS)
26 to $25+NREGON$	Beginning index in KCON for region control for each of all regions (KKC)
$26+NREGON$ to $LVIELL=25+NREGON+NMATLS$	Beginning index in KCON for all material control entries including joints (KNA)
$LVIELL+1$ to $LVIREG=LVIELL+NFRELL+2$	Beginning index in KCON of segment entry for ellipses referencing non-body links, zero if no ellipses refer to link. (KSEGEL)
$LVIREG+1$ to $LVIREG+MAXSEG$	Beginning index in KCON of segment entry for regions referencing all segments, zero if no regions refer to link. (KSEGRG)

Note: The free format area of KCON begins at $LVIREG+MAXSEG+1$ where NSEG is the number of fixed links, that is, the eight connected body links (head, upper torso, middle torso, lower torso, upper legs, lower legs, upper arms, or lower arms, respectively) together with vehicle and interial frame. NSEG is currently defined as ten. NFRELL is the number of non-fixed ellipses specified. $MAXSEG=NSEG+NFRELL$ and is the total number of all links. LVIELL is the base index for the non-body part of ellipse table. LVIREG is the base index for the whole region table.

TABLE 60. THE TYPICAL GENERAL SEGMENT ENTRY OF THE KCON ARRAY

Relative Index	Description
1	Number of ellipses or regions attached to this general segment (KOUSEG)
2 to KOUSEG+1	Beginning index for ellipse/region control (IKC/JKC)

TABLE 61. THE TYPICAL MATERIAL CONTROL ENTRY OF THE KCON ARRAY

Relative Index	Description
1	Beginning index of material properties in STOMAT
2-5	Material Name (4A4 format)

TABLE 62. THE TYPICAL ELLIPSE CONTROL ENTRY OF THE KCON ARRAY

Relative Index	Description
1 (IKC)	Beginning index in STOMAT of ellipse parameter entry (ISM)
2	Beginning index in KCON of material control entry, zero if rigid
3**	Attachment input indicator (LSEG) [and Primary att. indicator (ISEG) if >0] [+] +1,...,+MAXSEG [-] -1,...,-NSEG
4	Beginning index in KELLNM for ellipse name
5	Beginning index in KCON of ellipse attachment radial resistance entry, zero if null entry (IRAD)
6	Beginning index in KCON of ellipse attachment tangential damping entry, zero if null entry (ITANG)
7	Beginning index in KCON of material for ellipse attachment torsional resistance, zero if null material (ITORS)
8	Circle switch: 0 if circle, -1 circle like, 2 ellipse (ICIRCL)
9	Number of allowables against regions if KHIB is zero; otherwise number of inhibitions against regions (NHIBR)
10	Number of allowables against ellipses if LHIB is zero; otherwise number of inhibitions against ellipses (NHIBE)
11	Friction class (1 through 5)
12	JX: 1,2 if maximum axis along i,k respectively; zero until initialization complete
13	Beginning index in KCON of list of allowed/inhibited regions
14	Beginning index in KCON of list of allowed/inhibited ellipses
15**	Primary attachment indicator (ISEG) if LSEG<0 [NSEG+1...MAXSEG] or Secondary att. indicator (ISEGB) if LSEG>0 [0,4,5,6,7,8]
16	Ellipse type switch: -1 if fixed, 0 free, +1 organ ell. (IFOX) "fixed": Card 219, field 5 is positive "free": negative, and blank 3-6 on Card 249 "organ": -1 to -8, and at least one non-blank 3-6 on 249
17	User-defined segment no. for non-body link (>10), or 0 if none

**NOTES: Input reference system is IABS(LSEG) = IABS (3). Primary att. system (ISEG) is (3) if LSEG>0 or (15) if LSEG<0. Secondary attach. system (ISEGB) is (15) if LSEG>0 or zero if LSEG<0. See Table 59 for defin.

TABLE 63. THE TYPICAL REGION CONTROL ENTRY OF THE KCON ARRAY

Relative Index	Description
1 (KKC)	Beginning index in STOMAT of region parameter section (KSM)
2	Beginning index in KCON of material control section, 0 if rigid
3	Beginning index for region name in KREGNM and region information in KREGNS
4	0 if permanent deformation by parallel displacement; non-zero if permanent deformation is to be handled in MIG (IDEF)
5	Non zero if multiellipse force apportioning is not used (in MULTI)
6	Non-zero if multisegment force apportioning is not used (in CONTACT)
7	Friction class (0 if no friction)
8	0 if cavity analysis (MULTI) is used; non-zero otherwise (forces not interdependent)
9	Attachment Indicator(1,...,MAXSEG) (KSEG)
10	Number of surfaces in region (NSR)
11 to (10+NSR)	Beginning index in KCON of segment control sections for all segments (JKC)
NSR + 11	Non-zero if no migration is allowed (IMIG)
NSR + 12	Zero if region anchor point motion and corner point position is outputted in vehicle coordinates, non-zero if inertial
NSR + 13	Non-zero if no ellipse allowed against region, 0 if at least one ellipse is allowed against region
NSR + 14	Region type switch: -1 if fixed, 0 if free, +1 if organ (KFOX)

TABLE 64. THE TYPICAL CONTACT CONTROL ENTRY OF THE KCON ARRAY

Relative Index	Description
1 (JKC)	Beginning index in STOMAT of segment parameter entry (JSM)
2	Region beginning index in KCON (KKC)
3	Number of forces on segment (NFS)
4	Beginning index for segment name in KCONAM
5	Line segment number in region
6	Initialization switch (nonzero when initialized) (JINIT)
7	Stationary switch (nonzero when line is stationary w.r.t. KSEG system for rest of time) (JFREZ)
8	Number of times specified for positions in STOMAT (if line does not move, this is set to 1.) (JNXZ)
9	Current index in STOMAT of segment position entry (JKURXZ)
10	Last index in STOMAT of segment position entry (JENDXZ)
11	Beginning index in STOMAT of segment position entry (JBEGXZ)

TABLE 65. THE TYPICAL BELT CONTROL ENTRY OF THE KCON ARRAY.

Relative Index	Description
1	Beginning index of body attachment material control if shared deflection, 0 otherwise
2	Beginning index of belt and material titles in KELLNM
3	Beginning index of body and material titles in KREGNM, or 0
4	0 if belt force based on deflection; for simple belt system, beginning index in STOMAT of initial belt length if positive (force based on strain); (if negative, a new belt and force based on strain but no STOMAT reference).

Note: Entry 4 for simple belt system is made to correspond to MBELT (Card 717) for advanced belts.

TABLE 65A. THE TYPICAL ELLIPSE ATTACHMENT RADIAL
RESISTANCE ENTRY OF THE KCON ARRAY

Relative Index	Description
1	Beginning index of Ellipse Attachment Radial Resistance Entry in STOMAT (ISMR)
2	Number of points (KFLEX) in Linear Coefficient Table
3	Number of points (LFLEX) in Quadratic Coefficient Table
4	Number of points (MFLEX) in Cubic Coefficient Table
5	Number of points (NFLEX) in Damping Coefficient Table
6-7	Name of Radial Stiffness/Damping Resistance

TABLE 65B THE TYPICAL ELLIPSE ATTACHMENT TANGENTIAL DAMPING
COEFFICIENT CONTROL ENTRY IN THE KCON ARRAY

Relative Index	Description
1	Beginning index in STOMAT of Ellipse Attachment Tangential Damping Coefficient Table (ISMT)
2	Number of entries (JFLEX) in Tangential Damping Coefficient Table
3-4	Name of Tangential Damping Resistance

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TABLE 66. THE TYPICAL MATERIAL ENTRY OF THE STOMAT ARRAY

Relative Index	Description	
1 (KNA,KNB)	Deflection of Inertial Spike Maximum	(DA)
2	Deflection of Inertial Spike End	(DB)
3	Yield Point Deflection	(DC)
4	Deflection At Which Breakdown Begins	(DE)
5	Deflection At Which Failure Occurs	(DF)
6	Saturation Force Limit	(FM)
7	Saturation Unloading Slope or if negative, minus G-ratio	(DM)
8	G-Ratio (Permanent Deformation to BOG) or if negative, minus table number	(GI)
9	R-Ratio (Conserved Energy to Total Energy) or if negative, minus table number	(RI)
10	Force Convergence Requirement when this material used in shared situation	(FOREPS)
11	Index in KCON of Material Title	
12	Static Curve Polynomial Index in STOMAT or if negative, minus table number	(IIP)
13	Inertial Spike Polynomial Index in STOMAT or if negative, minus table number	(JJP)
14	Viscous damping coefficient for $\dot{\delta} > 0$	
15	Viscous damping coefficient for $\dot{\delta} < 0$	
16	(not used)	
17	Number of User Supplied Bilinear Unloading Curves (if zero, regular unloading used)	(NBI)
18	Beginning index in STOMAT for User Supplied Unloading Curve Entries	(KBI)

TABLE 66-1. THE TYPICAL BILINEAR UNLOADING CURVE ENTRY OF THE STOMAT ARRAY

Relative Index	Description
1 (KBI)	Deflection for complete unloading, δ_1
2	Deflection at break in bilinear curve, δ_2
3	Deflection at beginning of unloading, δ_3
4	Slope of lower segment of bilinear unloading curve, S_1
5	Slope of upper segment of bilinear unloading curve, S_2

(Repeated -- NBI times total)

TABLE 67. THE TYPICAL STATIC OR INERTIAL SPIKE CURVE COEFFICIENTS ENTRY IN THE STOMAT ARRAY.

Relative Index	Description
1	C ₁
2	C ₂
3	C ₃
4	C ₄
5	C ₅
6	C ₆

TABLE 69. THE TYPICAL REGION ENTRY OF THE STOMAT ARRAY

Relative Index	Description
1 (KSM) to NSR + 1	$\gamma_1, \dots, \gamma_{n+1}$ (mass compliance)
NSR + 2 to 2NSR + 2	k_1, \dots, k_{n+1} (for bending at corners)
2NSR + 3 to 3NSR + 1	Inertial Δx for migration, $i=1$ to $n-1$ (zero if region does not migrate) (no entry if $n=1$)
3NSR + 2 to 4NSR + 2	$x_1^{c'}, \dots, x_{n+1}^{c'}$ (inertial corner point x's)
4NSR + 3 to 5NSR + 3	$z_1^{c'}, \dots, z_{n+1}^{c'}$ (inertial corner point z's)
5NSR + 4	$\sin \theta_R$
5NSR + 5	$\cos \theta_R$
5NSR + 6	θ_R (region baseline angle)
5NSR + 7 to 6NSR + 5	$XSUM_1, \dots, XSUM_{n-1}$ (total x-migration for corner points, with respect to baseline) (no entry if $n=1$)
6NSR + 6 to 7NSR + 4	$ZSUM_1, \dots, ZSUM_{n-1}$ (total z-migration for corner points, with respect to baseline) (no entry if $n=1$)
7NSR + 5	$X_A(0)$ in cart or inertial coordinates (left anchor)
7NSR + 6	$Z_A(0)$ in cart or inertial coordinates (left anchor)
7NSR + 7	$X_B(0)$ in cart or inertial coordinates (right anchor)
7NSR + 8	$Z_B(0)$ in cart or inertial coordinates (right anchor)
7NSR + 9 to 8NSR + 7	Inertial Δz for migration, $i=1$ to $n-1$ (zero if region does not migrate) (no entry if $n=1$)

TABLE 70. THE TYPICAL CONTACT SEGMENT ENTRY OF THE STOMAT ARRAY

Relative Index	Description
1 (JSM)	Penetration Limit
2	Edge Constant
3	Direction Factor, inputted switch which indicates whether (at the beginning time) the inertial origin lies in front of (+1.) or behind (-1.) the line
4	Correlation factor, computed correlation sign so that the normal form of line shows distances positive behind the line
5	One half of current line segment length
6-7	Velocities of second endpoint coordinates (\dot{x}_2, \dot{z}_2)
8-11	Coefficients of normal form of both line and bisector w.r.t. KSEG system (r,p,s,w). Note: $u = rx' + pz' + s$ and $v = -px' + rz' + w$ where u is the directed distance from line and v is directed along line
12-15	Time rate of change of line coefficients w.r.t. KSEG system $(\dot{r}, \dot{p}, \dot{s}, \dot{w})$
16-19	Coefficients of line w.r.t. inertial system (A,C,D,W) Note: $u = AX + CZ + S$ $v = -CX + AZ + W$ where u and v are as above
20 -23	Time rate of change of line coeff. w.r.t. inertial system $(\dot{A}, \dot{C}, \dot{S}, \dot{W})$

TABLE 72. THE TYPICAL BELT ENTRY OF THE STOMAT ARRAY.

Relative Index	Contents
1	Lap belt length at $t=0$ or Upper torso belt length at $t=0$ or Lower torso belt length at $t=0$

NOTE: This entry not used for advanced belts.

TABLE 72A. THE ELLIPSE ATTACHMENT RADIAL RESISTANCE COEFFICIENTS
TABLE ENTRY OF THE STOMAT ARRAY.

Relative Index	Description
1 to KFLEX	Circumferential Angles for Linear Coefficient Table
KFLEX+1 to 2*KFLEX	Linear Coefficient Values
2*KFLEX+1 to 2*KFLEX+LFLEX	Circumferential Angles for Quadratic Coefficient Table
2*KFLEX+LFLEX+1 to 2*(KFLEX+LFLEX)	Quadratic Coefficient Values
2*(KFLEX+LFLEX)+1 to 2*(KFLEX+ LFLEX)+MFLEX	Circumferential Angles for Cubic Coefficient Table
2*(KFLEX+LFLEX)+ MFLEX+1 to 2*(KFLEX+LFLEX+MFLEX)	Cubic Coefficient Values
2*(KFLEX+LFLEX+MFLEX)+1 to 2*(KFLEX+LFLEX+ MFLEX)+NFLEX	Circumferential Angles for Damping Coefficient Table
2*(KFLEX+LFLEX+MFLEX)+ NFLEX+1 to 2*(KFLEX+ LFLEX+MFLEX+NFLEX)	Damping Coefficient Values

NOTE: KFLEX, LFLEX, MFLEX, and NFLEX are found in the corresponding Table 65A entry for this Radial Resistance Coefficients Table

TABLE 72B. THE TYPICAL ELLIPSE ATTACHMENT TANGENTIAL DAMPING
COEFFICIENT TABLE ENTRY IN THE STOMAT ARRAY

Relative Index	Description
1 to JFLEX	Circumferential Angles for Tangential Damping Coefficient Table
JFLEX+1 to 2*JFLEX	Tangential Damping Coefficient values

NOTE: JFLEX is found in the corresponding Table 65B entry for this
Tangential Damping Coefficient Table.

TABLE 73. THE STANDARD AREA OF THE KMIG ARRAY.

Index	Description
1	Number of regions (NRG)
2 to NRG + 1	Beginning index of region entry in KMIG if $\neq 0$ (KKM); 0 if no forces on region
KKM	Number of segments in region (NSR)
KKM + 1	Number of segments with forces > 0 (NSF)
KKM + 2	*Number of forces > 0 on region (NFR)
KKM + 3 to KKM + NSR + 2	Beginning index in KMIG of list of contacting ellipses (or 0 if no forces > 0 against segment) for segment (KKE)
KKE	Number of forces > 0 on segment (NFS)
KKE + 1 to KKE + NFS	Beginning index of force entry in STOMIG (KSG)

* $F > 0$ is the condition after LODFEL and before MULTI. KMIG will have entries for forces equal to zero if a non-zero force is modified to zero by MULTI.

TABLE 74. THE TYPICAL SEGMENT FORCE ENTRY OF THE STOMIG AND STOMUG ARRAYS.

Relative Index	Description
1 (KSG)	x^F } inertial point of application
2	z^F }
3	F_x } force components in inertial frame
4	F_z }
5	$\Delta\delta_x$ (initialized to $ \Delta\delta $ by SETMIG)
6	$\Delta\delta_z$ (initialized to 0 by SETMIG)

TABLE 75. THE TYPICAL CONTROL ENTRY OF THE KACT ARRAY.

Relative Index	Description
1 (IKAT)	First interaction identifier (IA)
	IA Significance
	>0 Beginning index in KCON of ellipse or region
	-1 Head contact of steering column
	-2 Upper Torso contact of steering column
	-3 Middle Torso contact of steering column
	-4 Lower Torso contact of steering column
	-5 to -8 Steering Wheel Reaction Number -IA-4
	-9 to -21 -IA is beginning index in KCON for belt standard area entry (see Table 59)
	-22 Torsional resistance for non-rigidly attached ellipse
	-31 to -38 Simple material joint number -IA-30 flexion
	-39 Simp. matl. upper neck extension (rearward)
	-40 Simp. matl. lower neck extension
	-41 Simp. matl. shoulder length
	-42 to -43 General material upper neck flexion, extension
	-44 to -45 Gen. matl. lower neck flexion, extension
	-46 to -47 Gen. matl. UT flexion, extension
	-48 to -49 Gen. matl. LT flexion, extension
	-50 to -51 Gen. matl. hip flexion, extension
	-52 to -53 Gen. matl. knee flexion, extension
	-54 to -55 Gen. matl. shoulder forward, rearward arm motion
	-56 to -57 General material elbow flexion, extension
	-58 to -59 General material neck elongation, compression
	-60 Unused General material
2	Second interaction identifier (IB):
	If IA > 0 and IB < 0: IB is beg. ind. in KCON of 2nd ellipse of ellipse-ellipse case,
	If IA > 0 and IB = 0: this is a region summary entry,
	If IA > 0 and IB > 0: IB is beg. ind. in KCON of line entry of ellipse-line case,
	If IA is -1 to -4 then IB indicates wheel part contacted: IB=-5 is Steering Wheel End, IB=-6 is Steering Wheel Center, and IB=-7 is Steering Wheel Hub
	If IA is -5 to -8 then IB is expected = -2,
	If IA is -9 to -21 and IB > 0: IB is beg. ind. in KCON of body segment material,
	If IA is -9 to -21 and IB = -1: only belt material used,
	If IA is -22 then IB is beg. ind. in KCON of primary ellipse, Otherwise IB is unneeded and set zero.

TABLE 75. THE TYPICAL CONTROL ENTRY OF THE KACT ARRAY (CONTINUED).

Relative Index	Description
3	Beginning index in STOACT (IACT) of interaction time history entry, zero if none
4	Beginning index in CONOUT (ICNOUT) of interaction output entry, zero if not active at current time. Set to 2 if no CONOUT entry used. A negative sign indicates, that this interaction is active and needs initialization
5	Beginning index in KACT (IKACT) of interaction time history entry, zero if none
6	Beginning index in STOMAT (KNA) of first soft material, zero if both rigid or this is region entry
7	Beginning index in STOMAT (KNB) of second soft material, zero if second material is rigid or this is region entry
8	If IB is not zero, beginning record number on file MV for interaction output, zero if first time on. If IA>0 and IB=0, beginning index in KREGNS for region. If IA<0 and IB=0 (and entry 3 = 2), unneeded and set zero
9	Recording switch: zero if never recorded, 1 if recorded

TABLE 76. THE TYPICAL TIME HISTORY ENTRY OF THE KACT ARRAY

Relative Index	Description	
1-2 (IKACT,IKACT)*	Inputted Curve Control	(IA)
	$IA = \begin{cases} 1 & \text{if BOG .lt. DA} \\ 2 & \text{if DA .le. BOG .lt. DB} \\ 3 & \text{if DB .le. BOG .lt. DE} \\ 4 & \text{if DE .le. BOG .lt. DF} \\ 5 & \text{if BOG .ge. DF} \end{cases}$	(Upward Inert. Spike), (Downward Inert. Spike), (Static alone), (Breaking down), or (Failure).
Note: BOG here signifies maximum D which has occurred (not stored).		
3	Static curve beginning index in STOMAT or if negative, minus table number.	(IIP)
4	Inertial curve beginning index in STOMAT or if negative, minus table number.	(JJP)
5-6*	Saturation At Last Turnaround Switch: zero if no; one if yes	(IST)
7-8*	Penetration Control Switch	(NPRENG)
9-10*	Computed Curve Control	(KGO)
	$KGO = \begin{cases} 1 & \text{if using only inputted curves,} \\ 2 & \text{if using inputted \& unloading for D} \\ & \text{.ge. BOG \& OG .le. D .lt. BOG resp.,} \\ 3 & \text{if using inputted \& reloading for D} \\ & \text{.ge. BOG \& OG .le. D .lt. BOG resp.,} \\ 4 & \text{if using combination of all three} \\ & \text{curves: inputted when D .ge. BOG or} \\ & \text{reloading when RCOG .le. D .lt. BOG} \\ & \text{or unloading when OG .le. D .lt. RCOG,} \\ -3 & \text{if using breaking loading \& unloading} \\ & \text{\& static for D ranges DE .le. D .lt. DF} \\ & \text{\& D .le. BOG \& BOG .le. D .lt. DE resp.,} \\ & \text{or} \\ -4 & \text{if using breaking loading \& breaking un-} \\ & \text{loading for D ranges BOG .le. D .lt. DF} \\ & \text{\& OG .le. D .lt. BOG resp.} \end{cases}$	
11-12*	Saturation Occurrence Switch	(IS)
13-24	1-12 repeated for other soft material if present.	

* Current value in odd relative index and last established value in even relative index.

TABLE 77. THE TYPICAL TIME HISTORY ENTRY OF THE STOACT ARRAY

Relative Index	Description	
1 (IACT)	Beginning index for this interaction in KACT	
2-3*	Simulated Time	(T)
4-5*	Deflection	(D)
6-7*	Deflection Rate	(DD)
8-9*	Permanent Deformation	(OG)
10-11*	Turnaround Deflection on Inputted Curves	(BOG)
12-13*	**Conserved Energy for Last-Defined Loading- Unloading Cycle	(CE)
14-15*	Saturation Deflection	(DSAT)
16-17*	Force at Turnaround Deflection	(FBOG)
18-19*	Force	(FR)
20-21*	Slope of Force-Deflection Curve	(FRPM)
22-23*	Instantaneous Permanent Deformation	(OGT)
24-25*	**Absorbed Energy for Last-Defined Loading- Unloading Cycle	(AE)
26-27*	Instantaneous Absorbed Energy	(AET)
28-29*	Unloading Changeover Deflection (zero if Quadratic Unloading)	(UCOG)
30-31*	Reloading Effective Deflection	(RCOG)
32-33*	Reloading Constant Coeff	(RL(1))
34-35*	Reloading Linear Coeff	(RL(2))
36-37*	Unloading Constant or Upper Constant Coeff	(UL(1))
38-39*	Unloading Linear or Upper Linear Coeff	(UL(2))
40-41*	Unloading Quadratic or Lower Constant Coeff	(UL(3))
42-43*	Unloading Lower Linear Coeff	(UL(4))
44-83	4-43 repeated for other soft material if present	

* Current value stored in even relative index and last established value stored in odd relative index.

** Computed only at change from loading to unloading (i.e., at turnaround of cycle).

TABLE 77-A. COMBINATIONS OF USES OF INPUTTED AND COMPUTED CURVES

Curve Type	Applicable Range	Curve Location	KGO(K)					
			1	2	3	4	-3	-4
Static	BOGP to min (DSAT,DE)	(IIP(K))	X	X	X	X	X	-
Inertial Spike	BOGP to min (DB,DE)	(JJP(K))	X	X	X	X	X	-
Quadratic Unload	OGP to BOGP	ULP(1-3)	-	X	-	X	X	-
High Bilinear Unload	UCOGP to min (BOGP, RCOGP)	ULP(1-2)	-	X	-	X	X	-
Low Bilinear Unload	OGP to min (UCOGP, RCOGP)	ULP(3-4)	-	X	-	X	X	-
Reload	RCOGP to BOGP	RLP(1-2)	-	-	X	X	-	-
Saturation Loading	max (BOGP,DSATP) to DE	FM(K)	X	X	-	-	X	-
Saturation Unload	OGP to BOGP	ULP(1-2)	-	X	-	-	X	-
Breakdown Loading	max (DE,BOGP) TO DF	RLP(1-2)	-	-	-	-	X	X
Breakdown Unload	OGP to BOGP	ULP(1-2)	-	-	-	-	-	X

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TABLE 78. THE TYPICAL ELLIPSE-SEGMENT ENTRY OF THE CONOUT ARRAY.

Relative Index	Description
1 (IM)	δ deflection line
2	$\dot{\delta}$ deflection rate line
3	F normal force
4	T tangential force
5	x x position on contact segment (nondimensional)
6	\dot{x} x component tangential velocity on contact segment
7	$\left. \begin{array}{l} x_0 \\ z_0 \end{array} \right\}$ tangential point in inertial coordinates on ellipse.
8	
9	$\left. \begin{array}{l} x_{z_rel} \\ z_{z_rel} \end{array} \right\}$ tangential contact point in body segment coordinates
10	
11	δ ellipse
12	$\dot{\delta}$ ellipse

TABLE 78A. THE TYPICAL NON-BODY LINK PRIMARY ELLIPSE OUTPUT ENTRY
IN THE CONOUT ARRAY

Relative Index	Description
1	Radial distance of ellipse center motion (DELR)
2	Radial velocity of ellipse center motion (DELRD)
3	Radial spring force (FRS)
4	Radial damping force (FRD)
5	Total radial force (FRT)
6	Ellipse torsional angle (THET)
7	Ellipse torsional angular velocity (THETD)
8	Ellipse torsional moment (TMOM)
9	Ellipse circumferential angle (THEC)
10	Ellipse circumferential angular velocity (THECD)
11	Ellipse circumferential force (CEF)
12	Ellipse circumferential moment (CEM)

TABLE 79. THE TYPICAL ELLIPSE-ELLIPSE ENTRY OF THE CONOUT ARRAY.

Relative Index	Description	
1 (IM)	δ deflection	
2	$\dot{\delta}$ deflection rate	
3	F normal force	
4	XE(1,1) } center of 1st ellipse in inertial coordinates	
5		XE(2,1) }
6	XE(1,2) } center of 2nd ellipse in inertial coordinates	
7		XE(2,2) }
8	XZ _{rel} for ellipse A } coordinates in body segment systems of contact point	
9		ZZ _{rel} for ellipse A }
10		XZ _{rel} for ellipse B }
11		ZZ _{rel} for ellipse B }

TABLE 80. THE TYPICAL REGION ENTRY OF THE CONOUT ARRAY.

Relative Index	Description
1 (IMR)	Number of contacting ellipses with non-zero force
2,3	ΣF_x and ΣF_z for forces on region, with respect to region system
4,5	Average x- and z- migrations over the n-1 corner points, with respect to region system
6	ΔX_A since $t = 0$ (anchor A)
7	ΔZ_A since $t = 0$ (anchor A)
8	ΔX_B since $t = 0$ (anchor B)
9	ΔZ_B since $t = 0$ (anchor B)
10	X_A
11	Z_A
12	X_1
13	Z_1
14	X_2
15	Z_2
16	X_3
17	Z_3
18	X_4
19	Z_4
20	X_5
21	Z_5

} relative to inertial or vehicle frame

} anchor A and corner point coordinates in inertial or vehicle frame

TABLE 81. THE TYPICAL BELT ENTRY IN THE CONOUT ARRAY.

Relative Index	Description
1 (IKO)	Elongation DISP*
2	Elongation Rate DISPD*
3	FBA
4	FB
5	FMOD
6	Resultant force
7	Belt force angle in vehicle frame
8	Belt Absorbed Energy AE
9	Zeroed

*NOTE: DISP and DISPD are never strains whether or not that option is elected.

TABLE 82. THE TYPICAL CONTROL ENTRY OF THE MSTOR ARRAY.

Second Index	Description
1	Number of points in table (n)
2	Beginning index in STOR
3	Scan type switch Magnitude: 0=constant, 1=piecewise linear, 2=step function Sign: positive = non-periodic, negative = periodic
4	Pointer at address of current x, negative if changes in table
5	Table High-end extrapolation control: 1 = Linear continuation of last segment 2. Last ordinate continuation.

TABLE 83. THE TYPICAL TABLE ENTRY OF THE STOR ARRAY.

Relative Index	Description
0	Period if scan type is periodic; absent if non-periodic
1 to n	Table Abscissas for n points (ordinate if constant)
n+1 to 2n	Table Ordinates for n points (absent if constant)
2n+1 to 3n-1	Computed slopes for each table interval (n-1 points) (present only for piecewise linear)
3n to 4n-2	Computed intercepts for each table interval (n-1 points) (present only for piecewise linear)

NOTE: The MSTOR Index reference points to relative index one whether or not the period is present.

NOTE: Table name (8 characters) is maintained in a separate array NAMTAB (2, LIMTAB) where LIMTAB is the maximum number of tables allowed (currently 112).

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TABLE 84. INTACT ARRAY LAYOUT.

Relative Index	Typical Entry
1	Switch { = -1 = Belt Entry = 0 = Ellipse-Ellipse Entry = 1 = Ellipse-Line Entry
2	Index of Ellipse or Belt name and material name in KELLNM
3	Index of line name in KCONAM, Otherwise zero
4	Index of region name or belt body attachment and material in KREGNM, or if ellipse, name and material in KELLNM
5	Beginning record number on binary file MV for contact entry

TABLE 85. KREGNS ARRAY LAYOUT.

Relative Index	Typical Entry
1	Switch { =0 no contacts this region or category 2 not wanted ≠0 Beginning record number of category 2 Entry
2	Beginning record number of category 3 Entry, 0 if category 3 not wanted
3	Number of Segments in region
4	Beginning index of Segment Titles for region in KCONAM
5	Switch { = 0 = output in vehicle coordinates ≠ 0 = output in inertial coordinates

TABLE 86. SEQUENTIAL BINARY OUTPUT DATA SET ON LOGICAL DEVICE
NUMBER MU [7]

1 Typical time entry record description

T AHAP AHSI ACAP ACSI AHPX AHPZ

(one line for every integration step)

2 Trailer record description

-T -T -T -T -T -T -T

(one line)

Note: MU set to 7

Note: T in typical record is negative if integration monitor has flagged either variable 1 or 19.

TABLE 87. INDEXED BINARY OUTPUT DATA SET ON LOGICAL DEVICE NUMBER MV [9]

Record Number	Contents
$\eta_{n-1} + 1$ to η_n	Region quantities, region segment quantities, and interaction quantities controlled by INTACT or KREGNS. There are N entries, each of which is NTIMES records long. (where $\eta_n = \eta_{n-1} + \text{NTIMES}$ for each n from 1 to N and $\eta_0 = 0$)

NOTE: MV presently set to 9

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TABLE 88. SEQUENTIAL BINARY OUTPUT DATA SET ON LOGICAL
DEVICE NUMBER NP. [10]

Rec. 1:	T, (XJI (I), I = 1,9), (ZJI(I), I = 1,9), (X(1,I), X(2,I), R(1,1,I), R(2,1,I), R(1,2,I), R(2,2,I), I = 1,8), XV, ZV, CTHV, STHV	71 values
Rec. 2:	x_1^C , z_1^C , (no. of segments in all regions + no. of regions) x 2	values
Rec. 3:	If NBAG = 1, XA, ZA, XBC, ZBC, ((BAGUL(I,J), I = 1,2), J = 5,117,4) Periphery has (XA, ZA) + 29 other points = 30.	62 values
Rec. 4:	If NSTCOL \neq 0, HXC, HZC, HXS, HZS	10 values
Rec. 5:	If NBELT = 1 or 2, XB1, ZB1, XB2, ZB2, XB3, ZB3	6 values
	If NBELT = 3 ((XZRING(I,J), I = 1,2), J = 1,2) ATTANC(1,1,3), ATTANC(1,2,3)	6 values
Rec. 6:	IUSEPL	1 value
Rec. 7:	If IUSEPL \neq 0 and NBAG = 2, X of 1st endpoint, Z of 1st endpoint, Y of 2nd endpoint, Z of 2nd endpoint, curvature switch, l_i or S_i , h_i , k_i , r_i , . . . (9 values for each of IUSEPL/9 bag profile segments)	IUSEPL values

Note: NP presently set to 10.

4.4.5 Auxiliary Program Output. Auxiliary or debugging printout for this processor 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 switch covers. Higher 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 89.

TABLE 89. 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 "DD," the contact force lever arms, is desired. This is specified under debug switch 7, 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 fourth digit. Because no special printout is desired from debug switch 8, the last two bits of the fourth hexadecimal digit must be "00." Because the desired debug level is 3, the first two bits of the fourth digit must be "11." Therefore, the fourth digit takes on the value "1100" or "C." Thus, the hexadecimal word will be "000C0000" at the effective time.

The table of effective times and control words is specified to the program by means of Cards 104 and 105 described in Table 7. 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 startlingly huge and hence utmost discretion must be exercised in the use of this feature.**

Table 92 contains a detailed list of the sixteen debug switches and the quantities which will be printed for each debug level of each switch. Table 92 should be used in conjunction with the Symbol Dictionary (see Section 4.4.6, Table 93) and in some cases the listing of the program.

Each line in Table 92 corresponds to one line in the printed output so this table can be used to identify individual quantities. In some cases, it has been necessary because of space to enter more than one line for a single printed line in the output. Such "continuation" lines are marked with an asterisk.

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

**See Card 104 (KONSIS).

Under the column entitled "Quantity" 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 "Subroutine."

These printouts are organized on Block Number which is printed as identification.

Table 91 contains a summary in words of the material presented in Table 92 for the convenience of the user. A short description of each set of quantities is given instead of the explicit format. Table 90 lists Block Numbers, the debug switch which produces each of them and the subroutines from which each of them comes.

Error messages produced by this simulator are shown in Table 95, which is self-explanatory.

TABLE 90. DEBUG BLOCK NUMBER, DEBUG SWITCH, AND SUBROUTINE CORRESPONDENCE

Debug Block Number	Debug Switch	Subroutine
1-8	3	MULTI
9-21	2	MIG
22-25	8	GOMVMA
26	8	MATRIX
27,28	8	OCCGEO
29-32	13	DAUX
33-35	12	JTORQ
36-38	10	EVAL
39-42	5	CNTACT
43	14	CNTACT
44,45	5	CNTACT
46-51	7	CNTACT
52,53	11	SETACT
54-61	14	CNTACT
62	7	CNTACT
63-69	15	ELLELL
70	5	CNTACT
71	2	CNTACT
72	3	CNTACT
73,74	3	CNTACT
75	2	CNTACT
76-83	1	BELT

TABLE 90. DEBUG BLOCK NUMBER, DEBUG SWITCH, AND SUBROUTINE CORRESPONDENCE
(Continued)

Debug Block Number	Debug Switch	Subroutine
84	11	SETMIG
85-87	16	REPACK
88-91	9	LODFEL
92	2	REPACK
93	8	OCCGEO
94	10	EVAL
95	11	PUSHER
96	1	BELT
97-100	-	not used
101-111	6	STEER
112	6	EOM
113	6	REACT
114	6	HDX11
115-136	1	BELT2
137-141	1	RSDUAL
142	1	INFL
143	1	MATRIX
144	4	AIRBAG
-	16	GOMVMA

TABLE 91. DESCRIPTION OF DEBUG PRINTOUT (Page 1 of 9)

Debug Switch	Debug Level	Debug Block Number	Description	Subroutine
1	1	76	Belt forces and moments	BELT
1	1	78	Belt forces and moments	BELT
1	1	80	Belt forces and moments	BELT
1	1	81	Belt forces and moments	BELT
1	1	82	Belt forces and moments	BELT
1	1	96	Belt attachment coordinates	BELT
1	1	115	Belt attachments and ring positions	BELT2
1	1	116	Belt system controls	BELT2
1	1	117	Belt length components and endpoints	BELT2
1	1	118	Belt deflections and deflection rates	BELT2
1	1	119	Friction quantities for upper ring	BELT2
1	1	120	Upper ring position and other quantities resulting from relaxation	BELT2
1	1	121	Lower ring position and other quantities resulting from relaxation	BELT2
1	1	122	Lower ring position and other quantities resulting from relaxation	BELT2
1	1	123	Belt deflections and deflection rates	BELT2
1	1	124	Friction quantities for lower ring	BELT2
1	1	125	Lower ring position and other quantities resulting from relaxation	BELT2

TABLE 91. DESCRIPTION OF DEBUG PRINTOUT (Page 2 of 9)

Debug Switch	Debug Level	Debug Block Number	Description	Subroutine
1	1	126	Belt length components and endpoints	BELT2
1	1	128	Stored addresses and belt deflections and forces	BELT2
1	1	129	Torso belt normal force friction quantities	BELT2
1	1	131	Lap and torso belt forces	BELT2
1	1	132	Belt force adjustments and generalized forces	BELT2
1	2	77	Belt angles and lengths	BELT
1	2	79	Belt angles and lengths	BELT
1	2	83	Belt angles and lengths	BELT
1	2	133	Belt system controls	BELT2
1	2	134	Belt acceleration components	BELT2
1	2	135	Belt system controls	BELT2
1	2	143	Generalized belt forces and force components	MATRIX
1	3	127	Belt lever arms	BELT2
1	3	130	Direction cosines and belt attachments	BELT2
1	3	136	Belt velocities and accelerations	BELT2

TABLE 91. DESCRIPTION OF DEBUG PRINTOUT (Page 3 of 9)

Debug Switch	Debug Level	Debug Block Number	Description	Subroutine
1	3	137	Belt forces, deflections, and rates for a pair slipping at a ring	RSDUAL
1	3	138	Friction quantities for upper or lower ring	RSDUAL
1	3	139	Various quantities determined for relaxation	RSDUAL
1	3	140	Various quantities determined for relaxation	RSDUAL
1	3	141	Belt forces, lengths, deflections, rates, and residuals	RSDUAL
1	3	142	Influence coefficients and attachment points	INFL
2	1	9	Indices, integers, and reals which summarize the state of a migrating region	MIG
2	1	16	The "middle" corner point coordinates of a two-segment region	MIG
2	1	17	Solution vector of "undetermined multipliers" and the $\Delta\theta$'s	MIG
2	1	20	Inertial components of the migration increments	MIG
2	1	71	Accumulated migration terms for endpoints of a segment, either inertial or relative	CNTACT
2	1	75	Displacement, force, and permanent deformation values packed for MIG.	CNTACT
2	1	92	Updated total migration for endpoints of region interior segments	REPACK

TABLE 91. DESCRIPTION OF DEBUG PRINTOUT (Page 4 of 9)

Debug Switch	Debug Level	Debug Block Number	Description	Subroutine
2	2	10	Structural properties and corner point positions for migrating region.	MIG
2	2	11	Sines and cosines of segment angles.	MIG
2	2	12	Sines, cosines, and angle for segment angles.	MIG
2	2	14	Quantities describing constrained displacement of a region segment.	MIG
2	2	18	Sines and cosines of segment angles before displacements.	MIG
2	2	19	Sines and cosines of segment angles after displacements.	MIG
2	3	13	Force and position quantities for determining constrained displacement of a region segment.	MIG
2	3	15	Coefficient matrix and right hand side for solution for constraint $\Delta\theta$'s.	MIG
2	3	21	Inertial corner point coordinates resulting from constrained displacements.	MIG
3	1	1	Positions, forces, deflections, and effective radii of ellipses against a segment and cavity material properties.	MULTI
3	1	2	Reordered values from block 1.	MULTI
3	1	72	Forces and deflections resulting from MULTI.	CNTACT
3	1	74	Force values before and after multi-segment apportioning.	CNTACT
3	2	4	Effective deflection and force.	MULTI
3	2	6	Effective deflection and force.	MULTI
3	2	8	Effective deflection and force.	MULTI

TABLE 91. DESCRIPTION OF DEBUG PRINTOUT (Page 5 of 9)

Debug Switch	Debug Level	Debug Block Number	Description	Subroutine
3	2	73	Bookkeeping information for multi-segment apportioning.	CNTACT
3	3	3	Cavity parameters and slopes.	MULTI
3	3	5	Cavity parameters and slopes.	MULTI
3	3	7	Cavity parameters and slopes.	MULTI
4	3	144	Airbag quantities from subroutine DBUG.	AIRBAG
5	1	39	Contact line corner point coordinates relative to vehicle.	CNTACT
5	1	40	Coefficients of contact line.	CNTACT
5	1	70	Inputted contact line corner point coordinates (if inertial).	CNTACT
5	2	41	Contact line intermediate results.	CNTACT
5	3	42	Terms in vehicle contribution to contact deflection rate.	CNTACT
5	1	44	Inertial coordinates of ellipse center and intermediate results for ellipse-contact calculations.	CNTACT
5	1	45	Inertial coordinates of circle center.	CNTACT
6	1	101	Resultant contact forces on the occupant due to the contact with steering assembly.	STEER
6	1	102	Resultant reaction forces on the steering wheel due to contact.	STEER
6	1	103	Position of steering assembly.	STEER
6	2	104	Interferences between body segment and steering assembly.	STEER
6	2	105	Normal interference rates between body segment and steering assembly.	STEER
6	2	106	Tangential interference rates between body segment and steering assembly.	STEER
6	2	107	Velocities, accelerations of generalized coordinates of steering assembly.	STEER
6	2	108	Positions of body contact surfaces.	STEER

TABLE 91. DESCRIPTION OF DEBUG PRINTOUT (Page 6 of 9)

Debug Switch	Debug Level	Debug Block Number	Description	Subroutine
6	3	109	Detail outputs for the interference between head and steering assembly contact points.	STEER
6	3	110	Detail outputs for the interference between body segments and steering assembly contact points.	STEER
		111		
6	3	112	Mass coefficient matrix and RHS of steering column.	EOM
6	3	113	Maximum allowable reactions and the reaction required for rigidity at steering assembly.	REACT
6	3	114	Gearbox position and velocity of steering column.	HDX11
7	1	47	Deflection, force and associated quantities for ellipse-contact interaction.	CNTACT
7	3	51	Region orientation and description of user-selected region options.	CNTACT
7	2	62	Total generalized force contribution from ellipse contact forces at a surface.	CNTACT
7	3	46	Inertial coordinates of possible contact points on ellipse.	CNTACT
7	3	48	Partial sums (through the IKC contact ellipse) for the generalized force contribution of contact forces for a surface.	CNTACT
7	3	49	Contact force lever arms for an ellipse-line interaction.	CNTACT
7	3	50	Intermediate results for determining circle-contact lever arms.	CNTACT
8	1	22	Time Counters.	GOMVMA
8	1	23	Time Counters.	GOMVMA
8	1	24	Time Counters.	GOMVMA
8	1	25	Time Counters.	GOMVMA
8	1	27	Joint positions, segment CG coordinates, and velocities	OCCGEO

TABLE 91. DESCRIPTION OF DEBUG PRINTOUT (Page 7 of 9)

Debug Switch	Debug Level	Debug Block Number	Description	Subroutine
8	2	26	Mass coefficient matrix, RHS, and RHS minus kinetic energy terms.	MATRIX
8	3	28	Rotation matrices and derivatives plus derivatives of segment CG coordinates.	OCCGEO
8	3	93	Linear and angular momenta.	OCCGEO
9	1	88	Interaction deflection, force, and deformation.	LODFEL
9	2	89-90	Shared deflection iteration information.	LODFEL
9	3	91	Interaction material control parameters.	LODFEL
10	1	36	Force evaluation control parameters.	EVAL
10	2	37	Force evaluation deformation and energy parameters.	EVAL
10	3	38	Force evaluation computed coefficients and material parameters.	EVAL
10	3	94	Packing array usage lengths.	EVAL
11	1	95	Packing array usage lengths.	PUSHER
11	1	52	Interaction control parameters for generation of KACT entries.	SETACT
11	2	53	Generated KACT entry.	SETACT
11	3	84	Count and control parameters for generation of KMUG and STOMUG entries.	SETMIG
12	1	35	Torque and torque components for joints; relative angles and velocities.	JTORQ
12	2	34	Body link angles and velocities.	JTORQ
12	3	33	Quantities involved in shoulder element force calculations.	JTORQ

TABLE 91. DESCRIPTION OF DEBUG PRINTOUT (Page 8 of 9)

Debug Switch	Debug Level	Debug Block Number	Description	Subroutine
13	1	31	Vehicle coordinates, velocities, and accelerations.	DAUX
13	1	32	Generalized coordinates, velocities, and accelerations; muscle tension forces.	DAUX
13	2	29	Generalized forces for normal, tangential, and ellipse-ellipse forces.	DAUX
13	3	30	Steering column, airbag, and belt forces and moments.	DAUX
14	1	59	Friction forces and lever arms.	CNTACT
14	2	54	Contribution of inertial motion of body segments to surface tangential coordinate velocity components for ellipse.	CNTACT
14	2	55	Block 54 plus contribution of vehicle motion.	CNTACT
14	2	56	Block 55 plus contribution from contact line position.	CNTACT
14	2	57	Block 56 plus additional contribution from contact line position.	CNTACT
14	2	61	Total generalized force contribution from ellipse friction forces at a surface.	CNTACT
14	3	58	Contributing factors of values in block 57.	CNTACT
14	3	60	Partial sums (through the IKC contact ellipse) for the generalized force contribution of friction forces on a surface.	CNTACT

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TABLE 91. DESCRIPTION OF DEBUG PRINTOUT (Page 9 of 9)

Debug Switch	Debug Level	Debug Block Number	Description	Subroutine
14	3	43	Vehicle motion contribution to tangential velocity at contact surface.	CNTACT
15	1	63	Ellipse-ellipse deflection, force, and center coordinates of migrating circles.	CNTACT
15	2	64	Center coordinates of interacting contact ellipses, inertial and relative to body segment CG; lever arms for ellipse-ellipse force.	CNTACT
15	2	66	Migrating circle position parameters for circle-circle case or circle-ellipse.	CNTACT
15	2	67	Migrating circle position parameters for ellipse-ellipse case.	CNTACT
15	2	68	Quantities calculated for case of interacting parallel ellipses.	CNTACT
15	3	65	Ellipse center coordinate contributions to ellipse-ellipse force lever arms and partial sum of generalized force vector elements (through the IKC-JKC ellipse-ellipse interaction)	CNTACT
15	3	69	Semi-major axis direction numbers contributions to ellipse-ellipse force lever arms.	CNTACT
16	1	85	KACT and STOACT update controls.	REPACK
16	2	86-87	Updated part of KACT and STOACT time history entries.	REPACK
16	3	-	Triggers a hexadecimal memory dump if that has been permitted by the user.	GOMVMA

TABLE 92. FORMATS OF DEBUG PRINTOUT (Page 1 of 15)

Debug Switch	Debug Level	Block Number	Quantity	Subroutine
3	1	1	SS(1) ... SS(5) FF(1) ... FF(5) DD(1) ... DD(5) RR(1) ... RR(5) XSEG(1) ... XSEG(4) *N ISCALE	MULTI
3	1	2	S(1) ... S(5) F(1) ... F(5) D(1) ... D(5) RS(1) ... RS(5)	MULTI
3	3	3	K S1(K) S2(K) S3(K) S4(K) SL1(K) SL2(K)	MULTI
3	2	4	M K EFFD(M,K) F(M) FSUM	MULTI
3	3	5	K S1(K) S2(K) S3(K) S4(K) SL1(K) SL2(K)	MULTI
3	2	6	M K EFFD(M,K) F(M) FSUM	MULTI
3	3	7	ISET(NP) S1 S2 S3 S4 SL1 SL2 NP M S1 S2 S3 S4 SL1 SL2	MULTI
3 6	2	8	K ISET(NP) EFFD(K,ISET(NP)) F(K) FSUM NP K M EFFD(K,M)	MULTI
2	1	9	KKC KSM IUPA MIGCT KKM NSR NSF NFR KRK SR CR THETAR XA1 ZA1 * XAN ZAN	MIG
2	2	10	J XK(J) XG(J) XCP(J) ZCP(J) XL(J) (inside NSR+1 deep loop)	MIG
2	2	11	JKC JSM I ST(I) CT(I)	MIG
2	2	12	JKC JSM I ST(I) CT(I) TH(I)	MIG
2	3	13	KKC JKC I N NFS KSG XF ZF FX FZ XLP GAM	MIG
2	2	14	JKC I KKE NFS D XLP TSA TSB DDX DDZ DTRK DXF DZF	MIG

TABLE 92. FORMATS OF DEBUG PRINTOUT (Page 2 of 15)

Debug Switch	Debug Level	Block Number	Quantity	Subroutine
2	3	15	NDIM A(1) A(N) NDIM B(1) B(NDIM)	MIG
2	1	16	NSR=2 XM(1) XM(2) ZM(1) ZM(2) XCP(2) ZCP(2)	MIG
2	1	17	NSR NSF B(1) B(NDIM)	MIG
2	2	18	ST(1) ST(NSR) CT(1) CT(NSR)	MIG
2	2	19	ST(1) ST(NSR) CT(1) CT(NSR)	MIG
2	1	20	N J K STOMAT(J+1) ... STOMAT(J+N) STOMAT(K+1) ... STOMAT(K+N)	MIG
2	3	21	TSA TSB A(1) A(N) A(101) ... A(100+N)	MIG
8	1	22	T MILL I J DT PRTI PLTI BUGI	GOMVMA
8	1	23	T MILL I J DT PRTI PLTI BUGI	GOMVMA
8	1	24	T MILL I J DT PRTI PLTI BUGI	GOMVMA
8	1	25	T MILL I J DT PRTI PLTI BUGI	GOMVMA
8	2	26	AMTX(1,1) AMTX(1, 10) AMTX(1,11) AMTX(1,15) . . . AMTX(14,1) AMTX(10,10) AMTX(14,11) AMTX(10,10) QXH QZH QTHI QTH9 QELN QXS QZS	MATRIX

TABLE 92. FORMATS OF DEBUG PRINTOUT (Page 3 of 15)

Debug Switch	Debug Level	Block Number	Quantity	Subroutine
8	1	27	XJI(1) XJI(10) ZJI(1) ZJI(10) XJDI(1) XJDI(10) ZJDI(1) ZJDI(10)	OCCGEO
8	3	28	((X(I,J), J=1,8), I=1,2) (((DX(I,J,K), J=1,8), I=1,2), K=1,15) (((R(I,J,K), K=1,8), J=1,2), I=1,2) (((DR(I,J,K), J=1,8), I=1,4), K=1,2)	OCCGEO
13	2	29	B(1) B(10) B(11) B(14) BS(1) BS(10) BS(11) BS(14) BF(1) BF(10) BF(11) BF(14) BE(1) BE(10) BE(11) BE(14)	DAUX
13	3	30	PX5 PZ5 MF5 PX1 PZ1 MF1 MF2 PX4 PZ4 MF4 PXI(1) PZI(1) MFI(1) PXI(2) MFI(2) PXI(3) PZI(3) MFI(3) PXI(4) PZI(4) MFI(4) PXI(LBTLA) PZI(LBTLA) MFI(LBTLA) LBTLA FBTX FBTZ FMBF2 FBHX FBHZ FMBF1 FBLX FBLZ FMBF4	DAUX
13	1	31	CQ(1,1) CQ(1,2) CQ(1,3) CQ(3,1) CQ(3,2) CQ(3,3) DAUX	
13	1	32	L RQQ(LD) RQQ(LV) RQQ(LA) AMTX(J,15)	

for L = 1 to 22

TABLE 92. FORMATS OF DEBUG PRINTOUT (Page 4 of 15)

Debug Switch	Debug Level	Block Number	Quantity										Subroutine			
12	3	33	ELS	THETAS	DKDTH(1)...	DKDTH(3)	KJI(10,1)...	KJI(10,3)								JTORQ
12	2	34	THI(1) THDI(1)	:	:	:	:	:	:	:	:	:	:	:	:	JTORQ
12	1	35	TI(1) TLI(1) TNI(1) TFI(1) TVI(1) THVI(1) THRI(1) FLN	:	:	:	:	:	:	:	:	:	:	:	:	JTORQ
			FLNL	:	FLNV	:	FLS	:	FLSL	:	FLSN	:	FLSV	:	TKSH	

TABLE 92. FORMATS OF DEBUG PRINTOUT (Page 5 of 15)

Debug Switch	Debug Level	Block Number	Quantity										Subroutine				
10	1	36	L	IIP(K)	JJP(K)	IA(L)	LLXX(1,L)	IS(L)	ICOPY(L)								EVAL
			D(L)	DD(L)	FORCE	FDEV	DDEL	AE(L)									
10	2	37	T	OG(L)	BOG(L)	FBOG(L)	FOG(L)	E(L)	D(L)	DD(L)							EVAL
			TMP(K)	OGP(K)	BOGP(K)	FBOGP(K)	FOGP(K)	EP(K)	DP(K)	DDP(K)							
10	3	38	PX(1,L)	PX(2,L)	PX(3,L)	PX(4,L)	PX(5,L)	PX(6,L)									EVAL
			PX(7,L)	PX(8,L)	PX(9,L)	PX(10,L)	FM(K)	DM(K)									
			DA(K)	DB(K)	DC(K)	DE(K)	DF(K)	FD(K)									
			GI(K)	GEE	RI(K)	ARE											
			LLXX(1,L)	LLX(1,K)	LLXX(2,L)	LLX(2,K)											
5	1	39	JKC	XHAT(1)			XHAT(4)	DHAT(1)									CNTACT
5	1	40	JKC	BC(4)	BC(2)	BC(3)	BC(13)	BC(31)									CNTACT
5	2	41	JKC	BB(1)			BB(12)	BC(18)									CNTACT
			BB(10)														
5	3	42	JKC	DDC	DMC(1)	DMC(2)	DMC(3)	DDS									CNTACT
14	3	43	JKC	XDDC	XDMC(1)	XDMC(2)	XDMC(3)										CNTACT
			XYDDS														
5	1	44	IKC	J	ISM	STOMAT(ISM+9)											CNTACT
						*STOMAT(ISM+2)											
						STOMAT(ISM+3)											
5	1	45	IKC	J	ISM	STOMAT(ISM+2)											CNTACT

TABLE 92. FORMATS OF DEBUG PRINTOUT (Page 7 of 15)

Debug Switch	Debug Level	Block Number	IKC	JKC	FTAN	CFTAN	FT	FNU	BC(22)	DE(1)	Quantity	Subroutine	
14	1	59	IKC	JKC	DE(5) DE(14)	DE(15)					DE(4) DE(13)	CNTACT	
14	3	60	IKC	JKC	BF(1) BF(10)				BF(14)	BF(9)		CNTACT	
14	2	61	BF(1) BF(7)					BF(7) BF(14)				CNTACT	
7	2	62	BS(1) BS(7)					BS(7) BS(14)				CNTACT	
15	645	63	IKC	JKC	DUM(1)	DUM(2)	RE(IE)	KTYPE(IE)	DUM(3)	DUM(4)	RE(IS)	ELLELL	
			*KTYPE SUM(1)	(IS)	XDEL SUM(2)	FEE	KKK DIST	IPENG	IITHRU				
15	2	64	IKC	JKC	XE(1,1) XE(1,2) DDE(1) DDE(10)	XE(2,1) XE(2,2)	STOMAT(K) STOMAT(M)	STOMAT(K+1) STOMAT(M+1)	K M		DDE(9)	ELLELL	
15	3	65	IKC	JKC	DER(1,L,1) DER(1,L,11) DER(2,L,1) DER(2,L,11)				DER(1,L,14) DER(2,L,14)		DER(1,L,10) DER(2,L,10)	ELLELL	
					BE(1) BE(11)			for L = 1 to 2			BE(10)		
15	2	66	IKC	JKC	XLAM(1,1)	XLAM(2,1)	TBAR(1)	XL(IE)	JX(IE)	KKK		ELLELL	
15	2	67	IKC	JKC	XLAM(1,1) XLAM(1,2)	XLAM(2,1) XLAM(2,2)	TBAR(1) TBAR(2)	XL(IE) XL(IS)	JX(IE) JX(IS)	KKK DET		ELLELL	
15	2	68	IKC	JKC	KASE	A1	A2	B1	B2	B3	B4	TBBAR(1) TBBAR(2)	XDEL ELLELL

TABLE 92. FORMATS OF DEBUG PRINTOUT (Page 9 of 15)

Debug Switch	Debug Level	Block Number	Quantity													Subroutine	
1	2	77	ELBL	ELBDL	ELBLO	PSIB(1)	PSIB(2)	PSIRR	TB1	DELTB	JB1						BELT
1	1	78	NBELT	DISP	DISPD	FBT	FBTX	FBTZ	FMBF2	DUM							BELT
1	2	79	ELB3	ELBD3	ELBTU0	PSIB(3)	PSIB(4)	TB2	DELTB	JB2							BELT
1	1	80	NBELT	JB2	JB3	FBHX	FBHZ	FMBF1	FBTX	FBTZ	FMBF2						BELT
1	1	81	NBELT	JB2	JB3	FBHX	FBHZ	FMBF1	FBTX	FBTZ	FMBF2						BELT
1	1	82	NBELT	DISX	ELBD4	FBT	FBHX	FBHZ	FMBF1	DUM							BELT
1	2	83	ELB4	ELBD4	ELBTLO	PSIB(3)	PSIB(4)	TB3	DELTB	JB3							BELT
11	3	84	IELL	ISEG	KSEG	NSEG	IREG	KREG	NREG	KSG	KKE						SETMIG
			*KKM	NFS	NSR												
16	1	85	KACT(I)	KACT(I+1)	I	IC	IKA	IKACT									REPACK
16	2	86	KACT(IKACT)														REPACK
			KACT(IKACT+10)														
		
		
		
			.	to	KACT(IKC)												

TABLE 92. FORMATS OF DEBUG PRINTOUT (Page 11 of 15)

Debug Switch	Debug Level	Block Number	Quantity																Subroutine	
			T	IDT	IDR	ISIZE	IBEG	INSERT	IUSEM	IUSEA	IUSEO	IUSES	* IUSEK			IUSEKA				
11	1	95														INTRAC	PUSHER			
1	1	96	XB1	XB2	XB3	ZB1	ZB2	ZB3				ZBD1	ZBD2	ZBD3				BELT		
-	-	97-100	NOT USED																	
6	1	101	HPXI(I),	I = 1,4															STEER	
			HPZI(I),	I = 1,4																
			HMFI(I),	I = 1,4																
6	1	102	IHF(I),	I = 1,5															STEER	
			(HFN(I),	I = 1,4)		(HFT(I),		I = 1,4)												
			(HFR(I),	I = 1,4)		(HFRP(I),		I = 1,4)												
			HFA1	HFA2		HMJ1		HMJ2												
			HFA1R	HFA2R		HMJ1R		HMJ2R												
649	6	103	XV	ZV	THV	HXC	HZC										STEER			
			HAL1	HAL2	HL	HH	HX11													
			(HXS(I),	I = 1,4),		(HZS(I),		I = 1,4)												
	6	2	HEIJ (1,J),	J = 1,4														STEER		
			HEIJ (2,J),	J = 1,4																
			.																	
			.																	
			.																	
			HEIJ (6,J),	J = 1,4														STEER		
6	2	105	HDEIJ (1,J),	J = 1,4														STEER		
			HDEIJ (2,J),	J = 1,4																
			.																	
			.																	
			HDEIJ (6,J),	J = 1,4														STEER		
6	2	106	HDEIJT (1,J),	J = 1,4														STEER		
			HDEIJT (2,J),	J = 1,4																
			.																	
			.																	
			HDEIJT (6,J),	J = 1,4														STEER		

TABLE 92. FORMATS OF DEBUG PRINTOUT (Page 12 of 15)

Debug Switch	Debug Level	Block Number	Quantity	Subroutine
6	2	107	HAL1D HAL2D HLD HDD HX11D HDXC HDZC DHAL1D DHAL2D DHLD DHHH HDDXC HDDZC	STEER
6	2	108	(HX1(I), I = 1,4), (HZ1(I), I = 1,4) (HX2(I), I = 1,4), (HZ2(I), I = 1,4) (HDXS(I), I = 1,4), (HDZS(I), I = 1,4)	STEER
6	3	109	I J HC1 HC2 HC10 RHOI(1) HEIJ(6,J)	STEER
6	3	110	K J HC1 HC2 HC3 HC4 HC5	STEER
6	3	111	I J HC1 HC2 HC3 HC4 HC5 H1D1 H1D2 H1D HEJX HEJZ HNIJ H1Z1(I) HEIJ(I,J) HVRX HVRZ HDEIJ(I,J) HDEIJT(I,J)	STEER
6	3	112	T (IHF(I), I = 1,5) IH9 ((HMTX(1,J), J = 1, IH9) . . . (HMTX(IH9,J), J = 1, IH9) (R(I), I = 1, IH9)	EOM
6	3	113	T HA2RD RX10DD RZ10DD RX20DD RZ20DD HFT2 HDELL HDDELL HFA1R HMJ1R HFA2R HMJ2R HFA1 HMJ1 HFA2 HMJ2 (IHF(I), I = 1,5)	REACT
6	3	114	T I HX11I(I) HX11 HDX11 YDIF XDIF	HDX11

TABLE 92. FORMATS OF DEBUG PRINTOUT (Page 13 of 15)

Debug Switch	Debug Level	Block Number	Quantity	Subroutine
1	1	115	J L BL(J) ATTANC(2,1,J) RINGXZ(1,L) ATTANC(2,2,J) RINGXZ(2,L) RINGY(L)	BELT2
1	1	116	T=0: ANCHOR(1)...ANCHOR(4) RING(1) RING(2) BFLAG(1) BFLAG(2)	BELT2
1	1	117	J BL(J) BX(J) BZ(J) BXA(1,J) BXA(2,J) BZA(1,J) BZA(2,J) DELB(J) DELD(J) BELT2 RINGXZ(1,1) RINGXZ(2,1) RINGXZ(1,2) RINGXZ(2,2) ATTANC(1,1,J) ATTANC(1,2,J) * ATTANC(2,1,J) ATTANC(2,2,J) RINGY(L)	BELT2
1	1	118	IUPB IM IN TSA TSB TSC DUMM DELB(1) DELD(1) BLZ(1) BLZ(7)	BELT2
1	1	119	TSD COSINE TSC RINGMU(1) FNORM FTANG FB(1)	BELT2
1	1	120	TS(1) TS(2) XZRING(1,1) XZRING(2,1) BL(1) BL(6) BL(7) TS(3) TS(4) ICT BELT2 DELTA(1) DELTAD(1) DELTA(3) DELTAD(3) FB(6) FB(7) FB(7)	BELT2
1	1	121	TS(1) TS(2) XZRING(1,2) XZRING(2,2) BL(2) BL(5) BLZ(5) TS(3) TS(4) ICT BELT2 DELTA(1) DELTAD(1) DELTA(2) DELTAD(2) FB(5) FB(5) FB(2)	BELT2
1	1	122	TS(1) TS(2) XZRING(1,2) XZRING(2,2) BL(3) BL(5) BLZ(5) TS(3) TS(4) ICT BELT2 DELTA(1) DELTAD(1) DELTA(3) DELTAD(3) FB(5) FB(5) FB(3)	BELT2
1	1	123	IUPB IM IN TSA TSB TSC DUMM BELT2 DELB(2) DELB(3) DELD(2) DELD(3) BLZ(2) BLZ(3)	BELT2
1	1	124	TSD COSINE TSC RINGMU(2) FNORM FTANG FB(2)	BELT2
1	1	125	TS(1) TS(2) XZRING(1,2) XZRING(2,2) BL(2) BL(3) BL(5) TS(3) TS(4) ICT BELT2 DELTA(1) DELTAD(1) DELTA(3) DELTAD(3) FB(5) FB(2) FB(3)	BELT2
1	1	126	J BXA(1,J) BZA(1,J) BXA(2,J) BZA(2,J) BX(J) BZ(J) BXD BZD BL(J) BELT2	BELT2
1	3	127	J PDB(J,1) PDB(J,6)	BELT2
1	1	128	J IMSAVE(J) INSAVE(J) DELB(J) DELD(J) FB(J)	BELT2
1	1	129	IR IE AB FS FN TSA BELT2	BELT2

Debug Switch	Debug Level	Block Number	Quantity	Subroutine
1	2	130	AAP CCP XX(1) ZZ(1) XX(2) ZZ(2) COSB(1) COSB(2)	BELT2
1	1	131	FBMOD(1) FBMOD(4) FBA(1)...FBA(4) TSA INFLNC FB(1)...FB(7)	BELT2
1	2	132	FMOD(1)...FMOD(4) BR(1)...BR(6)	BELT2
1	2	133	ANCHOR(1) ANCHOR(2) ANCHOR(3) BFLAG(1) BFLAG(2)	BELT2
1	2	134	I TSA TSB TSC TSD ALOCK(I)	BELT2
1	2	135	ANCHOR(1) ANCHOR(2) ANCHOR(3) BFLAG(1) BFLAG(2)	BELT2
1	3	136	DELD(1) DELD(5)..DELD(7) DDELD(1) DDELD(5)...DDELD(7)	BELT2
1	3	137	IUPB IM IN TSA TSB FB(J) DUMM(I) FPRIME DELTA(2) DELTA(3) DELTAD(2) DELTAD(3) BLZ(JLAX(2)) * BLZ(JLAX(3)) BL(JLAX(2)) BL(JLAX(3))	RSDUAL
1	3	138	TSD COSINE TSC RINGMU(LAX) FNORM FTANG FB(JLAX(2)) X(1) X(2)	RSDUAL
1	3	139	I J IUPB IM IN TSA TSB FB(J) BL(J) BLZ(J) DUMM(I) FPRIME DL(I,1) DL(I,2) DF(I,1) DF(I,2) R(1) R(2)	RSDUAL
1	3	140	FB(JLAX(2)) DL(2,1) DL(2,2) DF(2,1) DF(2,2) FB(JLAX(3)) DL(3,1) DL(3,2) DF(3,1) DF(3,2) TSE R(1) R(2)	RSDUAL
1	3	141	LAX BL(JLAX(1))..BL(JLAX(3)) FB(JLAX(1))..FB(JLAX(3)) X(1) X(2) DELTA(1)..DELTA(3) DELTAD(1)..DELTAD(3) R(1) R(2)	RSDUAL
1	3	142	K DR(1) DR(2) ATTANC(2,1,JLAX(1))..ATTANC(2,1, JLAX(3)) * ATTANC(2,2,JLAX(1))..ATTANC(2,2,JLAX(3))	INFL
1	2	143	LBTLA FBTX FBTZ FMBF2 FBHX FBHZ FMBF1 FBLX FBLZ FMBF4 DUM(1) DUM(2)...DUM(6)	MATRIX

TABLE 92. FORMATS OF DEBUG PRINTOUT (Page 15 of 15)

Debug Switch	Debug Level	Block Number	Quantity	Subroutine
4	3	144	INIT TIME CONTACT FULL BURST PRESUR TEMPR VOLUME BAGVOL BAGMAS ENDOT EXDOT XA ZA XBC ZBC RB RLTHET PERIM BPERIM ZTOT 1 ENTERR(1,1) ENTERR(2,1) ENTERR(1,2) ENTERR(2,2) ENTERR(1,3) ENTERR(2,3) 4 ENTERR(1,4) ENTERR(2,4) ENTERR(1,5) ENTERR(2,5) ENTERR(1,6) ENTERR(2,6)	AIRBAG (DEBUG)
16	3	-	16 ENTERR(1,16) ENTERR(2,16) ENTERR(1,17) ENTERR(2,17) ENTERR(1,18) ENTERR(2,18) 19 ENTERR(1,19) ENTERR(2,19) ENTERR(1,20) ENTERR(2,20)	

16 3 - If debug switch 16 is equal to 3, execution is terminated by "CALL ABDUMP," GOMVMA which can produce a dump of core.

4.4.6 Auxiliary Output Symbol References. This section consists of two tables which offer an aid to a more detailed examination of the program code and its correspondence to the analysis behind the code. The tables are intended primarily to help the user understand debug output.

Table 93 is the main symbol dictionary which is ordered on the Fortran name given to each quantity. The "Symbol" column contains the analytical symbol used in other sections of the report, particularly Part II, Analysis. The third column gives either the label of the common in which this variable resides or the name of the subprograms in which it is used if it is not shared between subprograms. Columns four and five are used together to detail quantities which have been stored in arrays instead of individual variables. If a number appears in column five, it refers to the corresponding value in the first column of Table 94 which defines the quantity or type of information for each value of the subscript up to the number in the "Dimension" column.

TABLE 93. SYMBOL DICTIONARY

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
A	-	/REAL/	NADUM	-	Temporary storage in CNTACT.
A	-	/REAL/	NADUM	9	Coefficient matrix for NDIM × NDIM system (equations 193 followed by equations 196) in MIG.
A	-	/REAL/	NADUM	12	Inertial corner point coordinates for constrained migration in MIG (sequentially after above).
A1 and A2	-	ELLELL	1	-	Test parameter for ellipse-ellipse
AB	-	BELT2	1	-	Absolute tangential component of net belt force for torso belt pair.
AE	-	/LF/	6	34	Absorbed energy in force-deflection.
ALOCK	-	/BP/	3	47	Value for resultant acceleration at reel which will cause it to lock if vehicle sensitive or acceleration for belt feed-out which will cause reel to lock if webbing sensitive.
AMTX	M, B	/MATRIX/	14 15	13 14	Mass coefficient matrix and right-hand side.
ANCHOR	-	/BRIP/	4	42	Switch for anchor type.
ARE	R	EVAL	1	-	R-ratio value for current evaluation.
ATTANC	$\lambda_n, v_n,$ r_n, t_n	/BRIP/	2 2 7	40 29 39	Belt attachment and anchor points.
B	-	/BQ/	14	13	Generalized force total from friction, normal force, and ellipse-ellipse force.
B	-	MIG	32	10	a) Right-hand side for NDIM × NDIM system (equations 193 followed by equations 196). b) Solution vector.
B1 to B4	-	ELLELL	1	-	Test parameters for ellipse-ellipse
BAGMAS	m	/BAGA/	1	1b sec ² /in	Mass of gas in airbag.
BAGVOL	v	/ABAGC/	1	in ³	Volume of airbag enclosure calculated from geometry of bag shape.
BB	-	CNTACT	12	-	Contact line intermediate results.
BBQG	Ω	/LF/	6	34	Maximum deflection ever.
BBQGP	-	/LP/	2	35	BBQG of preceding time step.
BC	-	CNTACT	31	26	Contact line information array.
BE	-	/BQ/	14	13	Negative of the generalized force from ellipse-ellipse interactions.
BF	-	/BQ/	14	13	Generalized force for friction.
BFLAG	-	/BP/	2	43	Switch which indicates belt condition (potentially resistive or broken/absent).

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
BL	l	/BRIP/	7	39	Belt length.
BLZ	l^n	/BRI/	7	39	Unstrained belt length.
BOG	Ω	/LF/	6	34	Maximum deflection.
BOGP	Ω	/LP/	2	35	BOG at last evaluation.
BPERIM	-	/ABAGA/	1	in	Bag perimeter when fully inflated (input value).
BR	-	/BQQ/	6	13	Generalized forces for belts (from BELT2).
BS	-	/BQ/	14	13	Generalized force for normal force between lines and ellipses.
BUGI	-	/ZQB/	1	sec	Next time at which debug control word changes.
BURST	-	/ABAGA/	1	-	Logical switch, .TRUE. if deflation membranes have ruptured, .FALSE. if not.
BX	-	BELT2	7	39	Inertial x-component of belt vector, anchor to attachment.
BXA	-	BELT2	2 7	39	Inertial x-component of CG-to-belt attachment vector or of cart origin-to-anchor vector.
BXD	-	BELT2	1	in	Rate of change of belt length inertial x-component.
BZ	-	BELT2	7	39	Inertial z-component of belt vector, anchor to attachment.
BZA	-	BELT2	2 7	39	Inertial z-component of CG-to-belt attachment vector or of cart origin-to-anchor vector.
BZD	-	BELT2	1	in	Rate of change of belt length inertial z-component.
CE	-	EVAL	1	in lbs	Conserved energy after current loading-unloading cycle.
CFTAN	-	CNTACT	1	-	Tangential friction forces.
CGF	-	EVAL	1	lbs	Force at point unloading commenced, used in computing reloading curve.
CM	-	EVAL	1	lbs/in	Force slope at point unloading commenced, used in computing reloading curve.
COG	-	EVAL	1	in	Deflection at point unloading commenced, used in computing reloading curve.
CONOUT	-	/REAL/	NCNOUT	-	Packing storage array containing computed output quantities.
CONTCT	-	/ABAGA/	1	-	Logical switch, .TRUE. if occupant has contacted airbag, .FALSE. if not.
COSINE	-	BELT2 RSDUAL	1	-	Cosine of vertex angle (see TSD).
CQ	-	/CART/	3 3	21 22	Vehicle position, velocity, and acceleration.

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
CR	-	CNTACT, MIG	1	-	Cosine of THETAR.
CT	-	MIG	28	8	Cosine of inertial line segment angle of TH.
D	δ_n	/CAV/	5	2	Deflection against line before cavity adjustment.
D	δ	/LF/	6	34	Current deflection.
D	-	MIG	1	-	-1 if point of action of force on segment is before "front" corner point, +1 if otherwise.
DA	δ_A	/LC/	2	35	Deflection at peak of inertial spike curve.
DB	δ_B	/LC/	2	35	Deflection at cutoff of inertial spike curve.
DC	δ_C	/LC/	2	35	Deflection at yield point.
DC	-	BELT2	2	29	Direction cosines.
DD	-	CNTACT	15	18	Lever arms and deflection rate for contacts.
DD	$\dot{\delta}$	/LF/	6	34	Current deflection rates.
DD	δ_n	MULTI	5	1	Deflection against line before cavity adjustment.
DDC	-	CNTACT	1	-	Vehicle contribution to contact deflection rate.
DDDEL	$\Delta\omega$	LODFEL	1	in	Current change in permanent deflection or if belt, absorbed energy.
DDE	-	ELLELL	15	18	Lever arms and deflection rate for ellipse-ellipse force.
DDEL	$\Delta\delta$	CNTACT, MIG, SETMIG	1	in	Current change in permanent deflection.
DDEL	$\Delta\omega$	EVAL	1	in	Evaluated change in permanent deformation.
DDELD	-	BELT2	7	39	Belt elongation acceleration.
DDMATA	-	/SHDEFL/	1	in/sec	Deflection rate of first material.
DDMATB	-	/SHDEFL/	1	in/sec	Deflection rate of second material.
DDP	$\dot{\delta}$	/LP/	2	35	Deflection rate at last evaluation.
DDS	-	CNTACT	1	-	Contact line contribution to contact deflection rate.
DDX	$\Delta\delta_x$	MIG	1	in	Incremental permanent deformation inertial x-component.
DDZ	$\Delta\delta_z$	MIG	1	in	Incremental permanent deformation inertial z-component.
DE	-	CNTACT	15	18	Lever arm and tangential speed for friction force.
DE	δ_0	/LC/	2	35	Deflection at beginning of breakdown.
DEL	δ	LODFEL	1	in	Deflection.
DELB	δ	BELT2	7	39	Belt elongation.
DELD	δ	BELT2	7	39	Belt elongation rate.
DELD	δ	LODFEL	1	in/sec	Deflection rate.

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
DELDLA	$\Delta\delta$	LODFEL	3	38	Change in deflection for first material from last time or previous evaluation.
DELND	\ddot{L}_n	/INTEG/	1	in/sec ²	ELN-acceleration.
DELTA	-	/BRI/	3	45	Belt elongation.
DELTAD	-	/BRI/	3	45	Belt elongation rate.
DELTB	Δt_B	/BELTA/	1	sec	Time duration for belt failure.
DER	-	ELLELL	2 2 14	29 27 18	Partial derivatives of ellipse center coordinates (XE).
DET	-	ELLELL	1	-	A determinant.
DF	δ_F	/LC/	2	35	Deflection at breaking point.
DF	-	/BRI/	3 2	45 29	Partial derivatives of belt forces with respect to x and z of ring.
DFORE	-	LODFEL	3	38	Difference of forces for first and second materials.
DHAL1D	$\ddot{\alpha}_1$	STEER	1	rad/sec ²	Angular acceleration of steering column.
DHAL2D	$\ddot{\alpha}_2$	STEER	1	rad/sec ²	Angular acceleration of steering wheel.
DHAT	\hat{x}_i or \hat{z}_i	CNTACT	4	25	XHAT - velocity.
DHHD	\ddot{h}	STEER	1	in/sec ²	Linear acceleration of steering wheel.
DHLD	$\ddot{\ell}$	STEER	1	in/sec ²	Linear acceleration of steering column.
DISP	-	BELT	1	in	Lap or upper torso belt deflection.
DISPD	-	BELT	1	in/sec	Lap or upper torso belt deflection rate.
DISX	-	BELT	1	in	Lower torso belt deflection.
DKDTH	$K'_{s,i}(\theta_s)$	JTORQ	3	24	Slope of KJI(10,1)- θ_s table.
DL	-	/BRI/	3 2	45 29	Partial derivatives of belt segment lengths with respect to x and z of ring.
DLAM	-	ELLELL	2 2 14	29 27 18	Partial derivatives of XLAM.
DM	β	/LC/	2	35	Unloading slope from force saturation.
DMATA	-	/SHDEFL/	1	in	Deflection of first material.
DMATB	-	/SHDEFL/	1	in	Deflection of second material.
DMC	-	CNTACT	3	-	Intermediate results in computing DDC.

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
DNORM	-	EVAL	1	in	Unity or belt length for calculation of belt strain
DP	δ	/LP/	2	35	Deflection at last evaluation
DR	-	/QV/	4	19	Partial and time derivatives of R.
			8	17	
			2	20	
DR	-	INFL	2	29	Partial derivatives of residuals R with respect to X and Z of ring.
DT	Δt	/MSCON/	1	sec	Integration time step.
DTH1D to DTH9D	$\ddot{\theta}_1$ to $\ddot{\theta}_9$	/INTEG/	1	rad/sec ²	Body link angle accelerations.
DTRK	Δt	MIG	1	sec	Time increment for migration.
DUM	-	BELT	1	in	Absorbed energy for a belt.
DUM	-	/DUM/	48	-	Temporary storage.
DUM	-	OCCGEO	44	50	Angular and linear momenta.
DUMM	-	BELT2	1	ft-lb	Belt absorbed energy.
DUMM	-	RSDUAL	3	45	Belt absorbed energy.
DX	-	/QV/	2	16	Partial and time derivatives of X.
			8	17	
			15	18	
DXF	ΔX_k	MIG	1	in	Inertial x-component of migration displacement at point of action of force.
DXHD	\ddot{x}_2	/INTEG/	1	in/sec ²	XH-acceleration
DXSD	\ddot{x}_s	/INTEG/	1	in/sec ²	XS-acceleration
DZF	Δz_k	MIG	1	in	Inertial z-component of migration displacement at point of action of force.
DZHD	\ddot{z}_2	/INTEG/	1	in/sec ²	ZH-acceleration.
DZSD	\ddot{z}_s	/INTEG/	1	in/sec ²	ZS-acceleration.
E	E	/LF/	6	34	Energy under load-deflection curve.
EFFD	δ_{ij}	/CAV/	5	4	Effective deflection against line with cavities.
			5	5	
ELB3	l_3^B	BELT	1	in	Length of upper torso belt.
ELB4	l_4^B	BELT	1	in	Length of lower torso belt.
ELBD3	\dot{l}_3^B	BELT	1	in/sec	Deflection rate for upper torso belt.
ELBD4	\dot{l}_4^B	BELT	1	in/sec	Deflection rate for lower torso belt.
ELBDL	\dot{l}^{BL}	BELT	1	in/sec	Lap belt deflection rate.

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
ELBL	l_{BL}	BELT	1	in	Lap belt length.
ELBLO	l_{BLO}	/BELTA/	1	in	Unrestrained lap belt length.
ELBTLO	-	/BELTA/	1	in	Unrestrained lower torso belt length.
ELBTUO	-	/BELTA/	1	in	Unrestrained upper torso belt length.
ELN	L_n	/INTEG/	1	in	Neck length.
ELND	\dot{L}_n	/INTEG/	1	in/sec	Rate of neck length change.
ELS	L_s	/SHOLDR/	1	in	Shoulder element length.
ENDOT	\dot{m}_n	/BAGA/	1	lb-sec/in	Mass influx rate from tabular input.
ENTERR	-	/ABAGA/	2 20	29 60	Points on the occupant and points of the interior of the occupant compartment which together define the area within which the bag is contained (in inertial coordinates).
EP	E	/LP/	2	35	Energy at last evaluation
ETA	δ	CNTACT	1	in	Deflection of contact line by body ellipse.
ETAD	$\dot{\delta}$	CNTACT	1	in/sec	Deflection rate.
EXDOT	\dot{m}_{ex}	/BAGA/	1	lb-sec/in	Mass efflux rate calculated from the thermodynamic equations.
F	$F_i(\delta_i)$	/CAV/	5	2	Force against line before cavity adjustment.
F	F_k	MULTI	5	4	Force for effective deflection against cavity.
FA	-	EVAL	1	lb	Static curve force.
FAA	-	EVAL	1	lb/in	Static curve slope.
FAC	λ	BELT2	1	-	Fractional influence factor for adjustment of smaller torso belt force toward larger torso belt force.
FB	F, T	/BRI/	7	39	Belt tension force.
FB	-	EVAL	1	lb	Inertial spike force.
FBA	-	/BRI/	4	39	Torso and lap belt forces for force balance at rings.
FBB	-	EVAL	1	lb/in	Inertial spike slope.
FBHX	-	/BELTB/	1	lb	x-component of force for lower torso belt.
FBHZ	-	/BELTB/	1	lb	z-component of force for lower torso belt.
FBL	-	BELT	1	lb	Lap belt force.
FBLX	-	/BELTB/	1	lb	x-component of force for both lap belt segments.
FBLZ	-	/BELTB/	1	lb	z-component of force for both lap belt segments.

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
FBMOD	-	/BELT2/	4	39	Modified force for belt I.
FBOG	$F(\Omega)$	/LF/	6	34	Force at maximum deflection.
FBOGP	$F(\Omega)$	/LP/	2	35	FBOG at last evaluation.
FBT	-	BELT	1	1b	Torso belt force.
FBTX	-	/BELTB/	1	1b	x-component of force for upper torso belt.
FBTZ	-	/BELTB/	1	1b	z-component of force for upper torso belt.
FD	F	/LC/	2	35	Force at last evaluation.
FDEV	F'	EVAL, LODFEL	1	lbs/in	Evaluated force slope versus deflection.
FEE	-	ELLELL	1	1b	Force for ellipse-ellipse interaction.
FF	$F_i(\delta_i)$	CNTACT, MULTI	5	1	Force against line before cavity adjustment.
FJI	F_i^J	JOINT	13	49	Constant friction moment or force.
FK	k	CNTACT	1	-	Normalization factor in contact calculations for deflection.
FLEN	-	/BTWOA/	1	in	Switch which if non-zero contains a belt length to be used for computing force-strain. If zero, force-deflection is to be used.
FLN	-	/JOINT/	1	1b	Neck compression force.
FLNL	-	/JOINT/	1	1b	Spring contribution to FLN.
FLNV	-	/JOINT/	1	1b	Damper contribution to FLN.
FLS	-	/JOINT/	1	1b	(Negative) shoulder element elongation force.
FLSL	-	/JOINT/	1	1b	Elastic contribution to FLS.
FLSN	-	/JOINT/	1	1b	"Stop" contribution to FLS.
FLSV	-	/JOINT/	1	1b	Damper contribution to FLS.
FM	F_{max}	/LC/	2	35	Force saturation limit.
FMBF1	-	/BELTB/	1	in-lb	Moment about torso element CG for lower torso belt.
FMBF2	-	/BELTB/	1	in-lb	Moment about upper torso CG for torso belt forces.
FMBF4	-	/BELTB/	1	in-lb	Moment about lower torso CG for lap belt forces.
FMOD	-	BELT2	4	39	Additive modification of belt force F_B .
FN	-	BELT2	1	1b	Component of torso belts force normal to chest.
FNORM	N	BELT2, RSDUAL	1	1b	Normal force at ring for belt friction.
FNU	-	/CON/	1	in/sec	Length of velocity ramp from zero relative velocity for surface friction coefficients.
FOG	$F'(\Omega)$	/LF/	6	34	Force slope at maximum deflection.
FOGP	$F'(\Omega)$	/LP/	2	35	FOG at last evaluation.

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
FORA	F	LODFEL	3	38	Force evaluation storage for first material.
FORB	F	LODFEL	3	38	Force evaluation storage for second material.
FORCE	F	EVAL, LODFEL	1	1b	Evaluated force.
FPRIME	-	RSDUAL	1	1b/in	Slope of force-deflection curve.
FS	-	BELT2	1	1b	Static friction force for torso belts.
FSUM	F_{Σ}	MULTI	1	1b	Partial sum of forces for deflection against line with cavities.
FT	-	CNTACT	1	1b	Total contact force.
FTAN	-	CNTACT	1	1b	Friction coefficient times normal force.
FTANG	-	BELT2 RSDUAL	1	1b	Ring friction force increment for torso belt.
FULL	-	/ABAGA/	1	-	Logical switch, •TRUE• if airbag is fully inflated (capable of exerting force on occupant), •FALSE• if not.
FX	-	MIG	1	1b	x-force in inertial frame.
FZ	-	MIG	1	1b	z-force in inertial frame.
GAM	γ	MIG	1	in/1b sec ²	Mass compliance at point of action of force.
GEE	G	EVAL	1	-	G-ratio value for current evaluation.
GI	-	/LC/	2	35	G-ratio control: constant value if positive, table number if negative.
H1D	-	STEER	1	in	Distance between two end points of each occupant contact surface.
H1D1	-	STEER	1	in	X-component of H1D.
H1D2	-	STEER	1	in	Z-component of H1D.
H1Z1	-	STEER	1	in	Distance between contact surface and center line of body segment.
HA2RD	-	REACT	1	rad/sec ²	$\ddot{\alpha}_1 - \ddot{\alpha}_2$
HAL1	α_1	/INTEG/	1	rad	Angular position of steering column.
HAL1D	$\dot{\alpha}_1$	/INTEG/	1	rad/sec	Angular velocity of steering column.
HAL2	α_2	/INTEG/	1	rad	Angular position of steering wheel.
HAL2D	$\dot{\alpha}_2$	/INTEG/	1	rad/sec	Angular velocity of steering wheel.
HALFK	k/2	CNTACT	1	-	Half of FK.
HC1	-	STEER	1	in	Temporary storage for the position vectors of steering wheel contact points and end points of contact surfaces.
HC2	-	STEER	1	in	
HC3	-	STEER	1	in	
HC4	-	STEER	1	in	
HC5	-	STEER	1	in	
HC10	-	STEER	1	in	

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Description
HDELL	$\dot{\delta}_\ell$	REACT	1	in/sec	Velocity of steering column in axial direction.
HDDXC	\ddot{x}_C	STEER	1	in/sec ²	Acceleration component in x and z direction, respectively, of reference point C.
HDDZC	\ddot{z}_C	STEER	1	in/sec	
HDEIJ	$\dot{\delta}_{ij}$	STEER	6 4	51 52	Normal deflection rates of contact surface.
HDEIJT	$\dot{\delta}_{Tij}$	STEER	6 4	51 52	Tangential deflection rates of contact surface.
HDELL	δ_ℓ	REACT	1	in	Deflection of steering column in axial direction.
HDX11	-	HDX11	1	in/sec	Velocity of gear box of steering column.
HDXC	\dot{x}_C	STEER	1	in/sec	Velocity component in x and z direction, respectively, of reference point C.
HDZC	\dot{z}_C	STEER	1	in/sec	
HDXS	\dot{F}_{ix}	STEER	4	52	Velocity of steering wheel contact points in x and z direction, respectively.
HDZS	\dot{F}_{iz}	STEER	4	52	
HEIJ	δ_{ij}	STEER	6 4	51 52	Deflection of contact surface.
HEJX	-	STEER	1	-	Temporary storage for the direction cosine of contact surface.
HEJZ	-	STEER	1	-	
HFA1	F_{A1}	/STERC/	1	1b	Reactive force exerted by the steering column energy dissipating device.
HFA1R	F_{A1R}	/STERF/	1	1b	Maximum allowable reactive force which can be exerted by the steering column energy dissipating device.
HFA2	F_{A2}	/STERC/	1	1b	Resistance of the steering wheel to axial deformation.
HFA2R	F_{A2R}	/STERF/	1	1b	Maximum allowable resistance of the steering wheel to axial deformation.
HFN	F_j	STEER	4	52	Contact forces normal to the plane of the steering wheel rim.
HFR	F_{jB}	STEER	4	52	Contact forces which act on the steering wheel rim and are normal to the body contact surface.
HFRP	F'_{jB}	STEER	4	52	Contact forces tangential to the body contact surface.
HFT	F'_j	STEER	4	52	Contact forces tangential to the plane of the steering rim.
HFT2	F_{T2}	REACT	1	1b	Temporary storage force.

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
HH	h	/INTEG/	1	in	Distance between the steering wheel attachment point on the column to the plane of steering wheel.
HHD	\dot{h}	/INTEG/	1	in/sec	Velocity of h.
HL	ℓ	/INTEG/	1	in	Length of steering column.
HLD	$\dot{\ell}$	/INTEG/	1	in/sec	Velocity of ℓ.
HMFI	HM <i>F</i> (<i>ii</i>)	/STERG/	4	54	Moment resultant of the steering wheel contact force system acting on the body segment <i>ii</i> with the moment being found with respect to the center of gravity of the body segment.
HMJ1	M_{J1}	/STERC/	1	in-lb	Bending resistance of the steering column.
HMJ1R	M_{J1R}	/STERF/	1	in-lb	Maximum allowable bending resistance of the steering column.
HMJ2	M_{J2}	/STERC/	1	in-lb	Bending resistance of the steering wheel.
HMJ2R	M_{J2R}	/STERF/	1	in-lb	Maximum allowable bending resistance of the steering wheel.
HMTX	$a_{ij}^S b_i$	EOM	4 5	55 56	Elements of steering column matrix equations of motion.
HNIJ	-	STEER	1	in	Temporary storage for the distance from the contact point of steering wheel to the corresponding center line of body segment.
HPXI	HPX(<i>ii</i>)	/STERG/	4	54	Force resultants acting on the body segment <i>ii</i> in the X and Z directions, respectively (contact with steering column).
HPZI	HPZ(<i>ii</i>)	/STERG/	4	54	
HVRX	-	STEER	1	in/sec	Temporary storage for the velocity of contact point relative to body segment.
HVRZ	-	STEER	1	in/sec	
HX1	X1	STEER	4	51	Coordinates of body segment points with respect to the space fixed coordinate system.
HZ1	Z1	STEER	4	51	
HX2	X2	STEER	4	57	Coordinates of body contact surface reference points with respect to the space fixed coordinate system.
HZ2	Z2	STEER	4	57	
HX11	-	/STERF/	1	in	Distance of steering column gear box to the vehicle reference point.
HX11D	-	/STERC/	1	in/sec	Velocity of HX11.
HX11I	-	/REAL/	NNSTRW	58	Input data of steering column gear box position at different time.

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
HXC	X_c	/STERH/	1	in	Coordinates of the lower hinge of the steering assembly with respect to the space fixed coordinate system.
HZC	Z_c	/STERH/	1	in	
HXS	F_{jx}	/STERH/	4	52	Space fixed coordinates of the steering assembly contact points.
HZS	F_{jz}	/STERH/	4	52	
I	-	GOMVMA	1	-	Output control switch, 1 for header record, 2 for typical record, 3 for trailer record.
I	-	REPACK	1	-	Beginning KACT index of control entry for interaction.
IA	-	/LF/	6	34	Input load-deflection curve part indicator (see IALF in Table 73)
IA	-	SETACT	1	-	Beginning of KCON index of ellipse or region if positive, beginning KCON index or belt if negative.
IAA	-	LODFEL	1	-	Beginning KCON index of ellipse or region if positive, beginning KCON index of belt if negative.
IACT	-	LODFEL	1	-	Beginning STOACT index of time history entry for interaction.
IAPP	-	CNTACT	1	-	Region switch which controls optional force apportioning for an ellipse against multiple line segments.
IB	-	SETACT LODFEL	1	-	Beginning KCON index for second participant in interaction or special value (see JKC or IB description in Table 72).
IBEG	-	PUSHER	1	-	Beginning index of section just created.
IC	-	LODFEL	1	-	Shared deflection evaluation number ranging one through three.
IC	-	REPACK	1	-	Beginning CONOUT index of output entry for interaction.
ICOPY	-	/LF/	6	34	Computed curve switch, non-zero if just computed new curve.
ICT	-	BELT2 RSDUAL RELAX	1	-	Counter for number of relaxation steps per ring per time evaluation.
IDEF	-	/LF/	1	-	Switch set non-zero if change in permanent deformation is to be computed.
IDELL	-	/INTGR/	NNITI NNITJ	31 32	Beginning index in KCON of ellipse control entry.
IDIR	-	PUSHER	1	-	Indicates array in which section is to be created: 0=KCON, 1=STOMAT, 2=STOACT, 3=KMUG, 4=KACT, 5=CONOUT, 6=STOMUG.
IDT	-	PUSHER	1	-	IDIR + 1

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
IE	-	BELT2	1	-	Influencer belt number.
IELL	-	SETMIG	1	-	KCON index of current ellipse.
IEP	-	EVAL	1	-	A switch used to control proper computation of energy or unloading.
IH9	-	EOM	1	-	Total degrees of freedom of steering assembly.
IHF	-	/STERC/	5	53	0 indicates no relative motion of steering assembly component. 1 indicates relative motion.
IIACT	-	LODFEL	1	-	Beginning KACT index of control entry for interaction.
IIP	-	/LP/	2	35	Static curve beginning index in STOMAT or table number if negative.
IKA	-	REPACK	1	-	Beginning STOACT index of time history entry for interaction.
IKACT	-	REPACK, LODFEL	1	-	Beginning KACT index of time history entry for interaction.
IKAT	-	SETACT	1	-	Beginning KACT index for interaction control entry.
IKC	-	Many	1	-	Beginning index in KCON of ellipse control entry.
IKOUT	-	SETACT	1	-	Beginning CONOUT index for corresponding output entry.
IM	-	BELT2 RSDUAL	1	-	Impingement history index.
IMAX	-	CNTACT	1	-	Number of ellipses contacting region at one time.
IMIG	-	CNTACT, SETMIG	1	-	Region switch which controls optional use of migration rule for structural deformation and/or permanent deformation.
IMSAVE	-	/BRI/	7	39	Stored values of IM.
IMULTI	-	CNTACT	1	-	Region switch which controls optional use of analysis for multiple circles against a line.
IN	-	BELT2 RSDUAL	1	-	Interaction control index.
INFLNC	-	/BP/	1	-	Influence type for torso belt pair.
INIT	-	DEBUG	1	-	Counter for calls to ABINIT.
INSAVE	-	/BRI/	7	39	Stored values of IN.
INSERT	-	PUSHER	1	-	Zero to append, non-zero to push down to create section.
INTRAC	-	/PACK/	1	-	Number of control entries in KACT.
IPN	-	SETACT	1	-	Penetration switch: if positive, came on from front; if zero, completely unloaded; if negative, came on from behind.
IR	-	BELT2	1	-	Influencer belt number.
IREG	-	SETMIG	1	-	KCON index of current region.

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
IS	-	/LF/	6	34	Force saturation switch, non-zero if saturation has occurred.
ISCALE	-	MULTI, CNTACT	1	-	Region switch controlling force scaling for multiple circle contact against line.
ISEG	-	SETMIG	1	-	KCON index of current line segment.
ISET	I	MULTI	5	6	Set of identification indices for circles with deflection equal to δ_{max} .
ISIZE	-	PUSHER	1	-	Size of section created.
ISM	-	Many	1	-	Beginning index in STOMAT of ellipse parameter section.
ITHRU	-	ELLELL	1	-	Zero if deflection is less than sum of radii; -1 if not.
IUPA	-	CNTACT, MIG	1	-	Non-zero if region position is defined in the inertial frame, zero if in the vehicle frame.
IUPB	-	BELT2, RSDUAL	1	-	Beginning index in KCON standard area for belt segment section (see KSA(1-7) and Table 56).
IUSEA	-	/PACK/	1	-	Length of STOACT array.
IUSEG	-	/PACK/	1	-	Length of KMIG and KMUG.
IUSEK	-	/PACK/	1	-	Length of KCON array.
IUSEKA	-	/PACK/	1	-	Length of KACT array.
IUSEM	-	/PACK/	1	-	Length of STOMAT array.
IUSEO	-	/PACK/	1	-	Length of CONOUT array.
IUSES	-	/PACK/	1	-	Length of STOMIG and STOMUG.
J	-	BELT2, RSDUAL	1	-	Belt number.
J	-	GOMVMA	1	-	Output control switch, 0 for non-print time, 1 for print time.
JB1 to JB3	-	/BELTA/	1	-	Indicator switches to signal belt failure for lap, upper torso, and lower torso.
JJP	-	/LP/	2	35	Inertial spike curve beginning index in STOMAT or table number if negative.
JKC	-	Many	1	-	Beginning index in KCON array of contact segment control entry.
JOUT	-	/INTGR/	NELPLN	4	Address in CONOUT for force between ellipse and line.
JSM	-	Many	1	-	Beginning index in STOMAT of segment parameter section.
JT	-	CNTACT	1	-	Number of ellipses considered for cavity analysis (maximum of 5).
JX	j	ELLELL	2	27	Major axis indicator, one for x, two for z.
K	-	INFL	1	-	Indicates which residual R is to be liquidated by joint relaxation in RELAX.

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
KACT	-	/INTGR/	NKACT	-	Packing storage array containing interaction control information for interpreting STOACT, CONOUT and events in run.
KASE	-	ELLELL	1	-	Switch indicating relative position of parallel ellipses.
KCI	-	/INTGR/	NELPRG	30	Beginning index in KCON of ellipse control entry.
KCON	-	/INTGR/	NKCON	-	Packing storage array containing input control information for interpreting STOMAT.
KGO	-	EVAL	1	-	Switch which controls force evaluation alternate methods.
KKC	-	Many	1	-	Beginning index in KCON of region control entry.
KKE	-	MIG, SETMIG	1	-	Beginning index in KMIG of list of ellipses contacting segment (see Table 70).
KKM	-	MIG, SETMIG	1	-	Beginning index of region entry in KMIG.
KKK	-	ELLELL	1	-	Switch, one if circle-circle, two if circle-ellipse, three if ellipse-ellipse.
KJI	-	/JOINT/	13 3	49 24	Joint spring coefficient.
KMIG	-	/INTGR/	NKMIG	-	Packing storage array containing control information for interpreting STOMIG.
KMUG	-	/INTGR/	NKMIG	-	Packing storage array containing control information for interpreting STOMUG.
KNA	-	LODFEL	1	-	Beginning STOMAT index for first material property entry or zero if rigid.
KNB	-	LODFEL	1	-	Beginning STOMAT index for second material property entry or zero if rigid.
KOT	-	/INTGR/	NNITI NNITJ	31 32	Address in CONOUT for force between ellipse and line.
KOUNTI	-	CNTACT	1	-	Counter for line segments in a region that are contacted by one or more ellipses.
KOUNTJ	-	CNTACT	1	-	Counter for ellipses interacting with the KOUNTI'th contact line.
KREG	-	SETMIG	1	-	KCON index of last entered region.
KRK	-	/CKOUT/	1	-	Derivative evaluation number for a Runge-Kutta integration time step, 1-4.
KSA	-	BELT2, INFL, RSDUAL	7	39	Beginning index in KCON standard area for belt segment section (see Table 56).

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
KSEG	-	SETMIG	1	-	KCON index of last entered line segment.
KSG	-	CNTACT, MIG, SETMIG	1	-	Beginning index of force entry in STOMIG.
KSM	-	Many	1	-	Beginning index in STOMAT of region parameter section.
KSWT	-	EVAL	1	-	Switch which controls methods of computing permanent deformation.
KTYPE	-	ELLELL	2	27	Ellipse type, 1=circle or circle-like, 2=ellipse.
L	-	EVAL, LODFEL	1	-	Evaluation index, 1 through 3 are last three evaluations for first material, 4 through 6 are last three evaluations for second material.
LAX	-	/BRI/	1	-	Ring indicator; 1=upper, 2=lower.
LBTLA	-	/BELTD/	1	-	Lower torso belt attached to upper torso link if 2, to lower torso link if 4, and to middle torso link otherwise.
LLX	-	/LC/	2	36	Old value of load-deflection evaluation control switches.
			2	35	
LLXX	-	/LC/	2	36	Load-deflection evaluation control switch.
			6	34	
MF1 to MF8	M_{1-8}^F	/FORCE/	1	in-lb	Moment at body link CG (number 1-8) resulting from steering column, air-bag and belts.
MF1	M_{1-8}^F	DAUX, MATRIX, OUTPUT	8	in-lb	Same as MF1 to MF8.
MIGCT	-	CNTACT, MIG	1	-	Counter for number of calls to migration subroutine at a given time.
MILL	-	GOMVMA	1	msec	CPU time used.
N	-	CNTACT	1	-	Number of ellipses against a given line segment at one time.
N	N	MULTI	1	-	Number of circles contacting line.
NA	-	EVAL	1	-	Beginning index for static curve force evaluation coefficients.
NB	-	EVAL	1	-	Beginning index for inertial spike force evaluation coefficients.
NBELT	-	/IOCNTL/	-	-	Belt switch; lap belt only if 1, lap and torso if 2.
NDIM	-	MIG	1	-	Order of the system inverted for migration, 2* NSF+NSR+2.
NFR	-	MIG, SETMIG	1	-	Number of forces greater than zero on region (see Table 70).
NFS	-	MIG, SETMIG	1	-	Number of non-zero forces on segment.
NIS	-	REPACK	1	-	Number of interior line segment end points for current region.
NIX	-	EVAL	1	-	Switch which controls the various uses of the force evaluation section.

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
NP	N'	MULTI	1	-	Number of circles with deflection equal to δ_{\max} .
NREG	-	SETMIG	1	-	Total number of regions entered so far.
NSEG	-	SETMIG	1	-	Total number of segments entered so far.
NSF	-	MIG, SETMIG	1	-	Number of segments with force greater than zero.
NSR	n	MIG, CONTACT, SETMIG	1	-	Number of segments in region.
OG	ω	/LF/	6	34	Permanent deformation.
OGP	ω	/LP/	2	35	OG at last evaluation.
PDB	-	BELT2	4 6	39 18	Belt lever arms (partials of belt deflections).
PEN	-	/REAL/	NELPLN	4	Deflection against line segment.
PERIM	-	/ABAGE/	1	in	Calculated bag perimeter.
PLTI	-	GOMVMA	1	sec	Next plot time.
PRESUR	P	/BAGC/	1	lb/in ²	Absolute pressure in airbag.
PRTI	-	GOMVMA	1	sec	Next print time.
PSA	-	CNTACT	1	-	Temporary storage.
PSB	-	CNTACT	1	-	Temporary storage.
PSIB	ψ b	/BELTE/	2	33	Belt angle.
PSIRR	-	BELT	1	rad	Vestigial.
PX	-	/LF/	10 6	37 34	Computed curve storage. See PX in Table 74.
PX1 to PX8	P_{1-8}^x	/FORCE/	1	1b	Component of force acting at CG of body link (number 1-8) in the inertial x direction resulting from steering column, airbag and belts.
PXI	P_{1-8}^x	DAUX, MATRIX, OUTPUT	8	1b	Same as PX1 to PX8.
PZ1 to PZ8	P_{1-8}^z	/FORCE/	1	1b	Same as PX1 to PX8, in Z direction.
PXI	P_{1-8}^z	DAUX, MATRIX, OUTPUT	8	1b	Same as PZ1 to PZ8.
QELN	Q_{L_n}	/MATRX/	1	1b	Generalized force for L_n .
QTH1	Q_{θ_1}	/MATRX/	1	in-lb	Generalized force for θ_1 .
QTH2	Q_{θ_2}	/MATRX/	1	in-lb	Generalized force for θ_2 .
QTH3	Q_{θ_3}	/MATRX/	1	in-lb	Generalized force for θ_3 .

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
QTH4	Q_{θ_4}	/MATRX/	1	in-lb	Generalized force for θ_4 .
QTH5	Q_{θ_5}	/MATRX/	1	in-lb	Generalized force for θ_5 .
QTH6	Q_{θ_6}	/MATRX/	1	in-lb	Generalized force for θ_6 .
QTH7	Q_{θ_7}	/MATRX/	1	in-lb	Generalized force for θ_7 .
QTH8	Q_{θ_8}	/MATRX/	1	in-lb	Generalized force for θ_8 .
QTH9	Q_{θ_9}	/MATRX/	1	in-lb	Generalized force for θ_9 .
QXH	Q_{x_2}	/MATRX/	1	lb	Generalized force for x_2 .
QZH	Q_{z_2}	/MATRX/	1	lb	Generalized force for z_2 .
QXS	Q_{x_s}	/MATRX/	1	lb	Generalized force for x_s .
QZS	Q_{z_s}	/MATRX/	1	lb	Generalized force for z_s .
R	T_{ijn}	/QV/	2 2 8	- - 17	Rotation matrix.
R	R	RSDUAL	2	41	Residuals for force balance at ring.
R	-	EOM	4	55	Vector of the right-hand side of steering column matrix equations of motion.
RB	-	DEBUG	1	in	Radius of bag during inflation, reference value when full (RADIUS in AIRBAG).
RE	-	ELLELL	2	27	Radius for contact circle associated with ellipse.
RHOI	ρ_j	/STERB/	2	59	Radius of the contact surfaces of head and shoulder.
RI	-	/LC/	2	35	R-ratio control: constant value if positive, table number if negative.
RING	-	/BRIP/	2	41	Switch for ring type.
RINGMU	-	/BRIP/	2	-	Coefficient of friction for belt slipping through ring.
RLTHET	θ_R	/ABAGA/	1	rad	Angle of line along which bag center moves during expansion, positive counterclockwise from vehicle X-axis.
RR	r	CNTACT, MULTI	5	1	Equivalent circle radius for ellipse.
RS	r	/CAV/	5	2	Equivalent circle radius for ellipse.
RX10DD RZ10DD	\ddot{r}_m \ddot{r}	REACT	1	in/sec ²	Acceleration at the center of gravity of the steering wheel.

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
RX2ODD RZ2ODD	\ddot{r}_m	REACT	1	in/sec ²	Acceleration at the center of gravity of the steering wheel.
S	s_n	/CAV/	5	2	Non-dimensional position of circle along line segment length.
S1	s_{1n}	/CAV/	5	2	Cavity parameter for longer base.
S2	s_{2n}	/CAV/	5	2	Cavity parameter for shorter base.
S3	s_{3n}	/CAV/	5	2	Cavity parameter for shorter base.
S4	s_{4n}	/CAV/	5	2	Cavity parameter for longer base.
SFAC	S	CNTACT	1	-	Contact surface edge effect factor.
SGF	-	EVAL	1	lbs	Force at point where reloading commences.
SL1	m_{1n}	/CAV/	5	2	Frontside cavity slope.
SL2	m_{2n}	/CAV/	5	2	Backside cavity slope.
SM	-	EVAL	1	lbs/in	Force slope at point where reloading commences.
SOG	-	EVAL	1	in	Deflection at point where reloading commences.
SR	-	CNTACT, MIG	1	-	Sine of THETAR.
SS	s_n	CNTACT, MULTI	5	1	Non-dimensional position of circle along line segment length (unordered).
ST	-	MIG	28	8	Sine of inertial line segment angle TH.
STOACT	-	/REAL/	NSTACT	-	Packing storage array containing computed quantities of which previous values are needed in computation.
STOMAT	-	/REAL/	NSTMAT	-	Packing storage array containing input constants and quantities which need to be passed from one part of the program to another but not updated.
STOMIG	-	/REAL/	NSTMIG	-	Packing storage array containing computed segment forces for previous time.
STOMUG	-	/REAL/	NSTMUG	-	Packing storage array containing computed segment forces for current time.
SUM	-	Many	3	-	Temporary storage.
SUM	-	BELT2	4	-	Work space for partials of residuals in RELAX.
T	t	/CKOUT/	1	sec	Time.
TB1 to TB3	-	BELT	1	sec	Time at which breaking strength of lap, upper torso, and lower torso belts, respectively, are exceeded.
TBAR	\bar{s}, \bar{t}	ELLELL	2	27	Position parameter for migrating circle.
TBBAR	-	ELLELL	2	27	Parameters for evaluation of TBAR for parallel ellipses.
TEMPR	T	/BAGA/	1	°R	Absolute temperature of gas in airbag.

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
TFI	T_j^f	/JOINT/	8	15	Friction joint torque.
TH	θ_i	MIG	28	8	Inertial line segment angle.
TH1 to TH9	θ_1 to θ_9	/INTEG/	1	rad	Body link angles (generalized coordinates 3-11).
TH1D to TH9D	$\dot{\theta}_1$ to $\dot{\theta}_9$	/INTEG/	1	rad/sec	Body link angle velocities.
THDI	$\dot{\theta}_i$	JTORQ	8	15	Body link angle velocity.
THETAR	θ_R	CNTACT, MIG	1	rad	Inertial angle of region baseline (line between endpoints of a region).
THETAS	θ_S	/SHOLDR/	1	rad	Angle of shoulder element with respect to i_2 .
THI	θ_i	JTORQ	8	15	Body link angle.
THRI	θ_i^R	/JOINT/	8	15	Relative joint angle.
THV	θ_v	/INTEG/	1	rad	Vehicle angle with respect to the space fixed coordinate system.
THVI	$\dot{\theta}_j^v$	/JOINT/	8	15	Relative angle velocity.
TI	T_1 to T_8	JTORQ	8	15	Total torque at joint.
TIME	t	DEBUG	1	sec	Time.
TKSH	-	/JOINT/	1	lb-in	Factor in generalized forces which result from θ_S -dependence of $KJI(10,I)$.
TLI	T_j^L	/JOINT/	8	15	Linear joint torque.
TMP	t	/LP/	2	35	Time at last evaluation.
TMUS	-	/INTEG/	11	48	Joint forces resulting from muscle tension.
TMUSD	-	/INTEG/	11	48	Time rate of change of TMUS.
TNI	T_j^n	/JOINT/	8	15	Nonlinear joint torque.
TS	-	BELT2	4	44	Ring coordinates and work space for RELAX.
TSA	-	MIG	1	-	Ratio of TSB to segment length.
TSA	-	Many	1	-	Temporary storage.
TSB	-	MIG	1	in	Distance from region anchor to point of action of force on the anchored segment before migration, measured along segment.

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
TSB	-	Many	1	-	Temporary storage.
TSC	-	BELT2 RSDUAL	1	lb	Belt tension force.
TSC	-	BELT2	1	in/sec ²	Inertial x acceleration of anchor with inertia reel.
TSD	-	BELT2	1	in/sec ²	Inertial z acceleration of anchor with inertia reel.
TSD	-	BELT2 RSDUAL	1	in ²	Square of side opposite vertex of triangle determined by two belt segments with vertex at ring.
TSE	-	RSDUAL	1	in	Initial webbing length.
TSP	-	Many	1	-	Temporary storage.
TSQ	-	Many	1	-	Temporary storage.
TVI	T_j^v	/JOINT/	8	15	Viscosity joint torque.
VOLUME	V	/BAGA/	1	in ³	Volume of gas in airbag calculated from thermodynamic equations.
WS	s	CNTACT	1	-	Non-dimensional contact position in special contact line system (see equation 133).
X	-	RSDUAL	2	16	Inertial coordinates of slip ring.
X	x_i	/QV/	2 8	16 17	Inertial coordinates of body link CG's.
XA	x_A	/BAGC/	1	in	X coordinate of airbag attachment point in inertial system.
XA1	x_1^A	CNTACT, MIG	1	in	Inertial x-coordinate of region "front" anchor.
XAN	x_n^A	CNTACT, MIG	1	in	Inertial x-coordinate of region "back" anchor.
XB1	x_1^B	/OCCD/	1	in	Inertial x-coordinate of lap belt attachment.
XB2	x_2^B	/OCCD/	1	in	Inertial x-coordinate of upper torso belt attachment.
XB3	x_3^B	/OCCD/	1	in	Inertial x-coordinate of lower torso belt attachment.
XBC	x_c	/BAGC/	1	in	X-coordinate of center of airbag circle in inertial system.
XBD1	\dot{x}_1^B	BELT	1	in/sec	XB1 - velocity.
XBD2	\dot{x}_2^B	BELT	1	in/sec	XB2 - velocity.
XBD3	\dot{x}_3^B	BELT	1	in/sec	XB3 - velocity.
XCP	x_i^c	CNTACT, MIG	29	7	Inertial x-coordinate of region corner point.
XDDC	-	CNTACT	1	in	Vehicle contribution to x-component of tangential velocity.
XDEL	-	ELLELL	1	in	Deflection for ellipse-ellipse interaction.

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
XDIF	-	HDX11	1	sec	Time difference between table points for gearbox position interpolation.
XDMC	-	CNTACT	3	-	Intermediate results in computing XDDC.
XDOT	-	CNTACT	1	-	Time derivative of WS.
XE	-	ELLELL	2 2	29 27	Inertial coordinates of ellipse center.
XEM	x_{em}	CNTACT	1	in	x-coordinate of ellipse center in body system.
XF	x^F	MIG	1	in	Inertial x-coordinate for point of contact.
XG	γ_i	MIG	29	7	Mass compliance at region corner point.
XH	x_2	/INTEG/	1	in	Inertial coordinate at upper torso CG.
XHAT	\hat{x}_i or \hat{z}_i	CNTACT	4	25	Line segment endpoint coordinate, inertial or relative to vehicle origin.
XHD	\dot{x}_2	/INTEG/	1	in/sec	XH - velocity.
XJDI	\dot{x}_i^J	/OCCC/	10	15	XJI - velocity.
XJI	x_i^J	/OCCC/	10	15	Inertial x-coordinate for occupant joint.
XK	k_i	MIG	29	7	Bending stiffness at region corner point.
XL	ℓ	ELLELL	2	27	Distance along semi-major axis between ellipse center and migrating circle center.
XL	ℓ_i	MIG	28	8	Region segment length.
XLAM	-	ELLELL	2 2	29 27	Direction number of semi-major axis.
XLP	ℓ_{jk}^i	MIG	1	in	Distance along line segment from "front" corner point to point of action of force.
XM	-	MIG	2	11	x-coordinate of end of segment away from anchor in two-segment region.
XS	x_s	/INTEG/	1	in	x-coordinate of joint 7 with respect to joint 9, in upper torso system.
XSD	\dot{x}_s	/INTEG/	1	in/sec	XS - velocity.
XSEG	-	CNTACT, MULTI	4	3	Line segment parameters for cavity analysis.
XV	x_v	/INTEG/	1	in	x-coordinate of the vehicle reference point with respect to the space fixed coordinate system.
XX	-	BELT2	2	46	Inertial x-coordinate of torso belt attachment.

TABLE 93. SYMBOL DICTIONARY (Cont.)

Fortran Name	Symbol	Subprogram or /Common/	Dimension	Units or Subscript Reference	Definition
XYDDS	-	CNTACT	1	-	Factor in contact surface contribution to components of tangential velocity.
XZ	X_0	CNTACT	1	in	x-coordinate of contact point.
XZA	-	CNTACT	1	in	x-coordinate of first possible contact point.
XZB	-	CNTACT	1	in	x-coordinate of second possible contact point.
XZRING	X_c, Z_c	/BRIP/	2 2	29 41	Ring positions for advanced belts in vehicle coordinates.
YDIF	-	HDX11	1	in	x-position difference between table points for gearbox position interpolation.
ZA	Z_A	/BAGC/	1	in	Z-coordinate of airbag attachment point in inertial system.
ZA1	Z_1^A	CNTACT, MIG	1	in	Inertial z-coordinate of region "front" anchor.
ZAN	Z_n^A	CNTACT, MIG	1	in	Inertial z-coordinate of region "back" anchor.
ZB1	Z_1^B	/OCCD/	1	in	Inertial z-coordinate of lap belt attachment.
ZB2	Z_2^B	/OCCD/	1	in	Inertial z-coordinate of upper torso belt attachment.
ZB3	Z_3^B	/OCCD/	1	in	Inertial z-coordinate of lower torso belt attachment.
ZBC	Z_c	/BAGC/	1	in	Z-coordinate of center of airbag circle in inertial system.
ZBD1	\dot{z}_1^B	BELT	1	in/sec	ZB1 - velocity.
ZBD2	\dot{z}_2^B	BELT	1	in/sec	ZB2 - velocity.
ZBD3	\dot{z}_3^B	BELT	1	in/sec	ZB3 - velocity.
ZCP	Z_i^c	CNTACT, MIG	29	7	Inertial z-coordinate of region corner point.
ZEM	Z_{em}	CNTACT	1	in	z-coordinate of ellipse center in body segment system.
ZF	Z^F	MIG	1	in	Inertial z-coordinate for point of contact.
ZH	Z_2	/INTEG/	1	in	Inertial z-coordinate at upper torso CG.
ZHD	\dot{z}_2	/INTEG/	1	in/sec	ZH - velocity.
ZJDI	\dot{z}_i^J	/OCCC/	10	15	ZJI - velocity.
ZJI	Z_i^J	/OCCC/	10	15	Inertial z-coordinate for occupant joint.
ZM	-	MIG	2	11	z-coordinate of end of segment away from anchor in two-segment region.

TABLE 93. SYMBOL DICTIONARY (Cont.)

	Symbol	Subprogram or /Common/		Units or Subscript Reference	Definition
ZS	Z_s	/INTEG/	1	in	z-coordinate of joint 7 with respect to joint 9, in upper torso system.
ZSD	\dot{Z}_s	/INTEG/	1	in/sec	ZS - velocity.
ZTOT	-	/ABAGD/	1	lb-in	Net moment on airbag resulting from contact with occupant and vehicle interior which causes adjustment of direction of bag expansion (RLTHET).
ZV	Z_v	/INTEG/	1	in	z-coordinate of the vehicle reference point with respect to the space fixed coordinate system.
ZZ	-	BELT2	2	46	Inertial z-coordinate of torso belt attachment.
ZZ	z_o	CNTACT	1	in	z-coordinate of contact point.
ZZA	-	CNTACT	1	in	z-coordinate of first possible contact point.
ZZB	-	CNTACT	1	in	z-coordinate of second possible contact point.

TABLE 94. SUBSCRIPT REFERENCE EXPLANATIONS

SUBSCRIPT REFERENCE NUMBER	SUBSCRIPT VALUES	SUBSCRIPT EXPLANATIONS	UNITS	SYMBOL
1	1-5	Up to five ellipses in contact with lines are considered	-	-
2	1-5	Up to five ellipses in contact with line; array elements re-ordered corresponding to s_1, s_2, \dots, s_5	-	-
3	1	Material property for dependence of longer trapezoid base length on deflection	-	λ_1
	2	Material property for dependence of longer trapezoid base length on circle radius	-	λ_2
	3	Material property for dependence of shorter trapezoid base length on circle radius.	-	λ_3
	4	Line segment length	-	l
4	1-NELPLN	Circle impinging against line with cavities	-	-
5	1-NELPLN	Cavity impinged against, corresponding to circle (j)	-	-
6	1-NELPLN	Array elements ordered so that $I_1 < I_2 < I_3 < I_4 < I_5$	-	-
7	1-29	One for each corner point, where 1 is for "front" anchor of region; up to 28 segments are possible for region which undergoes migration	in/lb sec ² or in lb/ rad or in.	-
8	1-28	One for each region segment; up to 28 segments are possible for region which undergoes migration	in. or rad. or dimension- less	-
9		NDIM X NDIM are used, by columns	-	-
10	1-32	a) First $2 * NSF + 2$ are for equations 193 next NSR are for equations 196 b) As a solution vector, the first $2 * NSF + 2$ are constraint λ 's and the next NSR are $\Delta\theta$'s.	-	-
11	1	For first segment in region	in.	-
	2	For second segment in region	in.	-
12	1 to (NSR-1)	X-coordinate for each corner point, not including anchors	in.	-
	101 to (NSR+100)	Z - coordinate for each corner point, not including anchors	in.	-
13	1	X_2 -equation	-	-
	2	Z_2 -equation	-	-
	3	θ_1 -equation	-	-

TABLE 94. SUBSCRIPT REFERENCE EXPLANATIONS

SUBSCRIPT REFERENCE NUMBER	SUBSCRIPT VALUES	SUBSCRIPT EXPLANATION	UNITS	SYMBOL
	4	θ_2 -equation	-	-
	5	θ_3 -equation	-	-
	6	θ_4 -equation	-	-
	7	θ_5 -equation	-	-
	8	θ_6 -equation	-	-
	9	θ_7 -equation	-	-
	10	θ_8 -equation	-	-
	11	θ_9 -equation	-	-
	12	L_n -equation	-	-
	13	X_s -equation	-	-
	14	Z_s -equation	-	-
14	1	\ddot{x}_2 coefficient	-	-
	2	\ddot{z}_2 coefficient	-	-
	3-11	$\ddot{\theta}_1$ -coefficient through $\ddot{\theta}_9$ -coefficient	-	-
	12	\ddot{L}_n -coefficient	-	-
	13	\ddot{X}_s -coefficient	-	-
	14	\ddot{Z}_s -coefficient	-	-
	15	Right hand side	-	-
15	1	Upper Neck	-	-
	2	Lower Neck	-	-
	3	Upper torso-middle torso	-	-
	4	Middle torso-lower torso	-	-
	5	Hip	-	-
	6	Knee	-	-
	7	Shoulder-Upper Arm	-	-
	8	Elbow	-	-
	9	Shoulder-Upper Torso	-	-
	10	Vestigial	-	-

TABLE 94. SUBSCRIPT REFERENCE EXPLANATIONS

SUBSCRIPT REFERENCE NUMBER	SUBSCRIPT VALUES	SUBSCRIPT EXPLANATION	UNITS	SYMBOL
16	1	X	in. or in/sec	-
	2	Z	in. or in/sec	-
17	1	Head	-	-
	2	Upper torso	-	-
	3	Middle torso	-	-
	4	Lower torso	-	-
	5	Upper legs	-	-
	6	Lower legs	-	-
	7	Upper arms	-	-
	8	Lower arms	-	-
18	1	X_2 -partial	-	-
	2	Z_2 -partial	-	-
	3	θ_1 -partial	-	-
	4	θ_2 -partial	-	-
	5	θ_3 -partial	-	-
	6	θ_4 -partial	-	-
	7	θ_5 -partial	-	-
	8	θ_6 -partial	-	-
	9	θ_7 -partial	-	-
	10	θ_8 -partial	-	-
	11	θ_9 -partial	-	-
	12	L_n -partial	-	-
	13	X_s -partial	-	-
	14	Z_s -partial	-	-
	15	Time derivative (velocity)	-	-

TABLE 94. SUBSCRIPT REFERENCE EXPLANATIONS

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SUBSCRIPT REFERENCE NUMBER	SUBSCRIPT VALUES	SUBSCRIPT EXPLANATION	UNITS	SYMBOL
19	1	For R(1,1,.)	-	-
	2	For R(1,2,.)	-	-
	3	For R(2,1,.)	-	-
	4	For R(2,2,.)	-	-
20	1	Partial with respect to θ_j , where j is the body link number (second subscript)	-	-
	2	Time derivative	-	-
21	1	Position	in. or rad.	-
	2	Velocity	in/sec or rad/sec	-
	3	Acceleration	in/sec ² or rad/sec ²	-
22	1	X	-	-
	2	Z	-	-
	3	θ	-	-
23	1	Upper stop	rad	-
	2	Lower stop	rad	-
24	1	Linear elastic resistance to motion from initial relative angle	in lb/rad or lb/in	-
	2	Quadratic stiffness for joint stop resistance	in lb/rad ² or lb/in ²	-
	3	Cubic stiffness for joint stop resistance	in lb/rad ³ or lb/in ³	-
25	1	X for first endpoint	in.	\hat{X}_1
	2	Z for first endpoint	in.	\hat{Z}_1
	3	X for second endpoint	in.	\hat{X}_2
	4	Z for second endpoint	in.	\hat{Z}_2
26	1	Coefficient rates of surface relative to vehicle.	in/sec	\dot{p}
	2	Coefficient rates of surface relative to vehicle.	in/sec	\dot{q}
	3	Coefficient rates of surface relative to vehicle.	in/sec	\dot{r}
	4	Coefficients of surface relative to vehicle.	in	p
	5	Coefficients of surface relative to vehicle.	in	q
	6	Coefficients of surface relative to vehicle.	in	r
	7	Coefficients of surface relative to vehicle.	in ²	s
	8	Coefficients of surface relative to inertial space.	in	A

TABLE 94. SUBSCRIPT REFERENCE EXPLANATIONS

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SUBSCRIPT REFERENCE NUMBER	SUBSCRIPT VALUES	SUBSCRIPT EXPLANATION	UNITS	SYMBOL
	9	Coefficients of surface relative to inertial space.	in	B
	10	Coefficients of surface relative to inertial space.	in	C
	11	Coefficients of surface relative to inertial space.	in ²	D
	12	Direction factor	-	-
	13	Coefficient rates of surface relative to vehicle.	in ² /sec	\dot{s}
	14	These are intermediate results.	in ³	-
	15-17	These are intermediate results.	in ²	-
	18	These are intermediate results.	in ³	-
	19-21	These are intermediate results.	in ²	-
	22-23	Surface side lengths.	in.	-
	24-29	Combinations of (8,9,10) taken in pairs.	in ²	-
	30	Square of (31).	in ²	-
	31	Normalizing factor.	in	-
27	1	First of ellipse - ellipse interaction pair	-	-
	2	Second of ellipse - ellipse interaction pair	-	-
28	1	Circle or circle-like	-	-
	2	Ellipse	-	-
29	1	X, i-direction	-	-
	2	Z, k-direction	-	-
30	1-NELPRG	One for each ellipse against region, up to IMAX	-	-
31	1-NNITI	One for each value of KOUNTI	-	-
32	1-NNITJ	One for each value of KOUNTJ	-	-
33	1	First lap belt segment	-	-
	2	Second lap belt segment	-	-
	3	Upper torso belt segment	-	-
	4	Lower torso belt segment	-	-
34	1	First evaluation for first material.	-	-
	2	Second evaluation for first material	-	-
	3	Third evaluation for first material	-	-
	4	First evaluation for second material	-	-
	5	Second evaluation for second material	-	-
	6	Third evaluation for second material	-	-
35	1	Dealing with first material	-	-
	2	Dealing with second material	-	-
36	1	Load-deflection evaluation mode switch (See LX(1) in Table 73)	-	-
	2	Load-deflection static curve control switch (See LX(2) in Table 73).	-	-
37	1-4	Note: See description LX(i) in Table 73. Unloading or reloading curve storage	lbs, lbs/ in. etc.	-
	5	Reload start deflection	inches	-

TABLE 94. SUBSCRIPT REFERENCE EXPLANATIONS

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SUBSCRIPT REFERENCE NUMBER	SUBSCRIPT VALUES	SUBSCRIPT EXPLANATION	UNITS	SYMBOL
	6	Change-over deflection.	inches	-
	7-10	Re-unloading curve storage.	lbs, lbs/ in, etc.	-
38	1	First evaluation for shared deflection.	-	-
	2	Second evaluation for shared deflection.	-	-
	3	Third evaluation for shared deflection.	-	-
39	1	Upper torso belt.	-	-
	2	Lower torso belt.	-	-
	3	Inboard lap belt.	-	-
	4	Outboard lap belt.	-	-
	5	Lower ring strap.	-	-
	6	Upper ring strap.	-	-
	7	Upper torso belt extension.	-	-
40	1	Belt attachment in body coordinates.	in	-
	2	Belt attachment in vehicle coordinates for third index 1, 2, or 3; belt anchor in vehicle coordinates for third index 4-7.	in	-
41	1	Upper belt ring.	-	-
	2	Lower belt ring.	-	-
42	1	Anchor for upper ring or upper ring strap.	-	-
	2	Anchor for lower ring or lower ring strap.	-	-
	3	Anchor for upper torso belt extension.	-	-
	4	Anchor for outboard lap belt.	-	-
43	1	Torso belt.	-	-
	2	Lap belt.	-	-
44	1	Ring x-coordinate in vehicle system.	in	-
	2	Ring z-coordinate in vehicle system.	in	-
	3	Residual for x-force balance at ring.	lb	-
	4	Residual for z-force balance at ring.	lb	-
45	1	Belt 6 if upper ring; belt 5 if lower ring.	in or in/sec	-
	2	Belt 1 if upper ring; belt 2 if lower ring.	in or in/sec	-
	3	Belt 7 if upper ring; belt 3 if lower ring.	in or in/sec	-
46	1	Influencer.	in	-
	2	Influencee.	in	-
47	1	Inertia reel at anchor 1.	in/sec ²	-
	2	Inertia reel at anchor 2.	in/sec ²	-
	3	Inertia reel at anchor 3.	in/sec ²	-
48	1	Upper neck joint torque.	lb-in	-
	2	Lower neck joint torque.	lb-in	-
	3	Upper torso-middle torso joint torque.	lb-in	-
	4	Middle torso-lower torso joint torque.	lb-in	-
	5	Hip joint torque.	lb-in	-
	6	Knee joint torque.	lb-in	-
	7	Upper torso-upper arm joint torque.	lb-in	-
	8	Elbow-joint torque.	lb-in	-

TABLE 94. SUBSCRIPT REFERENCE EXPLANATIONS

SUBSCRIPT REFERENCE NUMBER	SUBSCRIPT VALUES	SUBSCRIPT EXPLANATIONS	UNITS	SYMBOL
	9	Shoulder-upper torso joint torque.	lb-in	-
	10	Neck-length force resisting elongation.	lb	-
	11	Shoulder element force resisting elongation.	lb	-
49	1	Head-neck forward.	-	-
	2	Neck-upper torso forward.	-	-
	3	Upper spine.	-	-
	4	Lower spine.	-	-
	5	Hip.	-	-
	6	Knee.	-	-
	7	Upper arm-upper elbow.	-	-
	8	Elbow.	-	-
	9	Neck, linear elongation.	-	-
	10	Shoulder element elongation.	-	-
	11	Head-neck rear.	-	-
	12	Neck-upper torso rear.	-	-
	13	Neck, linear compression.	-	-
50	1-10	Cross terms for angular momenta.	lb in sec	-
	11	Sum of cross terms.	lb in sec	-
	12-20	$I\dot{\theta}$ angular momentum terms.	lb in sec	-
	21	Sum of $I\dot{\theta}$'s.	lb in sec	-
	22	Total angular momentum.	lb in sec	-
	23-32	Linear x-momentum terms.	lb sec	-
	33	Total x-momentum.	lb sec	-
	34-43	Linear z-momentum terms.	lb sec	-
	44	Total z- momentum.	lb sec	-
51	1	Upper torso semicircle segment.	in	-
	2	Upper torso line segment.	in	-
	3	Middle torso line segment.	in	-
	4	Lower torso line segment.	in	-
	5	Vestigial.	-	-
	6	Head circle.	in	-
52	1	Lower steering wheel rim.	-	-
	2	Steering wheel center.	-	-
	3	Upper steering wheel rim.	-	-
	4	Hub.	-	-
53	1	Gear box linear motion with respect to vehicle.	-	-
	2	Upper steering column linear motion with respect to vehicle.	-	-
	3	Lower steering column angular motion with respect to vehicle.	-	-
	4	Upper steering column angular motion with respect to vehicle (but no relative motion with respect to lower column).	-	-
	5	Upper steering column angular motion with respect to vehicle (and also relative motion with respect to lower column).	-	-

TABLE 94. SUBSCRIPT REFERENCE EXPLANATIONS

SUBSCRIPT REFERENCE NUMBER	SUBSCRIPT VALUES	SUBSCRIPT EXPLANATION	UNITS	SYMBOL
54	1	Head.	lb or in-lb	-
	2	Upper torso.	lb or in-lb	-
	3	Middle torso.	lb or in-lb	-
	4	Lower torso.	lb or in-lb	-
55	1	λ -equation.	-	-
	2	α_1 -equation.	-	-
	3	h -equation.	-	-
	4	α_z -equation.	-	-
56	1	$\ddot{\lambda}$ -coefficient.	lb-sec ² /in or lb-sec ²	a_{i1}
	2	$\ddot{\alpha}_1$ -coefficient.	lb-sec ² or lb-sec ² /in	a_{i2}
	3	\ddot{h} -coefficient.	lb-sec ² /in or lb-sec ²	a_{i3}
	4	$\ddot{\alpha}_z$ -coefficient.	lb-sec ² or lb-sec ² /in	a_{i4}
	5	Right hand side term.	lb or in-lb	b_i
57	1	Upper end of upper torso line segment.	in	-
	2	Lower end of upper torso line segment.	in	-
	3	Lower end of middle torso line segment.	in	-
	4	Lower end of lower torso line segment.	in	-
58	1-NNSTRW	Up to NNSTRW time points in table.	in	-
59	1	Head.	in	-
	2	Shoulder.	in	-
60	1	A vehicle interior line segment end-point near toeboard (inputted).	in	-
	2-5	Vehicle interior points between toeboard and header, either inputted or interpolated.	in	-
	6	A vehicle interior line segment end-point near top of windshield (inputted).	in	-
	7	Point on roof, above and behind occupant's head.	in	-
	8	Top of head circle.	in	-
	9	Front of head circle.	in	-
	10	Top of chest line.	in	-
	11	Bottom of chest line.	in	-

TABLE 94. SUBSCRIPT REFERENCE EXPLANATIONS

SUBSCRIPT REFERENCE NUMBER	SUBSCRIPT VALUES	SUBSCRIPT EXPLANATION	UNITS	SYMBOL
	12	Bottom of chest line.	in	-
	13	Bottom of gut line.	in	-
	14	Bottom of gut line.	in	-
	15	Bottom of pelvis line.	in	-
	16	Top of upper leg line.	in	-
	17	Bottom of upper leg line.	in	-
	18	Top of lower leg line.	in	-
	19	Bottom of lower leg line.	in	-
	20	Same as point 1.	in	-

TABLE 95. ERROR MESSAGES FROM GO (Page 1 of 4)

Number	Message	Condition and Action Required	Subroutine
1	AIRBAG IS SPECIFIED BUT BAG DATA IS NOT PRESENT IN FILE NU	Turn off airbag switch or add data.	ABINIT
2	WARNING --- LAP BELT OUT OF PLANE CBL LENGTH UNREALISTIC = XXXXX.XX	Negative value is unrealistic although run results should be reasonable. Ignore, or change initial slack, change initial belt length, or move lap belt anchors or attachment.	BELT
3	WARNING --- UPPER TORSO BELT OUT OF CBTU PLANE LENGTH UNREALISTIC = XXXXX.XX	Same as No. 2 for upper torso belt.	BELT
4	WARNING --- LOWER TORSO BELT OUT OF CBTL PLANE LENGTH UNREALISTIC = XXXXX.XX	Same as No. 2 for lower torso belt.	BELT
5	REGULAR BELTS ARE SPECIFIED BUT BELT DATA IS NOT PRESENT IN FILE NU	Correct belt switch or add data.	BELTIN
6	AT TIME X.XXXXXX RELAXATION PROCESS FOR FORCE BALANCE AT RING X FAILS TO CONVERGE WITHIN XXX STEPS. NON-FATAL. ICT = XXXX TS(1) = XXXXX TS(2) = XXXXX TS(3) = XXXXX TS(4) = XXXXX ISA = X	Convergent solution not found for relaxation. Increase allowed number of iterations or increase convergence epsilons. Check over advanced belt system parameters and material properties.	BELT2
7	ADVANCED BELTS ARE SPECIFIED BUT BELT DATA IS NOT PRESENT IN FILE NU	Correct belt switch or add data.	BELT2N
8	AT TIME XX.XXXXX ARRAYS FOR FORCE KOUNTI KOUNTJ CONTINUITY ARE TOO SMALL. XX XX REGION: region name	There is an error in the program code.	CNTACT
9	AT TIME XX.XXXXX MORE THAN TWENTY ELLIPSES ARE CONTACTING REGION regionname. KCI(NELPRG)	Same as 8.	CNTACT
10	AT TIME XX.XXXX ONLY 5 OF XXX ELLIPSES ARE CONSIDERED IN SUBROUTINE MULTI FOR CONTACT WITH SURFACE line name OF REGION region name	Non-fatal. Too little storage in CNTACT and MULTI for cavity analysis. Ignore if thought to be insignificant, redimension several quantities, or turn cavity analysis switch off.	CNTACT
11	HORIZONTAL MAXIMUM VERTICAL ACCELERATION TIME EXCEED ANGULAR	Add points to respective input table to extend acceleration table to or beyond t_{max}	ERRMSG

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TABLE 95. ERROR MESSAGES FROM GO (Page 2 of 4)

Number	Message	Condition and Action Required	Subroutine
12	MIG IER = -1 IN DAUX : PIVOT ELEMENT AT AN EOM ELIMINATION STEP IS ZERO	Singular matrix, check for zeroes in masses and moments of inertia or all zero bending stiffnesses.	ERRMSG
13	MIG IER = XXX IN DAUX : FATAL ERROR DUE TO POSSIBLE LOSS OF SIGNIFICANCE INDICATED AT ELIMINATION STEP XXX WHERE PIVOT ELEMENT WAS LESS THAN OR EQUAL TO THE INTERNAL TOLERANCE EPSINV TIMES ABSOLUTELY GREATEST ELEMENT OF MATRIX A.	Check input data for zero or negative masses or moments of inertia or all zero bending stiffnesses. Also see Error 35.	ERRMSG
14	SINGULAR SOLUTION MATRIX	Unused at present.	ERRMSG
15	*** STFP DOES NOT CONVERGE, MAX ITER CNT EXCEED ***	Increase CNTMAX, ERRTOL, or BAGPER.	ERRMSG
16	MAXIMUM MASS FLOW TIME EXCEED	Enlarge table.	ERRMSG
17	*** STFV DOES NOT CONVERGE, MAX ITER CNT EXCEED ***	Increase CNTMAX, ERRTOL, BAGPER, or BAGWTH.	ERRMSG
18	MAXIMUM SUPPLY TEMPERATURE TIME EXCEED	Enlarge table.	ERRMSG
19	MAXIMUM PERMEABILITY PRESSURE EXCEED	Enlarge table.	ERRMSG
20	FATAL ERROR --- INTERACTION TABLES SIZE EXCEEDED	Same as 8.	ERRMSG
21	FATAL ERROR --- NO ROOM FOR BELT INTERACTION	Same as 8.	ERRMSG
22	FATAL ERROR --- UNEXPECTED TYPE IERR = XX	Program error if no error message immediately preceding.	ERRMSG
23	FATAL ERROR --- NOT AT LEAST TWO FRONTAL INTERIOR POINTS FOR AIRBAG CONTACT	Make corrections on 411-Cards.	ERRMSG
24	FATAL ERROR --- FRONTAL INTERIOR FOR AIRBAG CONTACT IS UPSIDE DOWN	Make corrections on 411-Cards.	ERRMSG
25	FATAL ERROR --- INCOMPATIBLE LOAD-DEFLECTIONS IN SHARED CASE: Material 1 Name AGAINST Material 2 Name. ITERATION LIMIT (blank or NOT) EXCEEDED.	Change load-deflection curves so that there are fewer "valleys." Or increase iteration count limit if it is exceeded or increase force convergence epsilon.	ERRMSG
26	CPU EXECUTION TIME = XXX.XX HAS EXCEEDED LIMIT = XXX.XX (MIN.)	Specified limit exceeded, check input data or change limit.	ERRMSG
27	FATAL ERROR --- MIGRATION TABLE SIZE EXCEEDED	Same as 8.	ERRMSG
28	FATAL ERROR --- MIGRATION COEFFICIENT MATRIX SIZE EXCEEDED FOR REGION: region name (KCC = XXXX, NDIM = XXXX)	Same as 8.	ERRMSG

TABLE 95. ERROR MESSAGES FROM G0 (Page 3 of 4)

Number	Message	Condition and Action Required	Subroutine
29	DF DOES NOT EXCEED DE, RUN ABORTED	Check Cards 221, 403, 704, and 812.	EVAL
30	AT TIME = XX.XXXXX COMPUTED (RELOAD or UNLOAD) CURVE NO GOOD, USE (UNLOAD or STATIC) CURVE (11 values = DEL and PX(I,1) through PX(I,10) INTERACTION INVOLVES AAAAAAAAAAAAAAAA	Program corrective measures are reasonable. No user action required.	EVAL
31	AT TIME = XX.XXXXX UNLOADING CURVE LIES ABOVE LOADING CURVE. (same variable list as message 33 plus DUM(12) and FOG) INTERACTION INVOLVES AAAAAAAAAAAAAAAA	Warning, slope of unloading curve less than slope of loading curve at beginning of unloading. Reduce G-ratio and/or R-ratio, change static curve, or ignore.	EVAL
32	AT TIME X.XXXXX SLOPE OF CALC'D UNLOAD CURVE WAS NEG. STRAIGHT-LINE UNLOADING USED. MAINTAINS PERM. DEFORMATION, IGNORES ENERGY. INTERACTION INVOLVES AAAAAAAAAAAAAAAA	Reduce G-ratio and/or R-ratio, change static curve, or ignore.	EVAL
33	AT TIME = XX.XXXXX BAD UNLOADING CURVE, IIP JJP OG ENERGY NOT RIGHT XXXX XXXX XXXXXXXX.XXX BOG FORCE CE DUM(6) XXXXXXXX.XXX XXXXXXXX.XX XXXXXXXX.XX INTERACTION INVOLVES AAAAAAAAAAAAAAAA	Warning, straight line unloading curve used maintaining permanent deformation but ignoring energy.	EVAL
34	FATAL ERROR --- INTERACTION TABLES EXCEED IN FORCE1	Same as 8.	FORCE1
35	***WARNING: INTEGRATION IS SUSPECT FOR GENERALIZED ACCELERATION. CONDITION PROBABLY CAUSED BY CONSTANT FRICTION AT JOINT OR SURFACE OR BY LARGE STIFFNESS, VISCOUS DAMPING OR DT. (SEE GOMVMA: 1 = DTH1D, 2 = DTH2D, ..., 9 = DTH9D 10 = DXHD, 11 = DZHD, 12 = DXVD, 13 = DZVD, 14 = DTHVD, 15 = DHL, 16 = DHAL1D, 17 = DHAL2D, 18 = DHHD, 19 = DELND, 20 = DXSD, 21 = DZSD (1-9 = link angle accelerations, 10-11 = chest CG accelerations, 12-14 = vehicle accelerations, 15-18 = steer col. coordinates, 19 = neck length acceleration, 20-21 = shoulder coordinate accelerations.		GOMVMA
36	AT TIME XX.XXX INTEGRATION ACCELERATION DOES NOT APPROXIMATE "3-POINT" ESTIMATE DV/DT FOR VARIABLES NOS. -- XXXXXXXXXXXXXXXXXXXXXXXX	A warning only. Often the 4th-order Runge-Kutta integration should not approximate 3-point estimate. Is not of consequence unless most variables are bad or one variable is consistently bad. See message 35.	GOMVMA

TABLE 95. ERROR MESSAGES FROM GO (Page 4 of 4)

Number	Message	Condition and Action Required	Subroutine
37	AT TIME = XX.XXXX THERE IS AN IMPROPER NUMBER NFS KKE KKC JKC OF FORCES (XXX) ON A SEGMENT. XXX XXX XXX	Indicates probable program error.	MIG
38	WARNING --- VARIABLE POSITION SECTION PARAMETERS INCONSISTENT --- LEAD SEARCH RANGE PRE & POST IA IB II JNEXT XXXXX XXXXX XXXXX XXXXX CUR REC NO RANGE NCR MCR NPL XXXXXX XXXXXX NO. GRP/LINE = XXXXX NPN NUM NO./GRP = XXXXX NO. GRP = XXXXX LAST REC NO READ I JA XXXXXX VAL IND RANGE CUR LINE = XXXXXX JB XXXXXX	Warning, the LEAD array or one of the controls is not set up right or has been stored over. Program error or machine error.	PICKUP
39	UNEXPECTED CALL TO PUSHER FOR IDIR = X	Same as 8.	PUSHER
40	FATAL ERROR --- ILLEGAL ZERO IN LEAD(13)	Same as Error 38.	SEARCH
41	FATAL ERROR --- INTERACTION TABLES EXCEED IN SFORCE	Same as 8.	SFORCE
42	STEERING COLUMN IS SPECIFIED BUT ITS DATA IS NOT PRESENT IN FILE NU	Turn off steering column switch or add data.	STRINT

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NOTE: See Section 3.2-A.3 in Volume 2 regarding interpretation of integration monitor warning output.

6/30/88

4.5 The Output Pre-Processor

4.5.1 Program Organization and Flow. Figure 139 shows the calling structure for the Output Pre-Processor. Tables 96 and 97 describe the subprograms and commons, respectively.

4.5.2 Packing Techniques. The Output Pre-Processor is highly similar to the Input Pre-Processor in its use of packing to pass the input data from the input cards to the Output Processor. Table 98 gives the name of each component array of RQQ and IQQ, the FORTRAN name of the variable length part of each such array and the method of determining each length.

4.5.3 Binary Output Formats. OUTP appends the third fixed length section of file NU to the end of NU in order to pass output control data to OUT. Table 99 shows what data is written in each record. The second variable length section, occurring directly after this fixed length section, is used to pass input data pertaining to the Type A and Type B comparisons to OUT. Table 100 describes the layout of these records. The first three fields of each of these records are again the same. Field 1 holds IBLK-9, the type of control information. Field 2 holds ID+1, the subtype number. Field 3 holds NCARD, a running count of the cards.

4.5.4 Auxiliary Program Output. Three types of auxiliary output are available from the Output Pre-Processor. The first is the automatic echoing of all input cards read (see Section 4.2.4 for details). Table 101 presents a facsimile. The second is a Packing Dictionary containing the variable length storage layouts for the integer and real packing arrays, a summary of the counts used in creating them and a summary of the optional routines to be used by OUT. Table 102 shows an example. Error messages are the third type, and they are described in Table 103.

There is also debugging information controlled by the Input Debug Switch. Levels one and two are inactive. Level 3 produces a printout of the contents of each input card as laid out to be written into the binary file NU. This occurs interspersed within the card Echo Table as each card is read. It also produces a printout of the contents of each auxiliary record of file NU as written by OUTP for OUT. (Refer to Tables 99 and 100.)

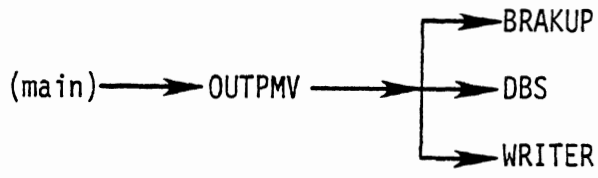


Figure 139. Calling Structure for the Output Pre-Processor (OUTP)

TABLE 96. SUBPROGRAM SPECIFICATIONS AND APPEARANCES FOR OUTP.

Number	Name	Description	Commons	Calls	Users	Output
1	BRAKUP	Analyze the free format instructions for output control and set up controlling arrays.	LDNS	LAND* LOR* MAXO SHFTL* SHFTR*	OUTPMV	E1
2	DBS	GM system routine to convert information in A-format into binary format for arithmetic use.	DUM LDNS	LAND* SIOC*	OUTPMV	NONE
3	MAIN	Calls OUTPMV and returns to system.	NONE	OUTPMV	NONE	NONE
4	OUTPMV	Provides overall control of Output Pre-Processor.	LDNS RITE	BRAKUP DBS WRITER	MAIN	NONE
5	WRITER	Writes main program and transfer vector routine for Output Processor.	RITE	NONE	OUTPMV	NONE

* Routine may require modification by local user. See Section 4.8.1.

TABLE 97. LABELED COMMON DESCRIPTIONS FOR OUTP.

Number	Name	Users	Description
1	DUM	DBS	Temporary storage.
2	LDNS	BRAKUP, DBS, OUTPMV	Logical device numbers and related parameters.
3	RITE	OUTPMV, WRITER	Routine control array and related parameters.

TABLE 98. ARRAY DIMENSIONS IN OUTP FOR OUT.

Array Name	Length	Source of Length
STOMAT	NSTMAT	Calculated in IN
ACC, TACC	NNDACC or ITS	Calculated in IN
STOR	NUMENT	Calculated in INP
KCON	NKCON	Calculated in IN
MSTOR	NUMTAB	Calculated in INP
ELLNAM	NELLS	Calculated in IN
KREGNS, REGNAM	NREGNS	Calculated in IN
CONNAM, KORG, CORG	NLINES	Calculated in IN
T, SAVRAG	NACTUL	Counted in G0
INTACT	NINTAC	Counted in G0
A, W, G, T	NUMACC	Counted in G0
COLD	NOCOLD	KTYPEA+KTYPEB ; input counts
POINTS	ISTEP	Input card 1501, field 1
ELLE	NELLP	NELLPS+NCIRCL + 1 if HEDRAD > 0 0 otherwise
IHOLD, KHOLD	NOHOLD	NREGNS if category 2 or 3 requested NREGNS+NREGNS if both requested NREGNS+NREGNS+NINTAC if category 4 requested

TABLE 99. FIXED LENGTH PORTION OF INDEXED BINARY FILE ON LOGICAL DEVICE NUMBER NU WRITTEN BY OUTP.

LRN	Contents
IOUTSX+1	DELTA, FC, FEMSOR, FIRST, FRAK, FT, HEDRAD, SKMASS, XMAX, XMIN, ZMAX, ZMIN, FCNAM(1-8)
2	IBAG, IBELT, ICNTCT, IDB, IELLP, IPP, ISTEP, IWHEEL, IZERO, KOUTIN, MIRROR, NORDER, NPP, NSLAN, NUSE, NOHOLD, NOKORG, NOREGS, NOCORG, NOIPTS
3	LOITAC, LOKRGN, LOKCON, LOHOLD, LDKORG, LELLNM, LCONNM, LREGNM, LOMSTR, LOT, LOACC, LOTACC, LOSMAT, LOSTOR, LOSAVR, LOELLE, LOPNTS, LOCORG, LOAP, LOWP
4	LOGP, LOTP, KROUTO(1-18)
5	TESTVL(1-18), RAH(1), RAH(2)
6	RAH(3-8), IORDER(41-46), LOIMAG, LOHTIT, LOTTIT, LOSTIT, LOCOLD, LOKHLD, NOCOLD, NIXP
7	IORDER(1-20)
8	IORDER(21-40)
9	ICONTL(1-20)
10	ICONTL(21-40)
11	ICONTL(41-46), KROUTO(19-22), JOUTSX, KO, NSCN, NFLT, MRN, KTYPEA, KTYPEB, NOP, METH, NELLP
12	RAL(1-8), IORDER(47-51), ICONTL(47-51), NDMRQQ, NDMIQQ

TABLE 100. VARIABLE LENGTH PORTION OF INDEXED BINARY FILE ON LOGICAL DEVICE NUMBER NU WRITTEN BY OUTP.

Number	IBLK	ID+1	Field	Item
1	4	1	4-13	KOLD(1-10) (Card 1300)
			14-15	COLD(11-12)
			16	KOLD(13)
2	5	1,2	4-16	KOLD(1-13) (Card 1400, 1401)
3	6	3	4	KSTYX (Cards 1502) number of this time point card among all time point cards read
			5	NOSPTS Number of points in record (may be less than 9 only for last card)
			6-14	POINTS($\gamma+1$) to POINTS($\gamma+NOSPTS$) where $\gamma = 9 * (KSTYX-1)$

OUTP

1	1001	*0, 1, 10-1*	4, 21, 22, *37, 38, 15*	23-26, 2*-5, 18-20*	33-36, 3*0-32, 16, *27-29, 39*	17, 40, *				
2	1002	*5-9, 45	*	*	*	*	*	*	*	*
3	1003	*0.	*0.	*0.	*11.55	*.025	*	*	*	*
4	1004	*40.	*500.	*560.	*0.	*.85	*201.	*5.	*5.	*
5	1500	*0.	*0.	*-3.	*62.	*5.	*-44.	*10.	*0.	*
6	1501	*21.	*0.	*0.	*1.	*1.	*0.	*1.	*0.	*10.
7	1600	*	*	*	*	*	*	*	*	*

Table 101. Facsimile of Echo of Input Data Cards from OUTP

PACKING DICTIONARY

A. VARIABLE-LENGTH STORAGE LAYOUT

REAL ARRAYS					
NAME	BEG.	IND.	LENGTH	OFFSET	BEG.
T	1133		41		1132
ACC	1174		353		1173
TACC	1527		27		1526
STOMAT	1		1132		0
STOR	1554		21		1553
SAVRAG	1575		0		1533
ELLE	1575		70		1567
POINTS	3820		21		3819
CORG	1645		24		1642
A	1		1206		-201
W	1207		1206		1005
G	2413		1206		2211
T (PRELIM)	3619		1206		3618
INTEGER ARRAYS					
NAME	BEG.	IND.	LENGTH	OFFSET	BEG.
INTACT	590		90		584
KREGNS	680		45		674
KCON	1		589		0
IHOLD	725		108		721
KORG	833		60		827
ELLNAM	893		80		884
CONNAM	973		48		968
REGNAM	1021		72		1012
MSTOR	1093		126		1086
IMAGE	1219		1848		1185
HTITLE	2067		18		2066
TTITLE	3085		7		3084
STITLE	3092		35		3091
COLD	3127		0		3113
KHOLD	3127		108		3124

B. SUMMARY OF COUNTS.

IOUTSX= 1617	JOUTSX= 1630	ISTEP= 21	KSTYX= 0
KTYPEA= 0	KTYPEB= 0	NOSPTS= 0	NCARD= 7
MRN= 1629	NOHOLD= 36	NELLP= 10	

C. SUMMARY OF ROUTINE USAGE

ROUTINE NAME	ROUTINE USAGE
CATG1	USE
CATG2	USE
CATG3	USE
CATG4	USE
CATG5	USE
COMPA	OMIT
COMPB	OMIT
DOLIST	OMIT
STYX	USE
PRELIM	USE
IDOUT	USE
TJOINT	OMIT
ZBFLT	OMIT
ZBELTA	OMIT
ZCOLM	OMIT
ZBAG	OMIT
FILTER	USE
HIC	USE
SPVIND	USE
THFAVG	USE
ELLIPS	USE
INTSCT	OMIT

Table 102. Facsimile of Packing Dictionary from OUTP

TABLE 103. ERROR MESSAGES FROM OUTP

Number	Message	Condition and Action Required	Subroutine
1	CHARACTER = X IN COL.NO. = XXX IS ILLEGAL	Warning, offending character skipped, correct and rerun.	BRAKUP
2	WARNING --- ILLEGAL CATEGORY NUMBER SPECIFIED, XX XX , ALL CATEGORIES PROVIDED	Number does not correspond to a category, all categories assumed desired.	BRAKUP
3	WARNING --- TOO MANY CATEGORIES SPECIFIED, ALL CATEGORIES PROVIDED	There are sufficient duplications of categories that they exceed the total number of categories. All categories assumed desired.	BRAKUP
4	INPUT PUNCHING ERROR : ERR.POST = XXX VALUE(1) VALUE(2) DS ERR.TYPE = XXX BEG.COL. = XXX PICT CONTL.WORD = XXX	Correct bad character and rerun.	DBS
5	SKIPPED. * * * * *	Input card listed above this comment skipped; check, correct, rerun.	OUTPMV
6	FATAL ERROR --- TYPE B COMPARISONS DO NOT XXX XXX MATCH. KTYPB1 KTYPB2	Check Type B comparison specifications, correct and rerun.	OUTPMV

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4.5.5 Programs Written by OUTP. The last function of OUTP is to take the computed dimensions of RQQ and IQQ and the tabulated options as desired for the output and write the main program, the transfer vector routine, and the second level transfer vector routine for OUT. Samples of each are given in Tables 104, 105, and 106, respectively. See Table 108 in OUT for all possible routines for TRAVEC and SUBTVC.

```

MICHIGAN TERMINAL SYSTEM FORTRAN G (21.8 TEST)          MAIN
0001          COMMON/REAL/RQQ( 3840)
0002          COMMON/INTGR/IQQ( 3234)
           C    DEFINE FILE  8( 2000, 22,U,IUPONT)
0003          CALL OUTMVM
0004          STOP
0005          END

```

Table 104. Main Program for OUT

```

MICHIGAN TERMINAL SYSTEM FORTRAN G(21.8 TEST)          TRAVEC

0001          SUBROUTINE TRAVEC(I,J)
0002          GO TO (1,2,3,4,5,6,7,8,9,10,11,12),I
0003          1 CALL CATG1(J)
0004          RETURN
0005          2 CALL CATG2(J)
0006          RETURN
0007          3 CALL CATG3(J)
0008          RETURN
0009          4 CALL CATG4(J)
0010          RETURN
0011          5 CALL CATG5(J)
0012          RETURN
0013          6 RETURN
0014          7 RETURN
0015          8 RETURN
0016          9 CALL STYX
0017          RETURN
0018          10 CALL PRELIM
0019          RETURN
0020          11 CALL IDOUT
0021          RETURN
0022          12 RETURN
0023          END

```

Table 105. Transfer Vector Routine for OUT (obsolete)

```

MICHIGAN TERMINAL SYSTEM FORTRAN G(21.8 TEST)          SUBTVC

0001          SUBROUTINE SUBTVC(II,A,B,C,E,F,G,D,K,J,*)
0002          DIMENSION A(1),B(1),C(1),D(1),E(1),F(1),G(1),J(1),K(1)
0003          I=II-12
0004          GO TO (13,14,15,16,17,18,19,20,21,22),I
0005          13 RETURN
0006          14 RETURN
0007          15 RETURN
0008          16 RETURN
0009          17 CALL FILTER(A,J(1),J(2),J(3),J(4),D(1),D(2),D(3),B,C,&1000)
0010          RETURN
0011          18 CALL HIC(D(1),D(2),A,B,C,E,F,G,J(1),J(2),J(3),J(4))
0012          RETURN
0013          19 CALL SEVIND(D(1),D(2),A,B,C)
0014          RETURN
0015          20 CALL THRAVG(J(1),D(1),A,B,C,J(2),K)
0016          RETURN
0017          21 CALL ELLIPS(J(1),J(2))
0018          RETURN
0019          22 RETURN
0020          1000 RETURN 1
0021          END

```

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Table 106. Second Level Transfer Vector Routine for OUT (obsolete)

OUTP

4.6 The Output Processor (OUT)

4.6.1 Program Organization and Flow. Figure 140 shows the calling structure for the Output Processor. Tables 107 and 109 describe the sub-programs and commons, respectively.

Table 108 relates the optional routines with indices used in calls to TRAVEC and SUBTVC. In Figure 140 the presence of a letter "T" or "S" on a calling arrow indicates that the route is via TRAVEC or SUBTVC, respectively.

Tables 110 and 111 show the layout of the real and integer packing arrays, respectively.

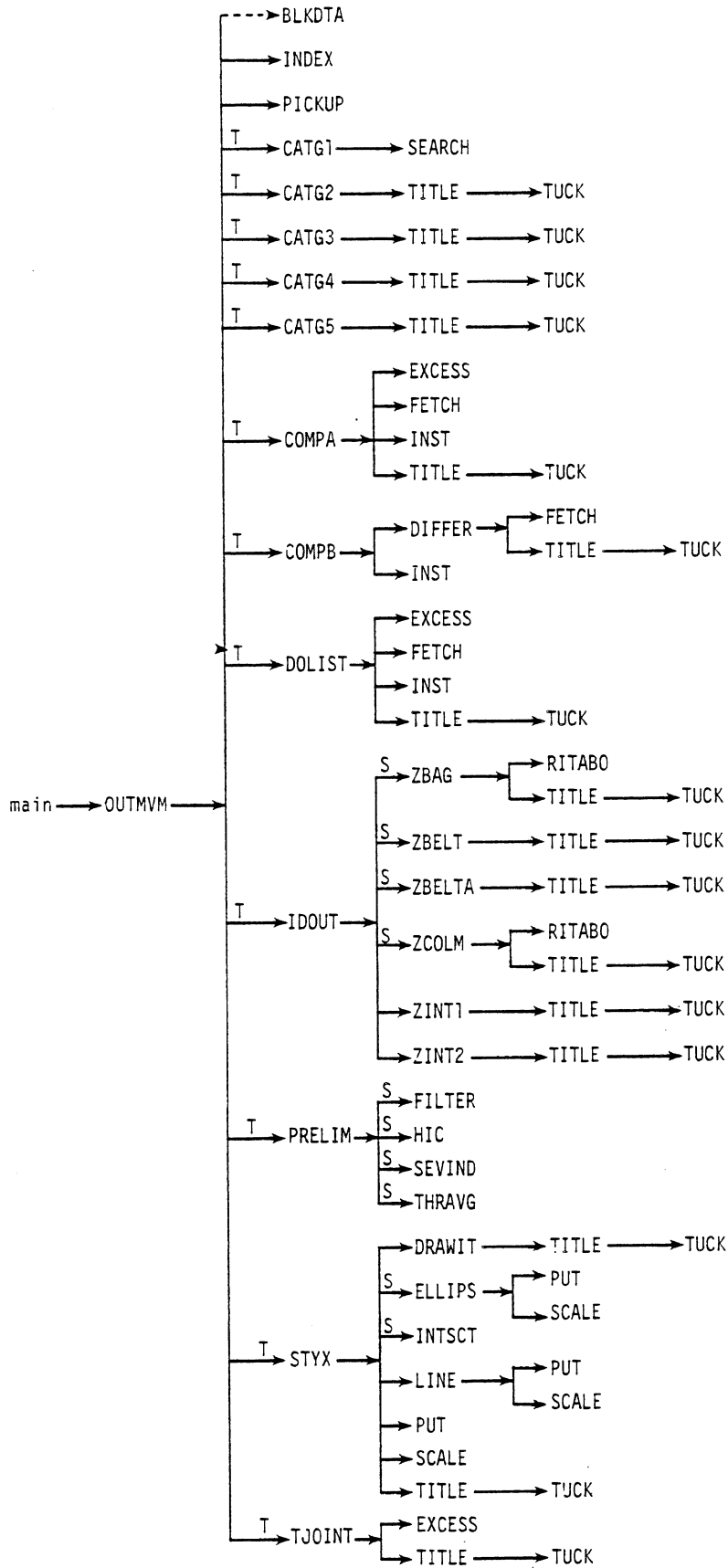


Figure 140. Calling Structure for the Output Processor (OUT).

TABLE 107. SUBPROGRAM SPECIFICATIONS AND APPEARANCES FOR OUT (Page 1 of 6)

Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprogram Called	Subprogram Calling	Special Output
1	BLKDTA		Initialize ordering and name tables.	INDEXX JUNK	NONE	OUTMVM	NONE
2	CATG1		Reads part of binary files on logical device numbers NU and MV and produces printed output for categories one through four.	BASE INDEXX INTGR JUNK PRNT REAL	TITLE	OUTMVM via TRAVEC	NONE
3	CATG2		Reads part of binary files on logical device number NU and produces printed output for categories five through nine.	BASE JUNK PRNT REAL SI	TITLE	OUTMVM via TRAVEC	NONE
4	CATG3		Reads part of binary file on logical device number NU and produces printed output for categories ten through twenty.	BASE JUNK PRNT REAL	TITLE	OUTMVM via TRAVEC	NONE
5	CATG4		Reads part of binary file on logical device number NU and produces printed output for categories twenty-three through thirty-nine.	BASE JUNK PRNT REAL	TITLE	OUTMVM via TRAVEC	NONE
6	CATG5		Reads part of binary file on logical device number NU and produces printed output for categories forty and forty-six through fifty.	BASE JUNK PREP PRNT REAL	TITLE	OUTMVM via TRAVEC	NONE
7	COMPA		Carries out all requests for type A comparisons.	BASE COMPS INDEXX INTGR PRNT	EXCESS FETCH INST TITLE	OUTMVM via TRAVEC	NONE
8	COMPB		Carries out all requests for type B comparisons.	BASE COMPS INTGR PRNT	DIFFER INST	OUTMVM via TRAVEC	NONE

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OUT

TABLE 107. SUBPROGRAM SPECIFICATIONS AND APPEARANCES FOR OUT (Page 2 of 6)

OUT

Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprogram Called	Subprogram Calling	Special Output
9	DIFFER		Routine which carries out an individual two variable comparison.	INDEXX PRNT	FETCH TITLE	COMPB	NONE
10	DOLIST		Routine which carries out the testing of the standard list.	BASE COMPS INDEXX INTGR PRNT SI	EXCESS FETCH INST TITLE	OUTMVM via TRAVEC	NONE
11	DRAWIT		Routine to print out finished plot page image.	BASE INTGR JUNK PRNT REAL	TITLE	STYX	NONE
12	ELLIPS		Plot outline of ellipse.	BASE CTYX REAL	SCALE PUT COS SIN	STYX via SUBTVC	NONE
13	EXCESS		Routine which carries out an individual one variable high and low test over a range.	PRNT	NONE	COMPA DOLIST TJOINT	NONE
14	FETCH		Routine which obtains a particular time value of a particular variable from binary storage.	BASE INDEXX PRNT REAL	NONE	COMPA DIFFER DOLIST	NONE
15	FILTER		Carries out Martin-Graham filtering of output acceleration data.	PRNT	SIN	PRELIM via SUBTVC	E2, E3 E4
16	HIC		Routine which computes the HIC index.	PRNT	SQRT	PRELIM via SUBTVC	E5
17	IDOUT		Routine which prints a summary of the input quantities.	PRNT	ZBAG* ZBELT* ZBELTA* ZCOLM* ZINT1 ZINT2	OUTMVM via TRAVEC	NONE

*via SUBTVC

TABLE 107. SUBPROGRAM SPECIFICATIONS AND APPEARANCES FOR OUT (Page 3 of 6)

Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprograms Called	Subprograms Calling	Special Output
18	INDEX		Routine which forms and prints an index of categories and force producers in terms of page numbers.	BASE INDEXX INTGR PRNT	NONE	OUTMVM	NONE
19	INST		Routine which determines the control parameters for locating a variable in binary storage and reading it in.	BASE INDEXX INTGR PRNT	NONE	COMPA COMPB DOLIST	E13
20	INTSCT		Routine to determine intersection between two circles.	NONE	SQRT	STYX via SUBTVC	NONE
21	LINE		Routine to enter a line into the plot image.	NONE	PUT SCALE	STYX	NONE
22	MAIN		Routine generated by OUTP which passes control to OUTMVM and then back to the system.	NONE	OUTMVM	NONE	NONE
23	OUTMVM		Controls the overall functioning of the Output Processor.	BASE COMPS CTYX INTGR JUNK PREP PRNT REAL SI	BLKDATA CATG1* CATG2* CATG3* CATG4* CATG5* COMPA* COMPB* DOLIST* IDOUT* INDEX AMAX1 PICKUP AMIN1 PRELIM* MINO STYX* TJOINT*	MAIN	E6
24	PICKUP		Reads a table in from binary storage.	PRNT	SEARCH	OUTMVM	E7

*via TRAVEC

TABLE 107. SUBPROGRAM SPECIFICATIONS AND APPEARANCES FOR OUT (Page 4 of 6)

OUT

Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprogram Called	Subprogram Calling	Special Output
25	PRELIM		Controls the calculation and storage of edited accelerations, filtered accelerations, and various severity indices.	BASE INTGR PREP PRNT REAL SI	FILTER* HIC* SEVIND* THRAVG* MINO SQRT	OUTMVM via TRAVEC	E8, E9 E10
					*via SUBTVC		
26	PUT		Routine to insert a character at a mesh point specified in plot image.	BASE INTGR	LAND** LOR** SHFTR**	ELLIPS LINE STYX	NONE
27	RITABO		Routine to read and print individual table points and control titles.	PRNT	NONE	ZBAG ZCOLM	NONE
28	SCALE		Routine to obtain the mesh point coordinates from coordinate value for insertion in plot image.	PREP	NONE	ELLIPS LINE STYX	NONE
29	SEARCH		Locates the beginning record number of a table in binary storage.	PRNT	NONE	PICKUP	E11
30	SEVIND		Compute regular GMR SI and Modified GMR SI for output accelerations.	NONE	NONE	PRELIM via SUBTVC	NONE
31	STYX		Produces the stick figure printer plots.	BASE CTYX INTGR JUNK PREP PRNT REAL	DRAWIT ELLIPS* INTSCT* LINE PUT SCALE TITLE COS AMIN1 SIN ATAN2 SQRT	OUTMVM via TRAVEC	NONE
					*via SUBTVC		

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** Routine may require modification by local user. See Section 4.8.1.

TABLE 107. SUBPROGRAM SPECIFICATIONS AND APPEARANCES FOR OUT (Page 5 of 6)

Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprogram Called	Subprogram Calling	Special Output
32	SUBTVC		Routine generated by OUTP which acts as transfer vector to second level optional routines.	NONE	ELLIPS FILTER HIC INTSCT SEVIND THRAVG ZBAG ZBELT ZBELTA ZCOLM	IDOUT PRELIM STYX	NONE
33	THRAVG		Routine to locate peak acceleration and compute three millisecond average.	NONE	MAX1	PRELIM via SUBTVC	NONE
34	TITLE		Increment page count and print page heading for regular printout page.	BASE INTGR PRNT	TUCK	CATG1 CATG2 CATG3 CATG4 CATG5 COMPA DIFFER DOLIST DRAWIT STYX TJOINT ZBAG ZCOLM ZINT1 ZINT2	NONE
35	TJOINT		Routine to carry out the testing of joint relative angles.	BASE COMPS PRNT REAL	EXCESS TITLE	OUTMVM via TRAVEC	NONE
36	TRAVEC		Routine generated by OUTP which acts as transfer vector for primary optional routines.	NONE	CATG1 CATG2 CATG3 CATG4 CATG5 COMPA COMPB DOLIST	IDOUT PRELIM STYX TJOINT	NONE

TABLE 107. SUBPROGRAM SPECIFICATIONS AND APPEARANCES FOR OUT (Page 6 of 6)

OUT

Number	Subprogram Name	Statement Location	Flow Sequence or Description	Commons	Subprogram Called	Subprogram Calling	Special Output
37	TUCK		Routine to record page number under identification of category for inclusion in index.	BASE INDEXX INTGR PRNT	NONE	TITLE	E12
38	ZBAG		Prints inputted values for airbag system.	JUNK PRNT	RITABO TITLE	IDOUT via SUBTVC	NONE
39	ZBELT		Prints inputted values for simple belt system.	BASE INTGR JUNK PRNT REAL	TITLE	IDOUT via SUBTVC	NONE
40	ZBELTA		Prints inputted values for advanced belt system.	BASE INTGR JUNK PRNT	TITLE	IDOUT via SUBTVC	NONE
41	ZCOLM		Prints inputted values for steering column system.	BASE INTGR JUNK PRNT	RITABO TITLE	IDOUT via SUBTVC	NONE
42	ZINT1		Prints first half of initial conditions and parameters for the vehicle & occupant.	BASE INTGR JUNK PRNT REAL	TITLE	IDOUT	NONE
43	ZINT2		Second half of ZINT1.	BASE INTGR JUNK PRNT REAL	TITLE SQRT	IDOUT	NONE

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* TABLE 108. SUBROUTINE/INDEX CORRESPONDENCE FOR CALLS TO TRAVEC AND SUBTVC (OUT)

Index	Subroutine	Subroutine
<u>I</u>	<u>TRAVEC(I)</u>	<u>SUBTVC(I)</u>
1	CATG1	ZBELT
2	CATG2	ZBELTA
3	CATG3	ZCOLM
4	CATG4	ZBAG
5	CATG5	FILTER
6	COMPA	HIC
7	COMPB	SEVIND
8	DOLIST	THRAVG
9	STYX	ELLIPS
10	PRELIM	INTSCT
11	IDOUT	
12	TJOINT	

* Obsolete

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TABLE 109. LABELED COMMON DESCRIPTIONS FOR OUT

Number	Common Name	Subprograms Which Use	Description
1	BASE	CATG1, CATG2, CATG3, CATG4, CATG5, COMPA, COMPB, DOLIST, DRAWIT, ELLIPS, FETCH, INDEX, INST, OUTMVM, PRELIM, PUT, STYX, TITLE, TJOINT, TUCK, ZBELT, ZBELTA, ZCOLM, ZINT1, ZINT2	Base indices of individual arrays within master arrays.
2	COMPS	COMPA, COMPB, DOLIST, OUTMVM, TJOINT	Contains test values for comparison.
3	CTYX	ELLIPS, OUTMVM, STYX	Contains control parameters for stick figure plots.
4	INDEXX	BLKDTA, CATG1, COMPA, DIFFER, DOLIST, FETCH, INDEX, INST, TUCK	Contains information to put together the index.
5	INTGR	CATG1, COMPA, COMPB, DOLIST, DRAWIT, INDEX, INST, OUTMVM, PRELIM, PUT, STYX, TITLE, TUCK, ZBELT, ZBELTA, ZCOLM, ZINT1, ZINT2	Integer master array.
6	JUNK	BLKDTA, CATG1, CATG2, CATG3, CATG4, CATG5, DRAWIT, OUTMVM, STYX, ZBAG, ZBELT, ZBELTA, ZCOLM, ZINT1, ZINT2	Contains units and body part names for formatting in IDOUT.
7	PREP	CATG5, OUTMVM, PRELIM, SCALE, STYX	Contains working tables and input tables. The format employed between OUTMVM and PRELIM differs from the rest.
8	PRNT	CATG1, CATG2, CATG3, CATG4, CATG5, COMPA, COMPB, DIFFER, DOLIST, DRAWIT, EXCESS, FETCH, FILTER, HIC, IDOUT, INDEX, INST, OUTMVM, PICKUP, PRELIM, RITABO, SEARCH, STYX, TITLE, TJOINT, TUCK, ZBAG, ZBELT, ZBELTA, ZCOLM, ZINT1, ZINT2	Contains printout control information and binary file placement tables.
9	REAL	CATG1, CATG2, CATG3, CATG4, CATG5, DRAWIT, ELLIPS, FETCH, OUTMVM, PRELIM, STYX, TJOINT, ZBELT, ZINT1, ZINT2	Real master array.
10	SI	CATG2, DOLIST, OUTMVM, PRELIM	Contains special severity indices.

TABLE 110. PACKING ARRAY LAYOUT FOR REALS IN OUT (RQQ)

	<u>Beginning Index</u>	<u>Array Name and Dimensions for RQQ</u>
1	LOSMAT [or LOAP]	STOMAT(NSTMAT) [or A(NUMACC,6)]
2	LOT [or LOWP]	T(NACTUL) [or W(NUMACC,6)]
3	LOACC [or LOGP]	ACC(NNOACC) [or G(NUMACC,6)]
4	LOTACC [or LOTP]	TACC(NNOACC) [or T(NUMACC)]
5	LOSTOR	STOR(NUMENT)
6	LOSAVR	SAVRAG(NACTUL,8)
7	LOELLE	ELLE(7,NELLP)
8	LOCORG	CORG(2,NLINES+NREGNS)
9[or 5]	LOPNTS	POINTS(ISTEP)

TABLE 111. PACKING ARRAY LAYOUT FOR INTEGERS IN OUT (IQQ)

	<u>Beginning Index</u>	<u>Array Name and Dimensions for IQQ</u>
1	LOKCON (=1)	KCON(NKCON)
2	LOITAC	INTACT(5,NINTAC)
3	LOKRGN	KREGNS(5,NREGNS)
4	LOHOLD	IHOLD(3,NOHOLD)
5	LOKORG	KORG(5,NLINES)
6	LELLNM	ELLNAM(8,NELLS)
7	LCONNM	CONNAM(4,NLINES)
8	LREGNM	REGNAM(8,NREGNS)
9	LOMSTR	MSTOR(KTBCSZ,NUMTAB) (KTBCSZ=6)
10	LOIMAG	IMAGE(33,56)
11	LOHTIT	HTITLE(18)
12	LOTTIT	TTITLE(7)
13	LOSTIT	STITLE(35)
14	LOCOLD	COLD(13,NOCOLD)
15	LOKHLD	KHOLD(3,NOHOLD)

4.6.2 Output Subprocessors*

4.6.2.1 Standard List of Comparisons. The eighteen quantities listed in Table 112 are subjected to a high test in absolute value. The output identifies the quantity, the peak value, the time at which the peak occurs, and the time duration during which the quantity exceeds an inputted test value together with the points in time at which the quantity exceeds and then returns below the test value (all this for each time range of violation). If a zero test value is specified, the test is not made.

A testing of joint relative angles for each of eight joints is also made against inputted high and low test values and is reported in the same fashion.

4.6.2.2 General Comparisons. Table 113 lists the forty-five standard printout categories, 1-40 and 46-50. General comparisons may be made on one or two variables specified in these printout categories. The variables are specified by category number and column number on the printed page starting where column one is the first column after the Time Column. Categories 2 and 3 require the corresponding region name. Category 4 requires the names of the two contact interactors. An alphabetical table of all such variables and their corresponding specifications will be found in Table 114. A table of belt indicator names is found in Table 115.

The Type A General Comparison is between one variable over its entire time range against a high and low inputted test value. The form of output is the same as that of the tests in the last section.

The Type B General Comparison tests one specified variable against another specified variable for all times. The output is Time, the First Quantity, the Second Quantity, the Difference between them, and a column containing "0" wherever the first is less than the second and "X" where the first is greater than or equal to the second. The user may specify as many of these comparisons as he desires.

*See Section 3.2 for further information.

TABLE 112. LIST OF INJURY RELATED TEST QUANTITIES

Number	Quantity Description
1	Head frontal acceleration at the center of gravity (Anterior-posterior, A-P)
2	Head vertical acceleration at the center of gravity (Superior-inferior, S-I)
3	Head resultant acceleration at the center of gravity
4	Head angular acceleration
5	Head injury criterion (HIC)
6	Face loads as measured on a deformable head contact ellipse
7	Chest deflection as measured on a deforming chest contact ellipse
8	Chest load as measured on a deforming chest contact ellipse
9	Chest frontal acceleration at the center of gravity (A-P)
10	Chest vertical acceleration at the center of gravity (S-I)
11	Chest resultant acceleration at the center of gravity (3 msec average)
12	Chest frontal severity index (A-P).
13	Chest vertical severity index (S-I)
14	Chest resultant severity index
15	Pelvic horizontal acceleration at the hip joint
16	Pelvic vertical acceleration at the hip joint
17	Pelvic resultant acceleration at the hip joint
18	Femur load at a specified point along the length representing the location of a sensor

Category Number	Description
0	Formatted Printout of Input Quantities
1	Vehicle Response
2	Real Line Region Parameters
3	Real Line Region Individual Line Segment Movement
4	Contact Forces Including Occupant-Vehicle, Occupant-Belt, Occupant-Occupant
5	Neck Reaction Forces
6	Unfiltered Body Accelerations (Head, Chest, Pelvis)
7	Filtered Body Accelerations (Head, Chest, Pelvis)
8	Unfiltered Severity Indices
9	Filtered Severity Indices
10	Body Link Angles
11	Body Link Angular Velocities
12	Body Link Angular Accelerations
13	Body Joint Coordinates
14	Body Joint Velocities
15	Body Joint Torques
16	Body Joint Absorbed Energies
17	Body Kinetic Energies
18	Airbag Variables
19	Airbag Contact Forces
20	Airbag Center of Mass Forces and Moments
21	Neck Joint Coordinates
22	Shoulder Joint Coordinates
23	Joint Torque Elastic Components
24	Joint Torque Joint-Stop Components
25	Joint Torque Friction Components
26	Joint Torque Viscosity Components
27	Joint Absorbed Energy Joint Stop Components
28	Joint Absorbed Energy Friction Components
29	Joint Absorbed Energy Viscosity Components
30	Center of Mass X-Component Forces
31	Center of Mass Z-Component Forces

Table 113. List of Output Categories

OUT	Category Number	Description
	32	Center of Mass Resultant Moments
	33	Steering Column Coordinates
	34	Steering Column Generalized Coordinates
	35	Steering Column Forces and Moments
	36	Forces and Moments on Body Due to Steering Column
	37	Neck and Shoulder Forces
	38	Muscle Tension Forces
	39	Muscle Tension Energy Absorption
	40	Femur and Tibia Accelerations and Loads
	41	Joint Relative Angle Comparisons Against Upper and Lower Test Values
	42	Standard List of Quantities to be Compared Against Test Values
	43	Individual Type A Comparisons
	44	Individual Type B Comparisons
	45	Printer-Plots of Stick Figures
	46	Head Center-of-Gravity Motion
	47	Chest Center-of-Gravity Motion
	48	Hip Motion
	49	Joint Relative Angles
	50	Joint Relative Angle Velocities
	51	Advanced Airbag System Thermodynamic Variables
	52	Pressure Forces on Body (AAS*)
	53	Occupant-Plane Normal Flotation Forces (AAS)
	54	Occupant-Plane Tangential Flotation Forces (AAS)
	55	Off-Occupant-Plane Normal Flotation Forces (AAS)
	56	Off-Occupant-Plane Tangential Flotation Forces (AAS)
	57	Bag Slap Forces on Body (AAS)
	58	Airbag Equilibrium and Contact Conditions (AAS)
	59	Airbag-Deformable Segment Motions (AAS)
	60	Total Bag Forces on Body (AAS)
	61	Total Inertial X-Component Bag Forces (AAS)
	62	Total Inertial Z-Component Bag Forces (AAS)
	63	Non-body link motion
	64	Non-body link resistance forces and moments

Table 113. List of Output Categories

*AAS = Advanced Airbag System

TABLE 114. OUTPUT TEST VARIABLES AND THEIR SPECIFICATIONS (Page 1 of 10)

QUANTITY DESCRIPTION	CATG. NO.	COL. NO.
Airbag CG force components - head moment	20	3
Airbag CG force components - head x	20	1
Airbag CG force components - head z	20	2
Airbag CG force components - lower torso moment	20	12
Airbag CG force components - lower torso x	20	10
Airbag CG force components - lower torso z	20	11
Airbag CG force components - middle torso moment	20	9
Airbag CG force components - middle torso x	20	7
Airbag CG force components - middle torso z	20	8
Airbag CG force components - upper leg moment	20	15
Airbag CG force components - upper leg x	20	13
Airbag CG force components - upper leg z	20	14
Airbag CG force components - upper torso moment	20	6
Airbag CG force components - upper torso x	20	4
Airbag CG force components - upper torso z	20	5
Airbag contact forces - head pressure	19	1
Airbag contact forces - head tension	19	2
Airbag contact forces - lower torso pressure	19	7
Airbag contact forces - lower torso tension	19	8
Airbag contact forces - middle torso pressure	19	5
Airbag contact forces - middle torso tension	19	6
Airbag contact forces - upper leg pressure	19	9
Airbag contact forces - upper leg tension	19	10
Airbag contact forces - upper torso pressure	19	3
Airbag contact forces - upper torso tension	19	4
Airbag variables - bag gas mass	18	4
Airbag variables - bag pressure	18	1
Airbag variables - bag temperature	18	2
Airbag variables - bag volume	18	3
Airbag variables - mass flow in	18	5
Airbag variables - mass flow out	18	6
Airbag variables - supply temperature	18	7
Body joint coordinate - elbow x	13	9
Body joint coordinate - elbow z	13	10
Body joint coordinate - hip x	13	5
Body joint coordinate - hip z	13	6
Body joint coordinate - knee x	13	7
Body joint coordinate - knee z	13	8
Body joint coordinate - lower spine x	13	3
Body joint coordinate - lower spine z	13	4
Body joint coordinate - upper spine x	13	1
Body joint coordinate - upper spine z	13	2
Body joint velocity - elbow x	14	9
Body joint velocity - elbow z	14	10
Body joint velocity - hip x	14	5
Body joint velocity - hip z	14	6

TABLE 114. OUTPUT TEST VARIABLES AND THEIR SPECIFICATIONS (Page 2 of 10)

QUANTITY DESCRIPTION	CATG. NO.	COL. NO.
Body joint velocity - knee x	14	7
Body joint velocity - knee z	14	8
Body joint velocity - lower spine x	14	3
Body joint velocity - lower spine z	14	4
Body joint velocity - upper spine x	14	1
Body joint velocity - upper spine z	14	2
Body link angles - head	10	1
Body link angles - lower arm	10	10
Body link angles - lower leg	10	7
Body link angles - lower torso	10	5
Body link angles - middle torso	10	4
Body link angles - neck	10	2
Body link angles - shoulder	10	8
Body link angles - upper arm	10	9
Body link angles - upper leg	10	6
Body link angles - upper torso	10	3
Body link angular acceleration - head	12	1
Body link angular acceleration - lower arm	12	10
Body link angular acceleration - lower leg	12	7
Body link angular acceleration - lower torso	12	5
Body link angular acceleration - middle torso	12	4
Body link angular acceleration - neck	12	2
Body link angular acceleration - shoulder	12	8
Body link angular acceleration - upper arm	12	9
Body link angular acceleration - upper leg	12	6
Body link angular acceleration - upper torso	12	3
Body link angular velocity - head	11	1
Body link angular velocity - lower arm	11	10
Body link angular velocity - lower leg	11	7
Body link angular velocity - lower torso	11	5
Body link angular velocity - middle torso	11	4
Body link angular velocity - neck	11	2
Body link angular velocity - shoulder	11	8
Body link angular velocity - upper arm	11	9
Body link angular velocity - upper leg	11	6
Body link angular velocity - upper torso	11	3
Center of mass resultant moment - head	32	1
Center of mass resultant moment - head applied force component	32	9
Center of mass resultant moment - lower arm	32	8
Center of mass resultant moment - lower leg	32	6
Center of mass resultant moment - lower torso	32	4
Center of mass resultant moment - middle torso	32	3
Center of mass resultant moment - upper arm	32	7
Center of mass resultant moment - upper leg	32	5
Center of mass resultant moment - upper torso	32	2
Center of mass x force component - head	30	1
Center of mass x force component - head applied force component	30	9
Center of mass x force component - lower arm	30	8
Center of mass x force component - lower leg	30	6

TABLE 114. OUTPUT TEST VARIABLES AND THEIR SPECIFICATIONS (Page 3 of 10)

QUANTITY DESCRIPTION	CATG. NO	COL. NO.
Center of mass x force component - lower torso	30	4
Center of mass x force component - middle torso	30	3
Center of mass x force component - upper arm	30	7
Center of mass x force component - upper leg	30	5
Center of mass x force component - upper torso	30	2
Center of mass z force component - head	31	1
Center of mass z force component - head applied force component	31	9
Center of mass z force component - lower arm	31	8
Center of mass z force component - lower leg	31	6
Center of mass z force component - lower torso	31	4
Center of mass z force component - middle torso	31	3
Center of mass z force component - upper arm	31	7
Center of mass z force component - upper leg	31	5
Center of mass z force component - upper torso	31	2
Contact belt vs attachment - absorbed energy	4	31
Contact belt vs attachment - deflection rate	4	25
Contact belt vs attachment - deflection	4	24
Contact belt vs attachment - unadjusted tension	4	26
Contact belt vs attachment - resultant force	4	28
Contact belt vs attachment - resultant heading angle	4	30
Contact belt vs attachment - ring equil. tension	4	26
Contact belt vs attachment - tension adjustment	4	28
Contact ellipse vs ellipse - body segment x for ellipse A	4	20
Contact ellipse vs ellipse - body segment z for ellipse A	4	21
Contact ellipse vs ellipse - body segment x for ellipse B	4	22
Contact ellipse vs ellipse - body segment z for ellipse B	4	23
Contact ellipse vs ellipse - center point x for ellipse A	4	16
Contact ellipse vs ellipse - center point z for ellipse A	4	17
Contact ellipse vs ellipse - center point x for ellipse B	4	18
Contact ellipse vs ellipse - center point z for ellipse B	4	19
Contact ellipse vs ellipse - deflection rate	4	14
Contact ellipse vs ellipse - deflection	4	13
Contact ellipse vs ellipse - normal force	4	15
Contact ellipse vs line - contact point x on body segment	4	11
Contact ellipse vs line - contact point z on body segment	4	12
Contact ellipse vs line - contact point position on line	4	7
Contact ellipse vs line - contact point velocity on line	4	8

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TABLE 114. OUTPUT TEST VARIABLES AND THEIR SPECIFICATIONS (Page 4 of 10)

QUANTITY DESCRIPTION	CATG. NO.	COL. NO.
Contact ellipse vs line - contact point x in inertial space	4	9
Contact ellipse vs line - contact point z in inertial space	4	10
Contact ellipse vs line - line deflection (ellipse)	4	1(2)
Contact ellipse vs line - line defl. rate (ellipse)	4	3(4)
Contact ellipse vs line - normal force	4	5
Contact ellipse vs line - tangential force	4	6
Femur and tibia loads - femur axial at knee	40	2
Femur and tibia loads - femur axial at sensor	40	1
Femur and tibia loads - femur shear at knee	40	3
Femur and tibia loads - tibia axial at foot	40	5
Femur and tibia loads - tibia axial at knee	40	4
Filtered accelerations - chest A-P	7	4
Filtered accelerations - chest resultant	7	6
Filtered accelerations - chest S-I	7	5
Filtered accelerations - head A-P	7	1
Filtered accelerations - head resultant	7	3
Filtered accelerations - head S-I	7	2
Filtered accelerations - hip resultant	7	9
Filtered accelerations - hip x	7	7
Filtered accelerations - hip z	7	8
Filtered severity index - chest SI A-P	9	7
Filtered severity index - chest SI resultant	9	9
Filtered severity index - chest SI S-I	9	8
Filtered severity index - chest mod SI A-P	9	10
Filtered severity index - chest mod SI resultant	9	12
Filtered severity index - chest mod SI S-I	9	11
Filtered severity index - head SI A-P	9	1
Filtered severity index - head SI resultant	9	3
Filtered severity index - head SI S-I	9	2
Filtered severity index - head mod SI A-P	9	4
Filtered severity index - head mod SI resultant	9	6
Filtered severity index - head mod SI S-I	9	5
Friction component joint torque - elbow	25	8
Friction component joint torque - hip	25	5
Friction component joint torque - knee	25	6
Friction component joint torque - lower neck	25	2
Friction component joint torque - lower spine	25	4
Friction component joint torque - shoulder at arm	25	7
Friction component joint torque - upper neck	25	1
Friction component joint torque - upper spine	25	3
Joint absorbed energy - elbow	16	11
Joint absorbed energy - hip	16	6
Joint absorbed energy - knee	16	7
Joint absorbed energy - lower neck	16	2
Joint absorbed energy - lower spine	16	5
Joint absorbed energy - neck length	16	3
Joint absorbed energy - shoulder at arm	16	9

TABLE 114. OUTPUT TEST VARIABLES AND THEIR SPECIFICATIONS (Page 5 of 10)

QUANTITY DESCRIPTION	CATG. NO.	COL. NO.
Joint absorbed energy - shoulder at torso	16	8
Joint absorbed energy - shoulder length	16	10
Joint absorbed energy - upper neck	16	1
Joint absorbed energy - upper spine	16	4
Joint friction absorbed energy - elbow	28	8
Joint friction absorbed energy - hip	28	5
Joint friction absorbed energy - knee	28	6
Joint friction absorbed energy - lower neck	28	2
Joint friction absorbed energy - lower spine	28	4
Joint friction absorbed energy - shoulder at arm	28	7
Joint friction absorbed energy - upper neck	28	1
Joint friction absorbed energy - upper spine	28	3
Joint muscle tension absorbed energy - elbow	39	8
Joint muscle tension absorbed energy - hip	39	6
Joint muscle tension absorbed energy - knee	39	7
Joint muscle tension absorbed energy - lower neck	39	2
Joint muscle tension absorbed energy - lower spine	39	5
Joint muscle tension absorbed energy - neck length	39	3
Joint muscle tension absorbed energy - shoulder at arm	39	11
Joint muscle tension absorbed energy - shoulder at torso	39	9
Joint muscle tension absorbed energy - shoulder length	39	10
Joint muscle tension absorbed energy - upper neck	39	1
Joint muscle tension absorbed energy - upper spine	39	4
Joint stop absorbed energy - elbow	27	9
Joint stop absorbed energy - hip	27	5
Joint stop absorbed energy - knee	27	6
Joint stop absorbed energy - lower neck	27	2
Joint stop absorbed energy - lower spine	27	4
Joint stop absorbed energy - shoulder at arm	27	7
Joint stop absorbed energy - shoulder length	27	8
Joint stop absorbed energy - upper neck	27	1
Joint stop absorbed energy - upper spine	27	3
Joint torques - elbow	15	9
Joint torques - hip	15	5
Joint torques - knee	15	6
Joint torques - lower neck	15	2
Joint torques - lower spine	15	4
Joint torques - shoulder at arm	15	8
Joint torques - shoulder at torso	15	7
Joint torques - upper neck	15	1
Joint torques - upper spine	15	3
Joint viscous absorbed energy - elbow	29	10
Joint viscous absorbed energy - hip	29	6
Joint viscous absorbed energy - knee	29	7
Joint viscous absorbed energy - lower neck	29	2
Joint viscous absorbed energy - lower spine	29	5
Joint viscous absorbed energy - neck length	29	3
Joint viscous absorbed energy - shoulder at arm	29	8
Joint viscous absorbed energy - shoulder length	29	9
Joint viscous absorbed energy - upper neck	29	1

TABLE 114. OUTPUT TEST VARIABLES AND THEIR SPECIFICATIONS (Page 6 of 10)

QUANTITY DESCRIPTION	CATG NO.	COL. NO.
Joint viscous absorbed energy - upper spine	29	4
Kinetic energy - arms	17	5
Kinetic energy - head	17	2
Kinetic energy - head superior-inferior	17	4
Kinetic energy - torso	17	3
Kinetic energy - total body	17	1
Line movement of Point A x	3	1
Line movement of Point A z	3	2
Line movement of Point 1 x	3	3
Line movement of Point 1 z	3	4
Line movement of Point 2 x	3	5
Line movement of Point 2 z	3	6
Line movement of Point 3 x	3	7
Line movement of Point 3 z	3	8
Line movement of Point 4 x	3	9
Line movement of Point 4 z	3	10
Line movement of Point 5 x	3	11
Line movement of Point 5 z	3	12
Linear component of joint torque - elbow	23	8
Linear component of joint torque - hip	23	5
Linear component of joint torque - knee	23	6
Linear component of joint torque - lower neck	23	2
Linear component of joint torque - lower spine	23	4
Linear component of joint torque - shoulder at arm	23	7
Linear component of joint torque - upper neck	23	1
Linear component of joint torque - upper spine	23	3
Muscle tension forces - neck	38	10
Muscle tension forces - shoulder length	38	11
Muscle tension torque - elbow	38	9
Muscle tension torque - hip	38	5
Muscle tension torque - knee	38	6
Muscle tension torque - lower neck	38	2
Muscle tension torque - lower spine	38	4
Muscle tension torque - shoulder at arm	38	8
Muscle tension torque - shoulder at torso	38	7
Muscle tension torque - upper neck	38	1
Muscle tension torque - upper spine	38	3
Neck and shoulder forces - neck linear	37	1
Neck and shoulder forces - neck muscle	37	4
Neck and shoulder forces - neck non-linear	37	2
Neck and shoulder forces - neck total	37	5
Neck and shoulder forces - neck viscous	37	3
Neck and shoulder forces - shoulder linear	37	6
Neck and shoulder forces - shoulder muscle	37	9
Neck and shoulder forces - shoulder non-linear	37	7
Neck and shoulder forces - shoulder total	37	10
Neck and shoulder forces - shoulder viscous	37	8
Neck joint coordinates - lower neck x	21	5
Neck joint coordinates - lower neck z	21	6

TABLE 114. OUTPUT TEST VARIABLES AND THEIR SPECIFICATIONS (Page 7 of 10)

QUANTITY DESCRIPTION	CATG. NO.	COL. NO.
Neck joint coordinates - lower neck x velocity	21	7
Neck joint coordinates - lower neck z velocity	21	8
Neck joint coordinates - neck length	21	9
Neck joint coordinates - neck length rate	21	10
Neck joint coordinates - upper neck x	21	1
Neck joint coordinates - upper neck z	21	2
Neck joint coordinates - upper neck x velocity	21	3
Neck joint coordinates - upper neck z velocity	21	4
Nonlinear component of joint torque - elbow	24	8
Nonlinear component of joint torque - hip	24	5
Nonlinear component of joint torque - knee	24	6
Nonlinear component of joint torque - lower neck	24	2
Nonlinear component of joint torque - lower spine	24	4
Nonlinear component of joint torque - shoulder at arm	24	7
Nonlinear component of joint torque - upper neck	24	1
Nonlinear component of joint torque - upper spine	24	3
Quantity for region - average migration XR	2	3
Quantity for region - average migration ZR	2	4
Quantity for region - end point movement A-X	2	5
Quantity for region - end point movement A-Z	2	6
Quantity for region - end point movement B-X	2	7
Quantity for region - end point movement B-Z	2	8
Quantity for region - force component XR	2	1
Quantity for region - force component ZR	2	2
Quantity for region - number ellipse contacting	2	9
Shoulder joint coordinates - shoulder at arm x	22	5
Shoulder joint coordinates - shoulder at arm z	22	6
Shoulder joint coordinates - shoulder at arm x velocity	22	7
Shoulder joint coordinates - shoulder at arm z velocity	22	8
Shoulder joint coordinates - shoulder at torso x	22	1
Shoulder joint coordinates - shoulder at torso z	22	2
Shoulder joint coordinates - shoulder at torso x velocity	22	3
Shoulder joint coordinates - shoulder at torso z velocity	22	4
Shoulder joint coordinates - shoulder length	22	9
Shoulder joint coordinates - shoulder length rate	22	10
Steering column coordinates - gear box x	33	11
Steering column coordinates - gear box z	33	12
Steering column coordinates - wheel attachment point x	33	9
Steering column coordinates - wheel attachment point x	33	10
Steering column coordinates - wheel hub x	33	7
Steering column coordinates - wheel hub z	33	8
Steering column coordinates - wheel lower edge x	33	1
Steering column coordinates - wheel lower edge z	33	2

TABLE 114. OUTPUT TEST VARIABLES AND THEIR SPECIFICATIONS (Page 8 of 10)

QUANTITY DESCRIPTION	CATG. NO.	COL. NO.
Steering column coordinates - wheel middle edge x	33	3
Steering column coordinates - wheel middle edge z	33	4
Steering column coordinates - wheel upper edge x	33	5
Steering column coordinates - wheel upper edge z	33	6
Steering column force components - head moment	36	3
Steering column force components - head x	36	1
Steering column force components - head z	36	2
Steering column force components - lower torso moment	36	12
Steering column force components - lower torso x	36	10
Steering column force components - lower torso z	36	11
Steering column force components - middle torso moment	36	9
Steering column force components - middle torso x	36	7
Steering column force components - middle torso z	36	8
Steering column force components - upper torso moment	36	6
Steering column force components - upper torso x	36	4
Steering column force components - upper torso z	36	5
Steering column forces - lower column extensional normal force	35	10
Steering column forces - lower hinge moment	35	12
Steering column forces - upper column extensional normal force	35	9
Steering column forces - upper hinge moment	35	11
Steering column forces - wheel hub normal force	35	7
Steering column forces - wheel hub tangential force	35	8
Steering column forces - wheel lower edge normal force	35	1
Steering column forces - wheel lower edge tangential force	35	2
Steering column forces - wheel middle edge normal force	35	3
Steering column forces - wheel middle edge tangential force	35	4
Steering column forces - wheel upper edge normal force	35	5
Steering column forces - wheel upper edge tangential force	35	6
Steering column kinematics - lower column extensional displacement	34	3
Steering column kinematics - lower column extensional velocity	34	4
Steering column kinematics - lower hinge angular displacement	34	7
Steering column kinematics - lower hinge angular velocity	34	8
Steering column kinematics - upper column extensional displacement	34	1
Steering column kinematics - upper column extensional velocity	34	2

TABLE 114. OUTPUT TEST VARIABLES AND THEIR SPECIFICATIONS (Page 9 of 10)

QUANTITY DESCRIPTION	CATG. NO.	COL. NO.
Steering column kinematics - upper hinge angular displacement	34	5
Steering column kinematics - upper hinge angular velocity	34	6
Unfiltered accelerations - chest A-P	6	4
Unfiltered accelerations - chest resultant	6	6
Unfiltered accelerations - chest S-I	6	5
Unfiltered accelerations - head A-P	6	1
Unfiltered accelerations - head resultant	6	3
Unfiltered accelerations - head S-I	6	2
Unfiltered accelerations - hip resultant	6	9
Unfiltered accelerations - hip x	6	7
Unfiltered accelerations - hip z	6	8
Unfiltered severity index - chest SI A-P	8	7
Unfiltered severity index - chest SI resultant	8	9
Unfiltered severity index - chest SI S-I	8	8
Unfiltered severity index - chest modified SI A-P	8	10
Unfiltered severity index - chest modified SI resultant	8	12
Unfiltered severity index - chest modified SI S-I	8	11
Unfiltered severity index - head SI A-P	8	1
Unfiltered severity index - head SI resultant	8	3
Unfiltered severity index - head SI S-I	8	2
Unfiltered severity index - head modified SI A-P	8	4
Unfiltered severity index - head modified SI resultant	8	6
Unfiltered severity index - head modified SI S-I	8	5
Vehicle response - horizontal acceleration	1	4
Vehicle response - horizontal displacement	1	2
Vehicle response - horizontal time	1	1
Vehicle response - horizontal velocity	1	3
Vehicle response - pitch acceleration	1	10
Vehicle response - pitch angle	1	8
Vehicle response - pitch velocity	1	9
Vehicle response - vertical acceleration	1	7
Vehicle response - vertical displacement	1	5
Vehicle response - vertical velocity	1	6
Viscosity component joint torque - elbow	26	8
Viscosity component joint torque - hip	26	5
Viscosity component joint torque - knee	26	6
Viscosity component joint torque - lower neck	26	2
Viscosity component joint torque - lower spine	26	4
Viscosity component joint torque - shoulder at arm	26	7
Viscosity component joint torque - upper neck	26	1
Viscosity component joint torque - upper spine	26	3

TABLE 114. OUTPUT TEST VARIABLES AND THEIR SPECIFICATIONS (Page 10 of 10)

QUANTITY DESCRIPTION	CATG. NO.	COL. NO.
Chest C.G. motion - x-position	47	1
Chest C.G. motion - x-velocity	47	2
Chest C.G. motion - x-acceleration	47	3
Chest C.G. motion - z-position	47	4
Chest C.G. motion - z-velocity	47	5
Chest C.G. motion - z-acceleration	47	6
Head C.G. motion - x-position	46	1
Head C.G. motion - x-velocity	46	2
Head C.G. motion - x-acceleration	46	3
Head C.G. motion - z-position	46	4
Head C.G. motion - z-velocity	46	5
Head C.G. motion - z-acceleration	46	6
Head C.G. motion - head angle	46	7
Head C.G. motion - angular velocity	46	8
Head C.G. motion - angular acceleration	46	9
Hip motion - x-position	48	1
Hip motion - x-velocity	48	2
Hip motion - x-acceleration	48	3
Hip motion - z-position	48	4
Hip motion - z-velocity	48	5
Hip motion - z-acceleration	48	6
Joint relative angles - upper neck	49	1
Joint relative angles - lower neck	49	2
Joint relative angles - upper spine	49	3
Joint relative angles - lower spine	49	4
Joint relative angles - hip	49	5
Joint relative angles - knee	49	6
Joint relative angles - shoulder at arm	49	7
Joint relative angles - elbow	49	8
Joint relative angle velocities - upper neck	50	1
Joint relative angle velocities - lower neck	50	2
Joint relative angle velocities - upper spine	50	3
Joint relative angle velocities - lower spine	50	4
Joint relative angle velocities - hip	50	5
Joint relative angle velocities - knee	50	6
Joint relative angle velocities - shoulder at arm	50	7
Joint relative angle velocities - elbow	50	8
Neck reaction forces - upper neck shear on neck	5	1
Neck reaction forces - upper neck compressive on neck	5	2
Neck reaction forces - upper neck shear on head	5	3
Neck reaction forces - upper neck compressive on head	5	4
Neck reaction forces - lower neck shear on neck	5	5
Neck reaction forces - lower neck compressive on neck	5	6
Neck reaction forces - lower neck shear on torso	5	7
Neck reaction forces - lower neck compressive on torso	5	8
Neck reaction forces - moment at upper neck	5	9
Neck reaction forces - moment at lower neck	5	10

TABLE 115. BELT IDENTIFIER NAMES

Belt Name	Report Belt Number	Internal Belt Number
A. Advanced Belts		
OUTBOARDbLAPbBLT	3	15
INBOARDbLAPbBELT	4	9
UPPERbTORSObBELT	1	11
LOWERbTORSObBELT	2	13
LOWERbRINGbSTRAP	5	17
UPPERbRINGbSTRAP	6	19
TORSObBELTbEXT.	7	21
B. Old Belts		
bbbbLAPbBELTbbbb	1	9
UPPERbTORSObBELT	2	11
LOWERbTORSObBELT	3	13

NOTE: Each small letter "b" signifies a blank column. The name must be specified exactly as shown to be recognized.

4.6.2.3 Digital Filtering.* The digital filter applied is a Martin-Graham filter as described in References [26] and [27] (see Figure 141). The ratio of output/input drops off in the manner of a cosine curve starting with the cut-off frequency. The roll-off frequency defines the band width starting with the cut-off frequency within which the output/input ratio is reduced to zero and ends with the termination frequency. A set of data points, g_n , is provided to the filter subroutine starting at time = t_0 and terminating at time = t_f . The filtered value of any one of these points depends on the values preceding and following it. The number of points used in computing the smoothed (filtered) value is $2 * NPP + 1$.

The filter weights are evaluated from the general equation

$$h(t) = \frac{\pi}{2t} \left[\frac{\sin \omega_t t + \sin \omega_c t}{\pi^2 - (\omega_t - \omega_c)^2 t^2} \right]$$

at distinct points $t_n = n\Delta t$ such that $h_n = \Delta t h(t_n)$, where Δt is the sampling interval of the data. The resulting weights are normalized from the constraint

$$h_0 + 2 \sum_{n=1}^{NPP} h_n = 1 .$$

The filtered data is computed simply by

$$a_n = h_0 g_n + \sum_{m=1}^{NPP} h_m (g_{n-m} + g_{n+m})$$

where a_n is the filtered value and g_n are the unfiltered values which have been extended by mirror images or polar images by NPP points at both ends. Figure 142 illustrates both mirror images and polar images.

*Digital filtering is not considered to be necessary for simulation results since normal integration time steps (.25 or .5 ms) effectively "remove" all high frequency content of the response.

Characteristics of a Martin-Graham Digital Filter

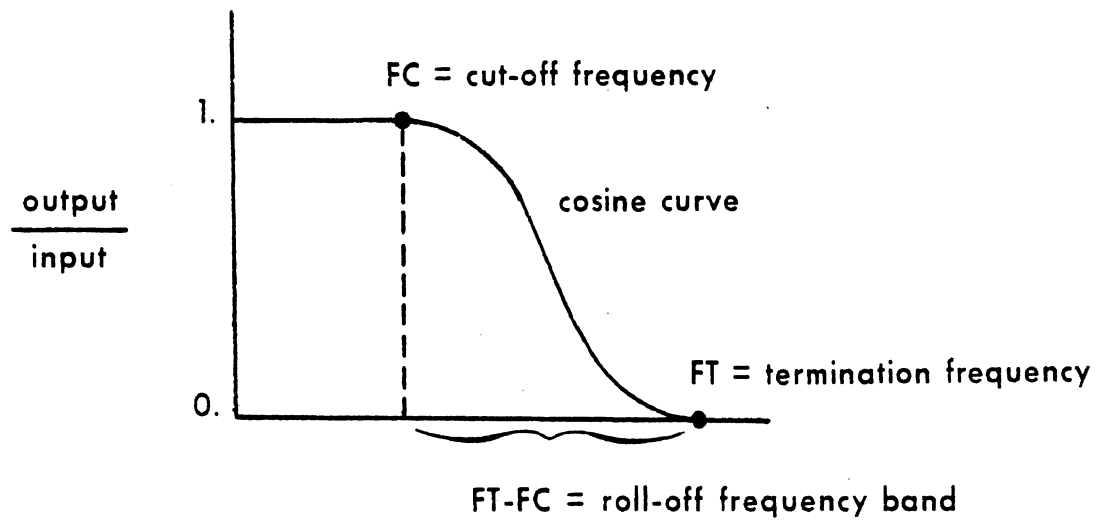


Figure 141. Characteristics of a Martin-Graham Digital Filter

OUT

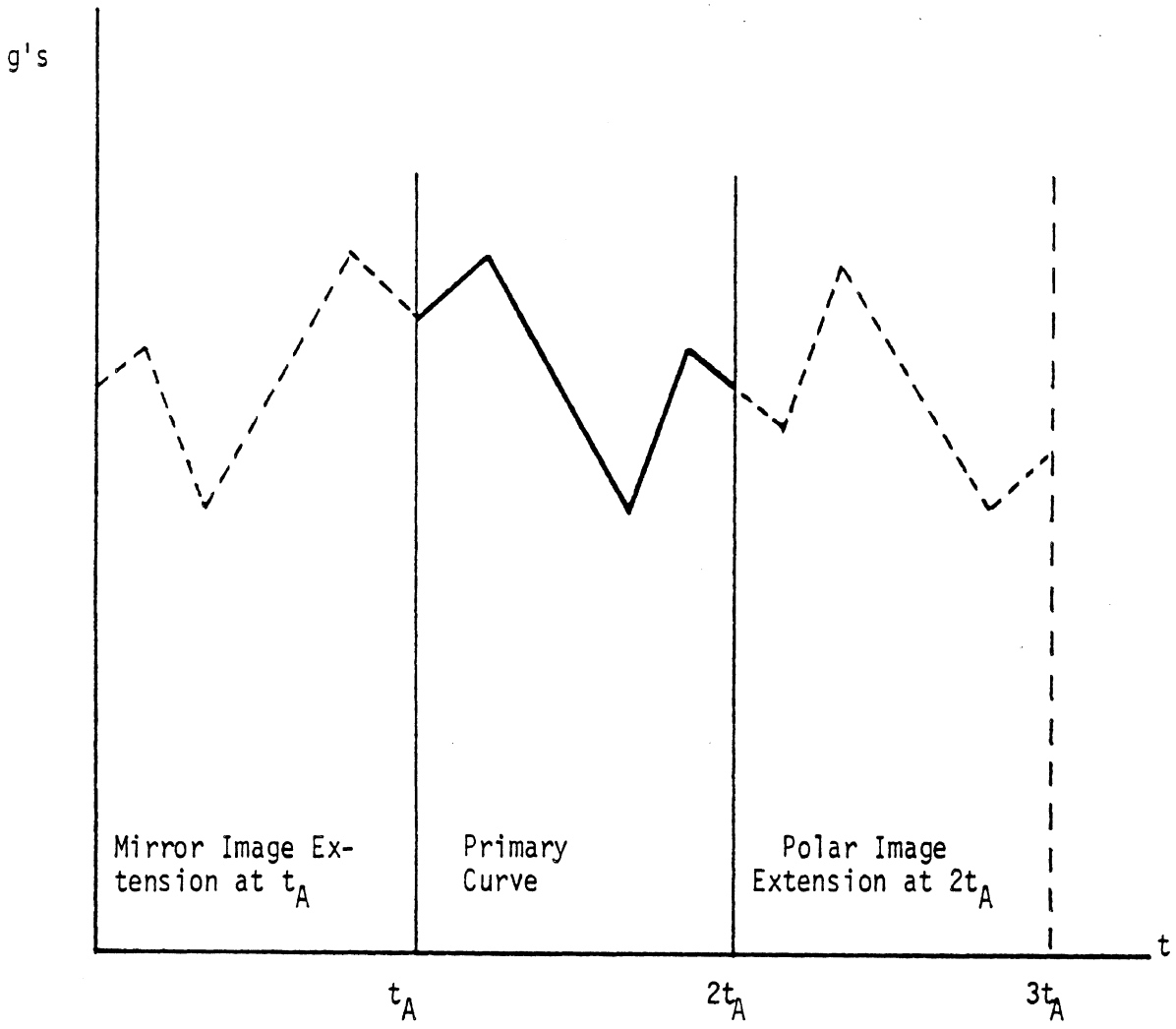


Figure 142. Mirror and Polar Images

4.6.2.4 Special Indices. Computation and printout of head and chest injury severity indices have been added to the program for the convenience of users who regularly use these indices. To permit comparison with similar experimentally obtained indices, these values are separately computed for the horizontal and vertical components of the head and chest accelerations and for the biaxial resultant of the two. The indices are computed both before and after numerical filtering of the accelerations.

The foregoing severity index values are based upon a weighted impulse concept originated by C.W. Gadd, General Motors Research, as follows:

$$SI = \int a^{2.5} dt$$

where a is the acceleration expressed in g's and t is time expressed in seconds.

In addition, the HIC index is computed and also three millisecond averages around the peak head and chest resultant accelerations. A facsimile of printout for the three millisecond averages is shown in Table 117.

The HIC (Head Injury Criterion) is defined as

$$\max_{t_1, t_2} \left[\frac{\int_{t_1}^{t_2} a dt}{t_2 - t_1} \right]^{2.5} (t_2 - t_1)$$

The quantity in brackets is the average acceleration. MVMA 2-D calculates both the standard HIC (unbounded $t_2 - t_1$) and the 36 ms HIC ($t_2 - t_1 \leq 36$ ms).

TABLE 117. FACSIMILE OF THE THREE MILLISECOND AVERAGE OUTPUT	
FOR FIL HED, 3 MSEC AVG=	266.19 AT TIME= 154.00
PEAK =	401.38 AT TIME= 155.00
FOR FIL CST, 3 MSEC AVG=	141.47 AT TIME= 148.00
PEAK =	158.96 AT TIME= 149.00

Finally, response measures are calculated for comparison with two exposure limits set by MVSS 201 (S3.2) and MVSS 208 (S6.3). The first of these is a limit on head response and the second is for chest response.

MVSS 201 requires that the resultant acceleration of the head center of gravity not exceed 80 g's continuously for three milliseconds. MVSS 208 requires that the resultant acceleration of the center of gravity of the upper thorax not exceed 60 g's, except for intervals whose cumulative duration is not more than three milliseconds.

Table 117-1 shows example printout for responses which exceed the MVSS limits (and also HIC, Severity Index, and Three-Millisecond Average data). For three-millisecond exceptions to the 80 g head criterion, the model prints out the beginning and end time for each exception together with the associated peak value and the time of the peak and also the head delta-v for acceleration exceeding 80 g's. For an exception to the 60 g chest criterion, similar data are printed. They include time at which chest acceleration first exceeds 60 g's, the time after which it remains below 60 g's, the total time duration for which 60 g's is exceeded, the peak and time of peak, and the total chest delta-v for acceleration exceeding 60 g's.

SEVERITY INDICES FOR UNFILTERED ACCELERATIONS (AT ACCELEROMETERS)

HIC= 2738.10, BEG. TIME= 80.00, END TIME= 105.00

HEAD 3-MSEC AVER= 220.218 AT TIME= 103.00
PEAK= 249.944 AT TIME= 103.00

CHEST 3-MSEC AVER= 83.461 AT TIME= 85.00
PEAK= 85.144 AT TIME= 85.00

60G CHEST / ACCUM. 3-MSEC EXCEPTION: BEG TIME= 81.29, END TIME= 100.15, TOTAL DURATION= 8.27
PEAK= 85.14 AT TIME= 85.00, DELTA V OVER 60 G'S= 1.14(M/SEC)

80G HEAD / 3-MSEC EXCEPTION: BEG TIME= 86.44, END TIME= 98.47, PEAK= 131.35 AT TIME= 97.00, DELTA V OVER 80 G'S= 1.71(M/SEC)

80G HEAD / 3-MSEC EXCEPTION: BEG TIME= 100.12, END TIME= 104.88, PEAK= 249.94 AT TIME= 103.00, DELTA V OVER 80 G'S= 4.42(M/SEC)

TIME	HEAD SEVERITY INDEX			GMR MODIFIED S.I.			CHEST SEVERITY INDEX			GMR MODIFIED S.I.		
	A-P	S-I	RESULTANT	A-P	S-I	RESULTANT	A-P	S-I	RESULTANT	A-P	S-I	RESULTANT
160.00	3607.40	517.79	4370.41	2062.69	242.37	2586.17	464.62	232.21	781.09	331.04	63.41	546.73
162.00	3610.93	517.89	4374.20	2062.90	242.37	2586.42	464.62	232.28	781.16	331.05	63.41	546.73
164.00	3612.68	517.94	4376.06	2062.94	242.37	2586.46	464.84	232.34	781.49	331.05	63.41	546.73
166.00	3612.95	517.96	4376.37	2062.94	242.37	2586.16	465.76	232.39	782.53	331.06	63.41	546.75
168.00	3613.01	517.98	4376.45	2062.94	242.37	2586.46	466.25	232.47	783.16	331.06	63.41	546.75
170.00	3613.29	517.99	4376.77	2062.94	242.38	2586.46	466.47	232.53	783.48	331.06	63.42	546.75
172.00	3613.40	517.99	4376.89	2062.94	242.38	2586.46	466.68	232.56	783.75	331.06	63.42	546.75
174.00	3613.41	518.01	4376.90	2062.94	242.38	2586.46	466.91	232.58	784.03	331.07	63.42	546.75
176.00	3613.41	518.04	4376.93	2062.95	242.38	2586.47	467.06	232.59	784.19	331.07	63.42	546.75
178.00	3613.41	518.06	4376.96	2062.95	242.38	2586.47	467.16	232.59	784.29	331.07	63.42	546.75
180.00	3613.42	518.07	4376.98	2062.95	242.38	2586.47	467.23	232.59	784.37	331.07	63.43	546.75
182.00	3613.42	518.07	4376.98	2062.95	242.39	2586.47	467.26	232.59	784.40	331.07	63.43	546.75
184.00	3613.42	518.07	4376.98	2062.95	242.39	2586.47	467.27	232.59	784.40	331.07	63.44	546.76
186.00	3613.43	518.09	4377.00	2062.96	242.39	2586.47	467.27	232.59	784.40	331.07	63.45	546.76
188.00	3613.44	518.13	4377.06	2062.96	242.39	2586.47	467.27	232.59	784.41	331.07	63.46	546.76
190.00	3613.44	518.22	4377.15	2062.96	242.39	2586.47	467.27	232.60	784.41	331.08	63.46	546.76
192.00	3613.45	518.36	4377.30	2062.96	242.39	2586.47	467.27	232.60	784.43	331.08	63.46	546.76
194.00	3613.46	518.52	4377.49	2062.96	242.39	2586.47	467.27	232.61	784.44	331.08	63.46	546.76
196.00	3613.47	518.68	4377.66	2062.96	242.39	2586.47	467.27	232.62	784.44	331.08	63.46	546.77
198.00	3613.48	518.82	4377.82	2062.96	242.40	2586.47	467.28	232.62	784.46	331.09	63.46	546.77
200.00	3613.49	518.92	4377.95	2062.96	242.40	2586.47	467.29	232.63	784.47	331.09	63.46	546.77

TABLE 117-1. INJURY INDICES.

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4.6.2.5 Femur and Tibia Loads. The MVMA 2-D model determines and prints out five components of femur and tibia loads (category 40). In order that transducer response from anthropomorphic dummy tests may be simulated, the model requires input data for: a) the location along the femur of an axial force transducer, and b) the upper leg mass between the transducer and the knee.* Force components printed out are: femur axial force at transducer; femur axial force at knee; femur shear force at knee; tibia axial force at knee; tibia axial force at foot. Total leg loads are calculated, so if the user assumes that the loads are shared equally by two legs, he must divide printout values by 2 to obtain the load for each leg.

The user interested in predicting tibia loads should be aware of the note on the card layout for Card 111 in Table 7 of Volume 2: In order to insure proper calculation of tibia loads, any contact ellipse representing the knee should be attached to the upper leg rather than to the lower leg.

The analysis used was taken from the MODROS model [2] and is documented in an unpublished General Motors Technical Center correspondence [29].

Definition of Variables

AHPX = X acceleration of hip
 AHPZ = Z acceleration of hip
 ACCKNX = X acceleration of knee
 ACCKNZ = Z acceleration of knee
 ACCM6X = X acceleration of lower leg CG (+ toward right)
 ACCM6Z = Z acceleration of lower leg CG (+ downward)
 ACCM5A = Axial acceleration of Upper Leg CG (+ toward knee)
 TIBIAF = Axial Force on Tibia at Foot (+ compression)
 TIBIAK = Axial Force on Tibia at Knee (+ compression)
 FEMUKX = X Force on Upper Leg at Knee (+ toward left)
 FEMUKZ = Z Force on Upper Leg at Knee (+ downward)
 FEMUKA = Axial Force on Upper Leg at Knee (+ compression)

[continued on next page]

* This mass is used in calculating a centrifugal force component of femur tension.

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- FEMUKS = Shear force on upper leg at knee (+ posterior)
- FEMURA = Axial force on upper leg at sensor (+ compression)
- PXI(6) = X-component summation of external forces on lower leg, not including reaction force at knee (+ toward right)
- PZI(6) = Z-component summation of external forces on lower leg, not including reaction force at knee (+ downward)

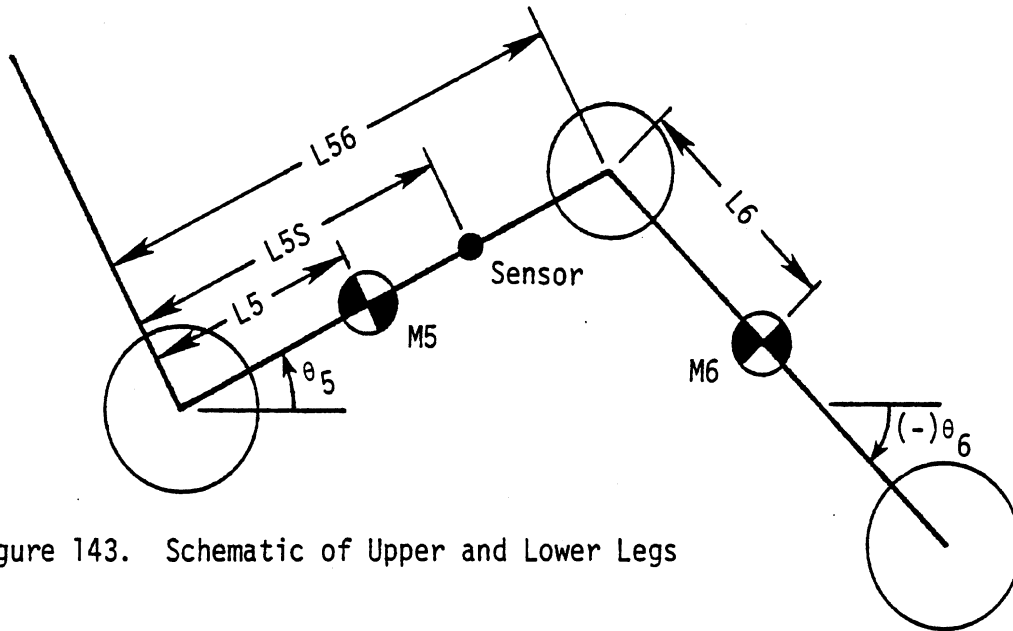
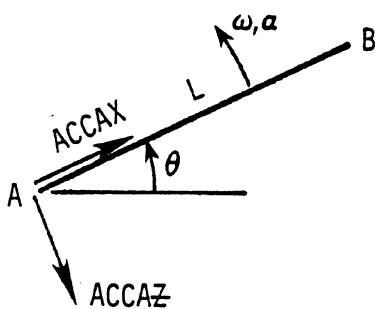


Figure 143. Schematic of Upper and Lower Legs

Accelerations of a Rotating Link



Given link AB with known endpoint acceleration components (ACCAX, ACCAZ) and L, θ , ω , α where θ , ω , and α are angular position, velocity, and acceleration of B about A: then acceleration components at endpoint B are

$$ACCBX = ACCAX - L\omega^2 \cos\theta - L\alpha \sin\theta$$

$$ACCBZ = ACCAZ + L\omega^2 \sin\theta - L\alpha \cos\theta$$

$L\omega^2$ is the centripetal acceleration and acts toward the center of rotation.

Calculation of Accelerations

$$ACCKNX = AHPX - L56 \dot{\theta}_5^2 \cos\theta_5 - L56 \ddot{\theta}_5 \sin\theta_5$$

$$ACCKNZ = AHPZ + L56 \dot{\theta}_5^2 \sin\theta_5 - L56 \ddot{\theta}_5 \cos\theta_5$$

$$ACCM6X = ACCKNX - L6 \dot{\theta}_6^2 \cos\theta_6 - L6 \ddot{\theta}_6 \sin\theta_6$$

$$ACCM6Z = ACCKNZ + L6 \dot{\theta}_6^2 \sin\theta_6 - L6 \ddot{\theta}_6 \cos\theta_6$$

The acceleration of M5 axially is

$$ACCM5A = AHPX \cos\theta_5 - AHPZ \sin\theta_5 - L5S \dot{\theta}_5^2$$

where L5S is the distance between the hip and the sensor.

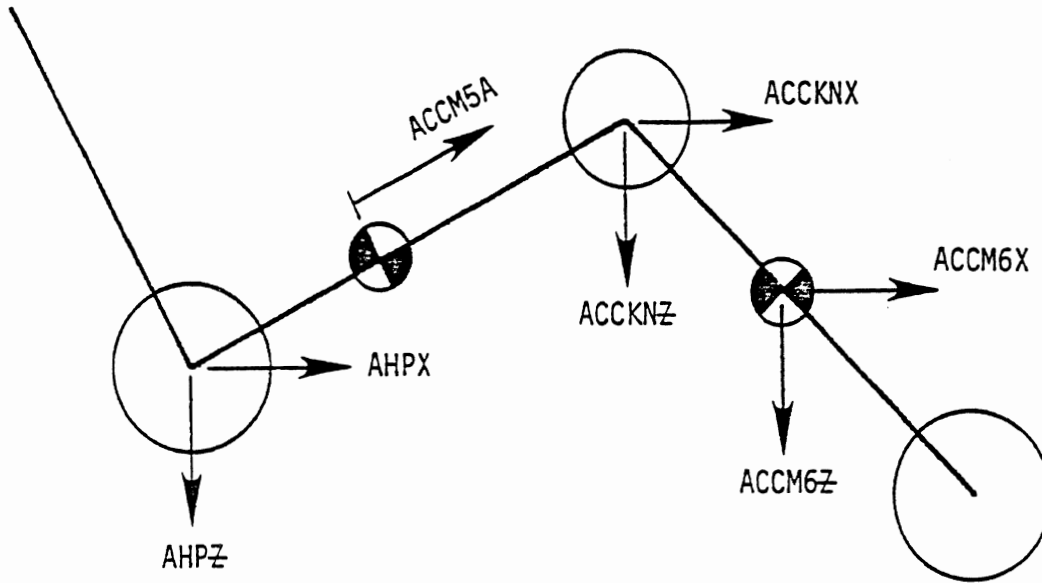


Figure 144. Leg Accelerations.

Axial Tibia Loads

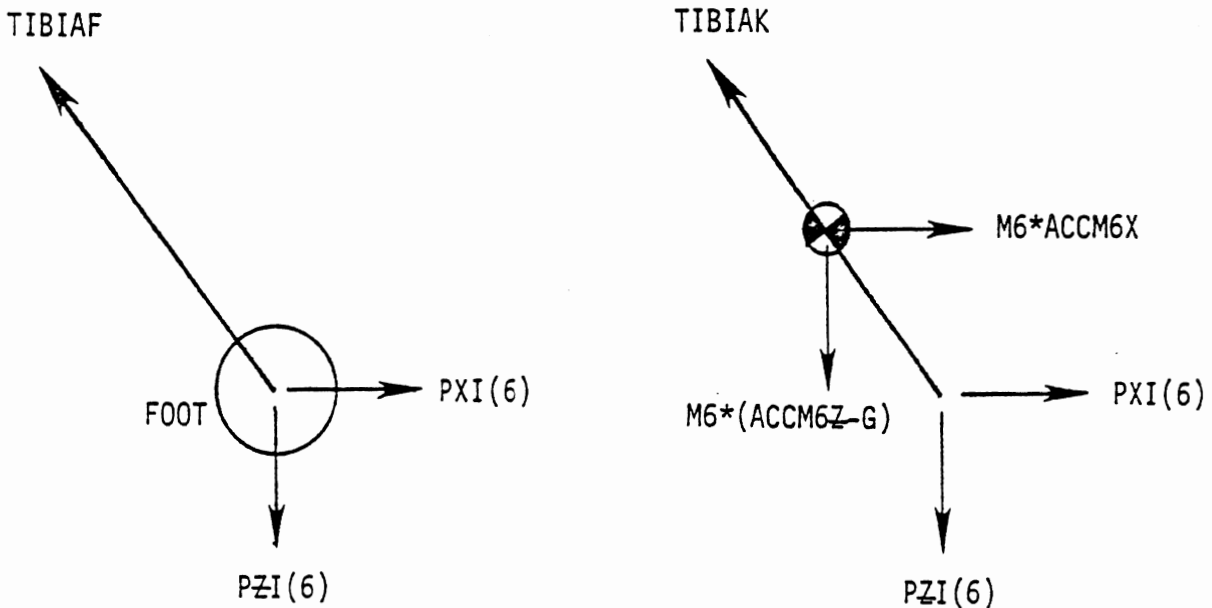


Figure 145. Free Body Diagrams of Lower Leg

Tibia axial forces at the foot and knee are

$$TIBIAF = -PXI(6) \cos\theta_6 + PZI(6) \sin\theta_6$$

$$TIBIAK = TIBIAF + M6*ACCM6X \cos\theta_6 - M6*(ACCM6Z - G) \sin\theta_6$$

It should be noted that the calculation of TIBIAF assumes that all external forces on the lower leg are against the foot. If contact ellipses attached to the lower leg other than foot ellipses develop substantial forces then printout for TIBIAF will not be accurate for axial forces at the foot.

Femur Loads at Knee

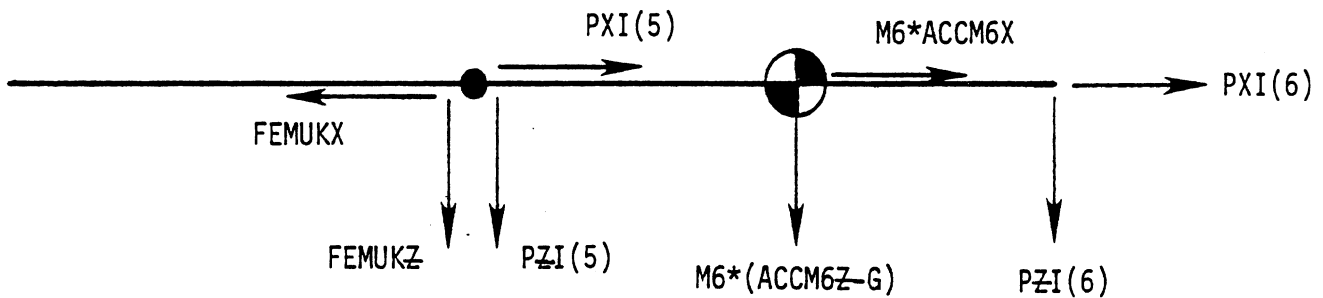
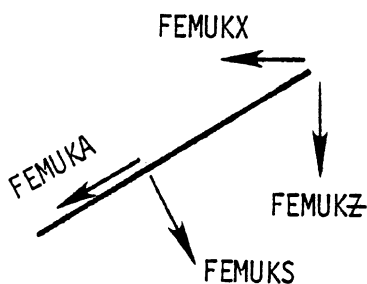


Figure 146. Free Body Diagram with Femur Loads at Knee

$$FEMUKX = - PXI(5) - PXI(6) + M6*ACCM6X \quad (+ \text{ Left})$$

$$FEMUKZ = PZI(5) + PZI(6) - M6*(-G + ACCM6Z) \quad (+ \text{ Downward})$$

Rotate X and Z forces by θ_5 to obtain Axial and Shear forces.



$$FEMUKA = FEMUKX \cos\theta_5 + FEMUKZ \sin\theta_5$$

$$FEMUKS = -FEMUKX \sin\theta_5 + FEMUKZ \cos\theta_5$$

OUT

Femur Forces at Sensor

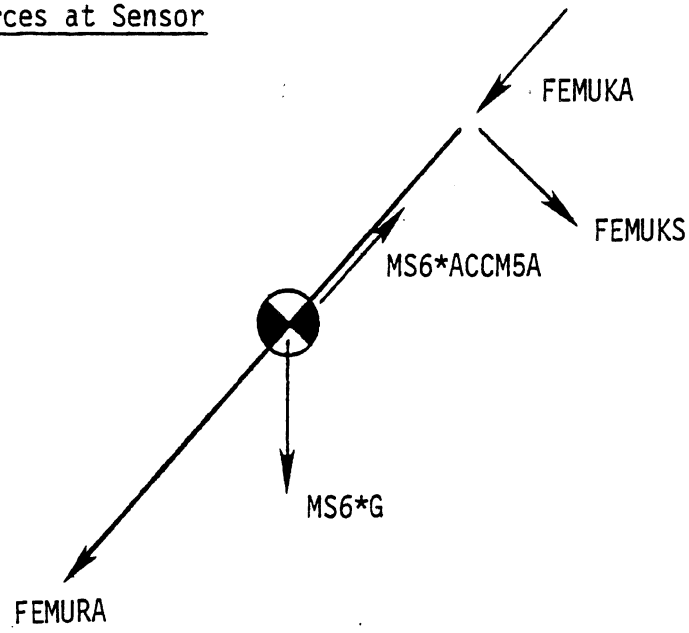


Figure 147. Free Body Diagram with Femur Load at Sensor

$$FEMURA = FEMUKA + MS6*ACCM5A + MS6*G*STH5 (+ \text{ compression})$$

MS6 is the mass between the sensor and the knee.

4.6.2.6 Ellipse Man Plot Program. The Ellipse Man Plot Program, PLOTCS, can be used to produce a time series of Calcomp plots that are similar to the printer plots obtainable from Category 45 of the standard output. An example ellipse man plot is shown in Figure 148.

The PLOTCS program plots only contact ellipses and center of gravity locations for the occupant. It does not plot straight-line segments for the body links, i.e., to connect the linkage joints. Most MVMA 2-D occupant data sets will, therefore, result in plots that have gaps between the contact ellipses. The only way to make the occupant appear more "whole" is to define extra contact ellipses in the MVMA 2-D data set for the purpose of filling the gaps. 106-Cards should not specify allowed interactions for these ellipses with the vehicle interior since their purpose is only to improve the appearance of the plots.

To obtain PLOTCS plots, specify an appropriate negative value for field 2 of Card 101 of the GO data set. For example, -20. will cause data to be saved for plots at 20 millisecond intervals. Then run the MVMA 2-D model (IN, GO, OUTP, and OUT processors). Be sure to assign logical device number 1 for running GO. GO will write plot information to that device.

Next, prepare a data set for input to the PLOTCS program and run PLOTCS as described in Table 119-A. Table 117-A describes the layout of the input data set for PLOTCS, and Table 117-B shows example data sets for English system and metric system MVMA 2-D simulations.

4.6.3. Auxiliary Program Output. Two types of auxiliary output are available from the Output Processor. The first is the optional scannings made by the HIC routine in the determination of the HIC index. A facsimile of this output is found in Table 118. The second type of output is the error messages described in Table 119.

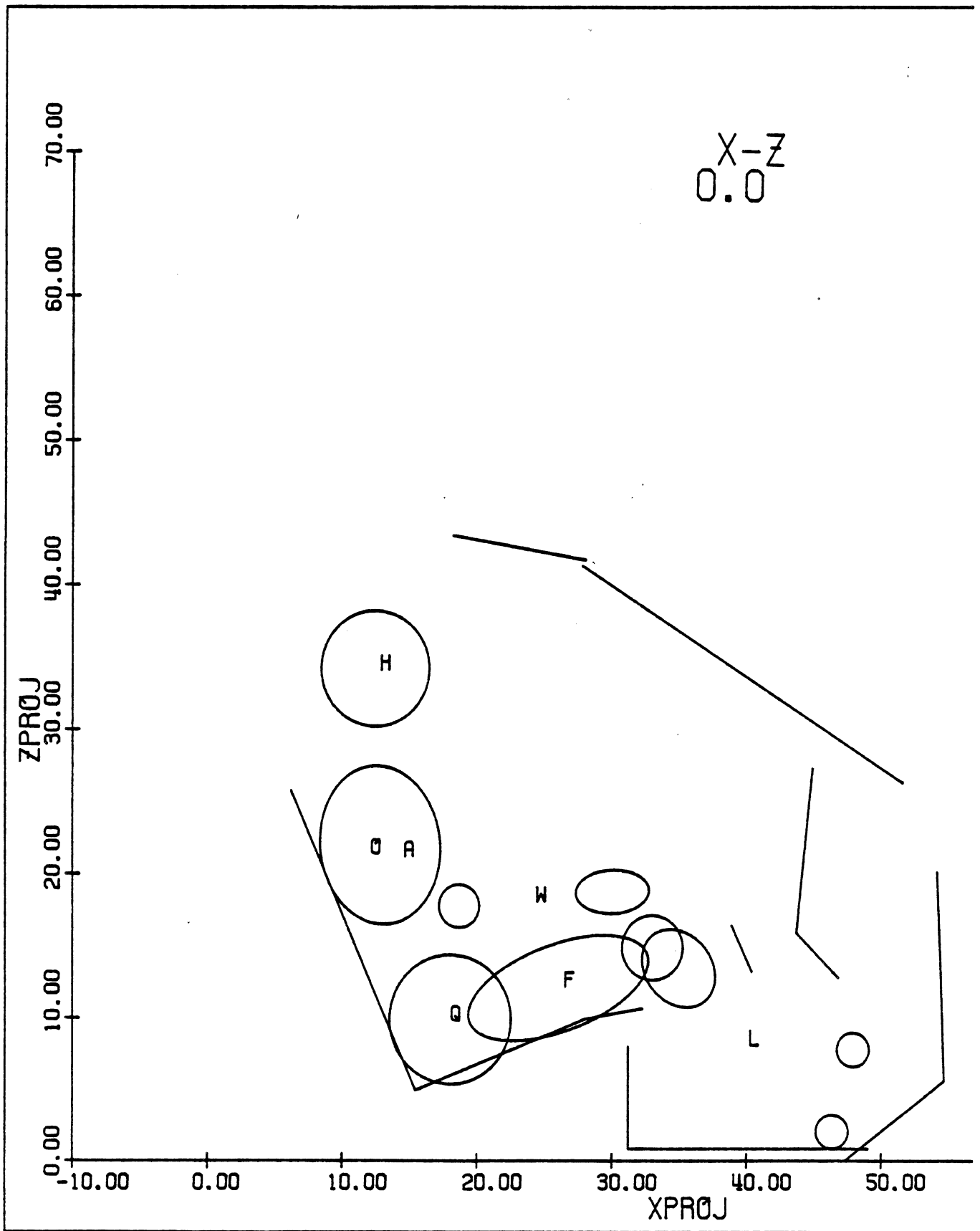


Figure 148. Example ellipse man plot from "PLOTCS" for $t = 0.0$ sec (portion of plot for $x > 60.00$ inches is not shown)

TABLE 117-A. "PLOTCS" ELLIPSE MAN PLOT PROGRAM CARD INPUT LAYOUT

Card 1 - Switches

<u>col</u>	<u>item</u>	<u>description</u>	<u>default</u>
1,2	FEETRS	feature markings if $\neq 0$	0
3,4	SUPTIT	plot title block if $\neq 0$	1
5,6	IPNL	plot panels if $\neq 0$	1
7,8	IBELT	plot belts if $\neq 0$	1
9,10	IOVER	plot all times on one plot if $\neq 0$	0
11,12	IVIEWS	number of views (set to 1 for MVMA 2-D)	3
13,14	LNORM	read in standard transformation matrix if $\neq 0$	0
15,16	LVIEW	coordinate system of views -1 is inertial, 0 is vehicle, > 0 is segment number	0

Card 2 - Times

<u>col</u>	<u>item</u>	<u>description</u>	<u>default</u>
1-8	T1	beginning plot time (sec)	0.
9-16	T2	ending plot time (sec)	.05
17-24	DELTAT	plot time increment (sec)	.01

(Note: all the rest of the cards have the same format as Card 2 except the title cards.)

Card 3 - Standard Origin (Needed only if LNORM $\neq 0$)

** ORGNRM(1-3) x,y,z of standard origin in input system (appropriate units—**inches** for English system units or **meters** for metric)

0.,0.,0.

Card 4 (Needed only if LNORM $\neq 0$)

FORWRD(1-3) direction cosines of plot system x-axis relative to basic system

1.,0.,0.

Card 5 (Needed only if LNORM $\neq 0$)

GAUCHE(1-3) direction cosines of plot system y-axis relative to basic system

0.,1.,0.

TABLE 117-A. PLOTTER PROGRAM CARD INPUT LAYOUT (continued)

Card 6 (Needed only if LNORM ≠ 0)

UP(1-3) direction cosines of plot system 0.,0.,1.
z-axis relative to basic system

(Note: these three cards supply the rows of the standard transformation matrix and should be chosen to select sensible potential viewing axes).
The following set of seven cards are needed for each view: K=1, I VIEWS

Card 7*K (K=1 for MVMA 2-D)

AMAT(1,1-3,K) first row of viewing matrix *

Card 7*K+1

AMAT(2,1-3,K) second row of viewing matrix *

Card 7*K+2

AMAT(3,1-3,K) third row of viewing matrix *

*Defaults are as follows:

$$AMAT(1) = \begin{vmatrix} 1. & 0. & 0. \\ 0. & 1. & 0. \\ 0. & 0. & 1. \end{vmatrix}, \quad AMAT(2) = \begin{vmatrix} 0. & -1. & 0. \\ 1. & 0. & 0. \\ 0. & 0. & 1. \end{vmatrix}, \quad AMAT(3) = \begin{vmatrix} 1. & 0. & 0. \\ 0. & 0. & 1. \\ 0. & -1. & 0. \end{vmatrix}$$

Card 7*K+3

XPLOTZ(K) x-coordinate of lower left corner of view plot area in
plot paper system (inches) .5

ZPLOTZ(K) z-coordinate of lower left corner of view plot area in
plot paper system (inches) .5,9.,17.5

XPLOTL(K) length of x direction of view plot area (inches) 11.

ZPLOTL(K) length of z direction of view plot area (inches) 8.5

Card 7*K+4

XPROJZ(K) x-coordinate of plot origin relative to lower left
corner of view plot area (inches) .5

ZPROJZ(K) z-coordinate of plot origin relative to lower left
corner of view plot area (inches) .5

XPROJL(K) length of x-axis (inches) 10.

ZPROJL(K) length of z-axis (inches) 7.

TABLE 117-A. PLOTTER PROGRAM CARD INPUT LAYOUT (continued)

(Note: the dimensions of the items on the above two cards are in paper inches; ie actual inches on the plot paper. Single default values apply to all three values of K.)

<u>Card 7*K+5</u>	(all values in inches or meters)	K = 1, 2, 3
XREALZ(K)	x and z values represented by the view plot origin	-10.,-50.,-10.
** ZREALZ(K)	(units to match those of the program supplying the plots.)	0.,0.,-35.
XREALM(K)	lengths represented by the x and z plot axes (ap-	100.
ZREALM(K)	propriate units)	70.
PLTSTP(K)	plot step size for representing curves (appropriate units)	.2

(Note: the scales in x and z, as determined by XREALM(K) and XPROJL(K) and by ZREALM(K) and ZPROJL(K) must be the same or the program will make them the same by using the one to scale down the other. The lengths and origin values should be chosen to cover the expected ranges of motion.)

Card 7*K+6

VWTTL(1-3,K) 12 character title of plot. X-Z, Y-Z, X-Y

(Note: this card has format 3A4. The title will appear in the upper right hand corner of the plot along with the time in milliseconds.)

Omit the title card or insert a blank card if no title is desired.

** NOTE: Although the Z-coordinate is defined as positive downward for standard MVMA 2-D printouts, including printer-plot "stick figures" (Category 45), the PLOTCS program assumes Z to be positive upward. Therefore, Z-values used for ORGNRM(3) and ZREALZ(K) on Cards 3 and 7*K+5, respectively, must be opposite in sign to values in MVMA 2-D printouts.

TABLE 117-B. EXAMPLE INPUT DATA SETS FOR "PLOTCS" ELLIPSE MAN PLOT PROGRAM.

The first data set below is typical for ellipse man plotting for an MVMA 2-D simulation run in English system units. Some values in the first data set would have to be modified for the equivalent metric system simulation. Quantities dependent on the system of units used for the simulation are underlined. English system values for those quantities must be in inches; metric system values must be in meters. The second data set below would be used for the equivalent metric system simulation.

Example PLOTCS data for English system units

```

0 1 1 1 0 1 1 0
0.      .2      .02
0.    0.    0.
1.      0.      0.
0.      -1.     0.
0.      0.      -1.
1.      0.      0.
0.      1.      0.
0.      0.      1.
.5      .5      11.      8.5
.5      .5      10.      7.
-10.  -10.  80.    56.    .2
X-Z VIEW (omit this card or insert a blank card if no title is desired)

```

Example PLOTCS data for metric system units

```

0 1 1 1 0 1 1 0
0.      .2      .02
0.    0.    0.
1.      0.      0.
0.      -1.     0.
0.      0.      -1.
1.      0.      0.
0.      1.      0.
0.      0.      1.
.5      .5      11.      8.5
.5      .5      10.      7.
-.254 -.254 2.032 1.4224 .00508
X-Z VIEW (omit this card or insert a blank card if no title is desired)

```


SCAN # PROM (SEC) TO (SEC) HIC AVR.(G) DURATION

1	0.0	0.095000	0.00	0.90	0.005000	1	6
2	0.0	0.010000	0.01	0.84	0.010000	1	11
3	0.0	0.015000	0.01	0.79	0.015000	1	16
4	0.0	0.020000	0.01	0.77	0.020000	1	21
5	0.0	0.025000	0.01	0.81	0.025000	1	26
6	0.0	0.030000	0.04	1.15	0.030000	1	31
7	0.0	0.035000	0.05	1.81	0.035000	1	36
8	0.0	0.040000	0.36	2.42	0.040000	1	41
9	0.0	0.045000	0.54	2.70	0.045000	1	46
10	0.0	0.050000	0.56	2.63	0.050000	1	51
11	0.0	0.055000	0.55	2.51	0.055000	1	56
12	0.0	0.060000	0.55	2.43	0.060000	1	61
13	0.0	0.065000	1.04	3.04	0.065000	1	66
14	0.0	0.070000	1.92	3.76	0.070000	1	71
15	0.0	0.075000	3.92	4.87	0.075000	1	76
16	0.0	0.080000	7.21	6.05	0.080000	1	81
17	0.0	0.085000	10.34	6.82	0.085000	1	86
18	0.0	0.089999	13.83	7.49	0.089999	1	91
19	0.0	0.094999	14.50	7.47	0.094999	1	96
20	0.0	0.099999	15.39	7.50	0.099999	1	101
21	0.0	0.104999	18.33	7.88	0.104999	1	106
22	0.0	0.109999	28.13	9.19	0.109999	1	111
23	0.0	0.114999	42.33	10.63	0.114999	1	116
24	0.0	0.119999	55.15	11.61	0.119999	1	121
25	0.0	0.124999	66.44	12.31	0.124999	1	126
26	0.0	0.129999	82.71	13.23	0.129999	1	131
27	0.0	0.134999	108.79	14.54	0.134999	1	136
28	0.0	0.139999	144.37	16.05	0.139999	1	141
29	0.0	0.144999	171.60	16.95	0.144999	1	146
30	0.0	0.149999	339.09	21.96	0.149999	1	151
31	0.0	0.154999	603.93	27.31	0.154999	1	156
32	0.0	0.159999	834.81	30.69	0.159999	1	161
33	0.0	0.164999	1119.85	34.09	0.164999	1	166
34	0.0	0.169998	1316.79	35.94	0.169998	1	171
35	0.0	0.174998	1512.58	37.56	0.174998	1	176
36	0.0	0.179998	1748.03	39.35	0.179998	1	181
37	0.0	0.184998	2017.29	41.21	0.184998	1	186
38	0.0	0.189998	2080.82	41.29	0.189998	1	191
39	0.0	0.194998	2142.95	41.34	0.194998	1	196
40	0.0	0.199998	2111.92	40.69	0.199998	1	201
41	0.005000	0.010000	0.00	0.78	0.005000	6	11
42	0.005000	0.015000	0.00	0.73	0.010000	6	16
43	0.005000	0.020000	0.01	0.72	0.015000	6	21
44	0.005000	0.025000	0.01	0.79	0.020000	6	26
45	0.005000	0.030000	0.04	1.20	0.025000	6	31
46	0.005000	0.035000	0.16	1.96	0.030000	6	36
47	0.005000	0.040000	0.40	2.64	0.035000	6	41
48	0.005000	0.045000	0.59	2.93	0.040000	6	46
49	0.005000	0.050000	0.60	2.82	0.045000	6	51
50	0.005000	0.055000	0.58	2.67	0.050000	6	56
51	0.005000	0.060000	0.58	2.57	0.055000	6	61
52	0.005000	0.065000	1.11	3.21	0.060000	6	66
53	0.005000	0.070000	2.05	3.98	0.065000	6	71
54	0.005000	0.075000	4.21	5.15	0.070000	6	76
55	0.005000	0.080000	7.76	6.40	0.075000	6	81
56	0.005000	0.085000	11.11	7.19	0.080000	6	86
57	0.005000	0.090000	14.82	7.87	0.085000	6	91

TABLE 118. FACSIMILE OF HIC SCANNING OUTPUT

Number	Message	Condition and Action Required	Subroutine
1	INCOMPLETE REQUEST FOR TYPE B COMPARISON.	Either the first or second card of the type B comparison specification was omitted or the correspondence number between cards was not consistent. Correct data and rerun OUTP and OUT.	COMPB
2	FATAL ERROR IN FILTER ROUTINE--CUTOUT FREQ=XXXXX.X IS TOO LARGE FOR SAMPLING INCREMENT=XX.XXXX, NO FILTERING POSSIBLE.	Lower value of FC and rerun.	FILTER
3	WARNING IN FILTER ROUTINE -- TERM. FREQ. HAS BEEN INCREASED FROM XXXXX.X TO XXXXX.X TO REDUCE FREQ. GAIN ERROR. COULD ALSO INCREASE NO. FILTER WGTS. GE. XXXX OR SAMPLING INCREMENT .GE. XX.XXXX.	Change input values and rerun if the modification made is not sufficient.	FILTER
744 4	WARNING IN FILTER ROUTINE -- TERM. FREQ. HAS BEEN INCREASED TO XXXXX.X TO AVOID A DIVISION BY ZERO.	Warning only.	FILTER
5	WARNING IN HIC PROGRAM -- TIME DURATION TOO SMALL.	Run for longer time.	HIC
6	VARIABLE SPECIFICATION ILLEGAL OR VARIABLE ABSENT -- CATG. NO = XXX COL. NO. = XXX IDENTIFIERS = XXXX XXXX.	Check variable specification (found on cards 1300, 1400, or 1401) for error and correct (see Table 80). If correct, the desired information was not recorded.	INST
7	CATEGORY NOT RECORDED -- CATG. NO. = XXX COL. NO. = XXX IDENTIFIERS = XXXX XXXX	Information asked for was not recorded INST in binary files by original run. Correct recording controls and repeat.	
8	WARNING -- TIME POINT CARD WHEN NO STYX USE, SKIPPED. XXX XXX XXX XXX	STYX control information present when OUTMVM not needed. If desired, set switch and rerun OUTP and OUT.	

Number	Message	Condition and Action Required	Subroutine
9	FATAL ERROR -- BAD LEAD VALUE FOR TABLES.	File NU has been clobbered, repeat entire run.	OUTMVM
10	FATAL ERROR -- BAD LEAD VALUE FOR ACCELS.	File NU has been clobbered, repeat entire run.	OUTMVM
11	FATAL ERROR -- BAD RECORD RECORDED BY OUTP. XXX XXX XXX XXX.	File NU has been clobbered, try repeating from OUTP and if this does not work, repeat entire run.	OUTMVM
12	WARNING -- VARIABLE POSITION SECTION PARAMETERS INCONSISTENT -- LEAD SEARCH RANGE PRE & POST IA IB II JNEXT CUP REC NO RANGE XXXXX XXXXX XXXXX XXXXX NCR MCR NO. GRP/LINE = NPL NO./GRP = NPN XXXXX XXXXX No.GRP = NUM LAST REC. NO. READ XXXXXX VAL IND RANGE CUR LINE = JA JB XXXXXX XXXXXX	Warning, the LEAD array or one of the controls is not set up right or has been stored over program error or machine error.	PICKUP
745			
13	ODD TIME POINT XX.XXXX EXPECTING XX.XXXX	Warning only. Some Acceleration data missing.	PRELIM
14	WARNING -- ERROR RETURN FROM ROUTINE WITH NO ERROR RETURN.	SUBTRC error return when calling routine with no error routine. Machine malfunction, repeat OUTP and OUT.	PRELIM
15	WARNING -- TABLE READ AND CONTROL ROUTINE INCONSISTENT.	File NU has been clobbered, repeat entire run.	RITABO

TABLE 119. ERROR MESSAGES FROM OUT

Number	Message	Condition and Action Required	Subroutine
16	FATAL ERROR -- ILLEGAL ZERO IN LEAD (13).	Same as message 12	SEARCH
17	WARNING -- TOO MANY CASES, INDEX INCOMPLETE.	Too many combinations of force producers to obtain an index listing for them all	TUCK

TABLE 119-A.

BRIEF SUMMARY OF USE OF
MVMA 2-D MODULES AND FILES

The MVMA 2-D Crash Victim Simulation model has four modules and uses up to nine I/O devices. The four program modules are IN, GO, OUTP, and OUT. These are, respectively, the Input Processor, the Execution Processor, the Output Pre-Processor, and the Output Processor. The seven primary I/O devices used are logical device numbers 2, 5, 6, 7, 8, 9, and 10.

The other two I/O devices that can be used are 1 and 3. An "ellipse man" plot program post-processor, PLOTCS, can be used optionally if LDN 1 is specified for GO. If Card 1503 and associated unnumbered cards are present in the data set, OUT will write user-selected time history data to LDN 3; these data may then be used in plotting or other postprocessing operations.

Except for Calcomp plot file output from the PLOTCS postprocessor, all I/O is handled by Fortran I/O routines.

"GO" calculations are in double precision. All other processors use single precision.

A simulation is carried out in the following manner.

1. Run IN.

- a. Device 5 = IN input data set (Cards 100-1000)
- b. Device 6 = sequential formatted file [printout]
- c. Device 8 = direct access unformatted (binary) file [output--main hold file]

2. Run GO.

- a. Device 1 = sequential formatted character file [output] -- read by PLOTCS
- b. Device 6 = sequential formatted file [printout]
- c. Device 7 = sequential unformatted (binary) file [output--acceleration data]
- d. Device 8 = direct access unformatted (binary) file [input/output--main hold file]
- e. Device 9 = direct access unformatted (binary) file [output--contacts data]
- f. Device 10 = sequential unformatted (binary) file [output--stick figure data]

3. Run OUTP.

- a. Device 2 = sequential formatted file, a hold-catch-temporary file into which the generated FORTRAN source code for the subroutine MAINF required for OUT is written
- b. Device 6 = sequential formatted file [printout]
- c. Device 8 = direct access unformatted (binary) file [input/output--main hold file]

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4. Compile the source code for the OUT subroutine MAINF which was generated in step 3.
5. Link the object code for Subroutine MAINF with the object code for the Output Processor, OUT.
6. Run OUT.
 - a. Device 3 = direct access formatted character file [output--time histories for plotting, etc.]
 - b. Device 5 = OUT input data set (Cards 1001-1600)
 - c. Device 6 = sequential formatted file [printout]
 - d. Device 7 = sequential unformatted (binary) file [input--acceleration data]
 - e. Device 8 = direct access unformatted (binary) file [input--main hold file]
 - f. Device 9 = direct access unformatted (binary) file [input--contacts data]
 - g. Device 10 = sequential unformatted (binary) file [input--stick figure data]
7. Run PLOTCS with object modules for Calcomp plotting system.
 - a. Device 1 = sequential formatted character file [input] -- written by GO
 - b. Device 5 = PLOTCS input data set
 - c. Device 6 = sequential formatted file [printout]
 - d. Device 9 = sequential unformatted (binary) plot file [output] -- used as input to system plotting routines

NOTES:

1. Volume 3 contains information relating to installation and use of the MVMA 2-D model on MTS and non-MTS systems. Note, however, that references are made in Volume 3 to Version 4 of the model, which is no longer in use. References to the "Input Pre-processor", INP, should be ignored. There is no such module in Version 6. Version 6 is a subset of Version 4, so all the Version 4 documentation in Volume 3 serves adequately for Version 6. No documentation pertaining strictly to Version 6 is available. (See pages 4 and 5 of Volume 1 for additional explanation.)
2. During model installation on your computer, you must link object code from compilations of IN, GO, OUTP, and OUT with object code from auxiliary program modules for the respective processors (or with replacement modules for your own system). The auxiliary modules are on the MVMA 2-D release tape along with IN-GO-OUTP-OUT source code.
3. The MVMA 2-D CVS, Version 6, is in standard FORTRAN 77 code. The code was originally written in FORTRAN IV, i.e., FORTRAN 66. Code development at UMTRI is done on an IBM mainframe but the model has been

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installed with little difficulty on many different kinds of systems.

4. Fortran 77 "OPEN" and "CLOSE" file statements appear in the code where needed. They reference device numbers only, not explicit file names. Before MVMA 2-D is run, the attachment of existing files of adequate size to the proper devices must already have been accomplished by use of appropriate operating system commands. Should it be necessary for the "OPEN" and "CLOSE" statements to be modified for use on your system, they can be found in the MVMA 2-D source code modules by searching with an editor program.
5. See Table 117-A for a description of the input data set for the "ellipse man" plot program post-processor, PLOTCS. Data required for plots will be generated only if field 2 of Card 101 of the GO processor data set is negative. If plots are to be generated, logical device number 1 must be assigned as an output file for the GO processor run.
6. Also, see the tape documentation file which describes the recommended procedure for installing the MVMA 2-D CVS model on your computer.

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4.7 Operational Usage of the MVMA 2-D Model.*

Operational usage of the MVMA 2-D model is discussed with respect to two dissimilar computer systems: first, the MTS system upon which the developmental work was carried out; and second, any of the various systems employing the Job Control Language (JCL). Details of the operational usage in these two systems are presented in Tables 120 and 121 respectively. These two tables are annotated so that they may be adapted to any other system. Table 121 represents approximate and untried JCL for purposes of illustration.

TABLE 120. USAGE IN MTS

Command	Command Contents	Description and Remarks
1	\$EMP catchfile1	Prepare for run by emptying all the files or data sets employed for storage of information during run.
2	\$EMP catchfile2	
3	\$EMP catchfile3	
4	\$EMP catchfile4	
5	\$EMP catchprogramfile	
6	\$EMP catchprogramfile2	
7	\$EMP catchobjectfile	
8	\$RUN INP 1=catchprogramfile 5=datafile1 8=catchfile1 2=catchprogramfile2	
9	\$RUN *FTN SCARDS=catchprogramfile SPUNCH=catchobjectfile.	Compile the main program generated by INP for IN.
10	\$EMP catchprogramfile	Prepare file to receive programs generated by IN for GO.
11	\$RUN catchobjectfile+IN 1=catchprogramfile 8=catchfile1	Run the Input Processor (IN).
12	\$EMP catchobjectfile	Prepare file to receive compiled GO programs.
13	\$RUN *FTN SCARDS=catchprogramfile SPUNCH=catchobjectfile	Compile the programs generated by IN for GO.
14	\$SET LIBSRCH=GOLIB	Instruct loader to make use of GO library.

* The parts of this section that pertain to Version 4 features are obsolete in Version 6.

TABLE 120. (CONT.)

Command	Command Contents	Description and Remarks
15	\$RUN catchobjectfile 7=catchfile2 8=catchfile1 9=catchfile3 10=catchfile4	Run the Dynamic Solution Processor (GO).
16	\$EMP catchobjectfile	
17	\$EMP catchprogramfile	Prepare for another new program.
18	\$RUN *FTN SCARDS=catchprogramfile2 SPUNCH=catchobjectfile	Compile the main program generated by INP for OUTP.
19	\$RUN catchobjectfile+OUTP 1=catchprogramfile 5=datafile2 8=catchfile1	Run Output Preprocessor (OUTP).
20	\$EMP catchobjectfile	Prepare for another new compiled program.
21	\$RUN *FTN SCARDS=catchprogramfile SPUNCH=catchobjectfile	Compile the programs generated by OUTP for OUT.
22	\$SET LIBSRCH=OUTLIB	Instruct loader to make use of OUT library.
23	\$RUN catchobjectfile+OUTBKD 7=catchfile2 8=catchfile1 9=catchfile3 10=catchfile4	Run Output Processor (OUT).
24	\$SET LIBSRCH=OFF	Remove special instructions to loader.

The files or data used above are defined as follows:

	File Name	Description
1	INP	File containing collected object modules for all of INP.
2	IN	File containing collected object modules for all of IN except main program.
3	*FTN	File containing object of interface for the Fortran compiler.
4	GOLIB	File containing collected object modules for all of GO except main program and TRAVEC in library format.
5	OUTP	File containing collected object modules for all of OUTP.
6	OUTLIB	File containing collected object modules for all of OUT except MAIN, TRAVEC, SUBTRC, and the block data in library format.

7	OUTBKD	File containing object module of block data subprogram.
8	datafile1	File containing portion of data deck with card ID's from 100 through 1000.
9	datafile2	File containing portion of data deck with card ID's from 1001 through 1600.
10	catchfile1	File to contain direct access data set NU.
11	catchfile2	File to contain sequential data set MU.
12	catchfile3	File to contain direct access data set MV.
13	catchfile4	File to contain sequential data set NP.
14	catchprogramfile	File to contain generated Fortran source statements.
15	catchobjectfile	File to contain object modules for generated programs.
16	catchprogramfile2	File to contain generated Fortran source statements.

TABLE 121. Usage in JCL

Command	Command Contents	Command Description and Remarks
1	//INP2D EXEC PGM=MVMINP,REGION=300K	Run the Input Preprocessor (INP).
2	//STEPLIB DD DSN=HSRILOAD,DISP=SHR	Specify data set containing INP as a member.
3	//FT01F001 DD DSN=HOLDP(IN),DISP=(NEW,CATLG),	Set up catchprogramfile.
4	// UNIT=SYSDA,SPACE=(TRK,(10,10,2),RLSE),	
5	// DCB=(RECFM=F,BLKSIZE=80,LRECL=80,DSORG=PO)	
6	//FT02F001 DD DSN=HOLDOP(OUTP),DISP=(NEW,CATLG),	
7	// UNIT=SYSDA,SPACE=(TRK,(10,10,2),RLSE),	
8	// DCB=(RECFM=F,BLKSIZE=80,LRECL=80,DSORG=PO)	
9	//FT05F001 DD DDNAME=SYSIN	Specify input data reference later
10	//FT06F001 DD SYSOUT=A,DCB=(LRECL=133,BLKSIZE=2660	Specify printer, DCB probably not required.
11	//FT08F001 DD DSN=HOLD8,DISP=(NEW,CATLG),	Set up catchfile1

TABLE 121. (CONT.)

Command	Command Contents	Command Description and Remarks
12	// UNIT=SYSDA,SPACE=(88,(6000,6000),RLSE),	
13	// DCB=(RECFM=F,BLKSIZE=88,LRECL=88)	
14	//SYSIN DD *	Input data deck follows.
15	Input data deck,cards 100 through 1000	
16	//FIP2D EXEC PGM=IGIFORT,	Compile generated program.
17	// PARM=('NODECK','EBCDIC','NOLIST','LOAD',	
18	// 'MAP','SOURCE'),REGION=256K	
19	//SYSIN DD DSN=HOLDP(IN),DISP=OLD,	Catchprogramfile reference.
20	//SYSLIN DD DSN=HOLDO(IN),DISP=(NEW,CATLG),	Set up intermediate catchobjectfile.
21	// DCB=(RECFM=F,BLKSIZE=80,LRECL=80,DSORG=PO),	
22	// UNIT=SYSDA,SPACE=(TRK,(10,10,2))	
23	//SYSPRINT DD SYSOUT=A,DCB=BLKSIZE=3120	Specify printer.
24	//LIP2D EXEC PGM=HEWL,REGION=192K,	Link edit object of generated program.
25	// PARM=('LET','LIST','XREF','SIZE=(182K,100K)')	
26	//DD1 DD DSN=HSRILOAD,DISP=SHR	Specify data set containing INBLKD.
27	//SYSLIB DD DSN=INLIB,DISP=SHR	Specify input library.
28	// DD DSN=SYS2.FORTLIB,DISP=SHR	Specify Fortran library.
29	// DD DSN=SYS2.LINKLIB,DISP=SHR	Specify link library.
30	//SYSLIN DD DSN=HOLDO(IN),DISP=OLD	Specify generated program object.
31	// DD DDNAME=SYSIN	Specify command reference later.
32	//SYSLMOD DD DSN=INLOAD(IN),DISP=(NEW,CATLG),	Specify link edited absolute object.
33	// UNIT=SYSDA,SPACE=(TRK,(10,50,50),RLSE),	
34	// DCB=(RECFM=F,BLKSIZE=80,LRECL=80,DSORG=PO)	
35	//SYSPRINT DD SYSOUT=A	Specify printer.
36	//SYSUT1 DD UNIT=SYSDA2,SPACE=(1024,(50,20))	Specify temporary storage data set.
37	//SYSIN DD *	Link editor commands.

TABLE 121. (CONT.)

Command	Command Contents	Command Description and Remarks
38	INCLUDE DD1(INBLKD)	Make sure BLOCKDATA subprogram gets in.
39	//IN2D EXEC PGM=IN,REGION=300K	Execute IN.
40	//STEPLIB DD DSN=INLOAD,DISP=OLD	Use absolute object just created.
41	//FT01F001 DD DSN=HOLDP(GO),DISP=OLD	Catchprogramfile.
42	//FT06F001 DD SYSOUT=A,DCB=(LRECL=133,BLKSIZE=2660)	Printer.
43	//FT08F001 DD DSN=HOLD8,DISP=OLD	Catchfile 1.
44	//FG2D EXEC PGM=IGIFORT,	Execute Fortran compiler.
45	// PARM=('NODECK','EBCDIC','NOLIST','LOAD',	
46	// 'MAP','SOURCE'),REGION=256K	
47	//SYSIN DD DSN=HOLDP(GO),DISP=OLD	Generated MAIN & TRAVEC.
48	//SYSLIN DD DSN=HOLD0(GO),DISP=OLD	Object modules for MAIN & TRAVEC.
49	//SYSPRINT DD SYSOUT=A,DCB=BLKSIZE=3120	Printer.
50	//LG2D EXEC PGM=HEWL,REGION=192K,	Execute link editor.
51	// PARM=('LET','LIST','XREF','SIZE=(182K,100K)')	
52	//SYSLIB DD DSN=GOLIB,DISP=SHR	Specify GO library & others library.
53	// DD DSN=SYS2.FORTLIB,DISP=SHR	
54	// DD DSN=SYS2.LINKLIB,DISP=SHR	
55	//SYSLIN DD DSN=HOLD0(GO),DISP=OLD	Object modules for MAIN & TRAVEC.
56	// DD DUMMY	No link edit commands.
57	//SYSLMOD DD DSN=GOLOAD(GO),DISP=(NEW,CATLG),	Absolute object for GO.
58	// UNIT=SYSDA,SPACE=(TRK,(10,100,50),RLSE),	
59	// DCB=(RECFM=F,BLKSIZE=80,LRECL=80,DSORG=PO)	
60	//SYSPRINT DD SYSOUT=A	Printer.
61	//SYSUT1 DD UNIT=SYSDA2,SPACE=(1024,(50,20))	Temporary storage.
62	//G02D EXEC PGM=GO,REGION=450K	Execute GO.

TABLE 121. (CONT.)

Command	Command Contents	Command Description and Remarks
63	//STEPLIB DD DSN=GOLOAD,DISP=OLD	Use created GO absolute object.
64	//FT06F001 DD SYSOUT=A,DCB=(LRECL=133,BLKSIZE=2660)	Printer.
65	//FT07F001 DD DSN=HOLD7,DISP=(NEW,CATLG),	Set up catchfile2.
66	// UNIT=SYSDA,SPACE=(394,40),	
67	// DCB=(RECFM=VBS,LRECL=39,BLKSIZE=394)	
68	//FT08F001 DD DSN=HOLD8,DISP=OLD	Use catchfile1.
69	//FT09F001 DD DSN=HOLD9,DISP=(NEW,CATLG),	Set up catchfile3.
70	// UNIT=SYSDA,SPACE=(100,(6000,6000),RLSE),	
71	// DCB=(RECFM=F,BLKSIZE=100)	
72	//FT10F001 DD DSN=HOLD10,DISP=(NEW,CATLG),	Set up catchfile4.
73	// UNIT=SYSDA,SPACE=(TRK,(5,2),RISE),	
74	// DCB=(RECFM=VBS,LRECL=400,BLKSIZE=4004)	
75	//FOP2D EXEC PGM=IGIFORT,	Fortran compilation of OUTP dummy
76	// PARM=('NODECK','EBCDIC','NOLIST','LOAD',	main.
77	// 'MAP','SOURCE'), REGION=256K	
78	//SYSIN DD DSN=HOLDOP(OUTP),DISP=OLD	
79	//SYSLIN DD DSN=HOLDO(OUTP),DISP=OLD	
80	//SYSPRINT DD SYSOUT=A,DCB=BLKSIZE=3120	
81	//LOP2D EXEC PGM=HEWL,REGION=192K,	Link edit object of OUTP dummy
82	// PARM=('LET','LIST','XREF','SIZE=(182K,100K)')	main with rest of OUTP.
83	//SYSLIB DD DSN=OUTPLIB,DISP=SHR	
84	// DD DSN=SYS2.FORTLIB,DISP=SHR	
85	// DD DSN=SYS2.LINKLIB,DISP=SHR	
86	//SYSLIN DD DSN=HOLDO(OUTP),DISP=OLD	
87	// DD DUMMY	
88	//SYSLMOD DD DSN=OUTPLOAD(OUTP),DISP=(NEW,CATLG),	

TABLE 121. (CONT.)

Command	Command Contents	Command Description and Remarks
89	// UNIT=SYSDA,SPACE=(TRK,(10,100,50),RLSE),	
90	// DCB=(RECFM=F,BLKSIZE=80,LRECL=80,DSORG=PO)	
91	//OUTP2D EXEC PGM=OUTY,REGION=300K	Execute OUTP.
92	//STEPLIB DD DSN=OUTPLOAD,DISP=SHR	
93	//FT01F001 DD DSN=HOLDP(OUT),DISP=OLD	Catchprogramfile.
94	//FT05F001 DD DDNAME=SYSIN	Input later.
95	//FT06F001 DD SYSOUT=A,DCB=(LRECL=133,BLKSIZE=2660)	Printer.
96	//FT08F001 DD DSN=HOLD8,DISP=OLD	Catchfile1.
97	//SYSIN DD *	Input follows.
98	Input data deck, cards 1001 through 1600	
99	//FOP2D EXEC PGM=IGIFORT,	Execute Fortran compiler.
100	// PARM=('NODECK','EBCDIC','NOLIST','LOAD',	
101	// 'MAP','SOURCE'),REGION=256K	
102	//SYSIN DD DSN=HOLDP(OUT),DISP=OLD	Source of MAIN, TRAVEC, & SUBTRC.
103	//SYSLIN DD DSN=HOLD0(OUT),DISP=OLD	Object of Main, TRAVEC, & SUBTRC.
104	//SYSPRINT DD SYSOUT=A,DCB=BLKSIZE=3120	Printer.
105	//LOP2D EXEC PGM=HEWL,REGION=192K,	Execute link editor.
106	// PARM=('LET','LIST','XREF','SIZE=(182K,100K)')	
107	//DD1 DD DSN=HSRILOAD,DISP=SHR	Specify data set containing OUTBLD.
108	//SYSLIB DD DSN=OUTLIB,DISP=SHR	Specify OUT library and others.
109	// DD DSN=SYS2.FORTLIB,DISP=SHR	
110	// DD DSN=SYS2.LINKLIB,DISP=SHR	
111	//SYSLIN DD DSN=HOLD0(OUT),DISP=OLD	Object of OUT generated programs.
112	// DD DDNAME=SYSIN	Link edit commands later.
113	//SYSLMOD DD DSN=OUTLOAD(OUT),DISP=(NEW,CATLG),	Set up OUT absolute object.
114	// UNIT=SYSDA,SPACE=(TRK,(10,100,50),RLSE),	

TABLE 121. (CONT.)

Command	Command Contents	Command Description and Remarks
115	// DCB=(RECFM=F,BLKSIZE=80,LRECL=80,DSORG=PO)	
116	//SYSPRINT DD SYSOUT=A	Printer.
117	//SYSUT1 DD UNIT=SYSDA2,SPACE=(1024,(50,20))	Temporary storage.
118	//SYSIN DD *	
119	INCLUDE DD1(OUTBLD)	Make sure BLOCKDATA subprogram gets in.
120	//OUT2D EXEC PGM=OUT,REGION=450K	Execute OUT.
121	//STEPLIB DD DSN=OUTLOAD,DISP=OLD	Use OUT absolute object.
122	//FT06F001 DD SYSOUT=A,DCB=(LRECL=133,BLKSIZE=2660)	Printer.
123	//FT07F001 DD DSN=HOLD7,DISP=OLD.	Catchfile2.
124	//FT08F001 DD DSN=HOLD8,DISP=OLD	Catchfile1.
125	//FT09F001 DD DSN=HOLD9,DISP=OLD	Catchfile3.
126	//FT10F001 DD DSN=HOLD10,DISP=OLD	Catchfile4.

where the cataloged files HOLDP, HOLDOP, HOLD8, HOLD0, INLOAD, GOLOAD, HOLD7, HOLD9, HOLD10, OUTPHOLD, and OUTLOAD should be retained until the run is seen to be satisfactory and then destroyed and where the following data sets are assumed.

HSRILOAD	containing elements MVMINP, INBLKD, MVOUTP, & OUTBLD
INLIB, GOLIB, OUTLIB	Respective libraries
SYS2.FORTLIB, SYS2.LINKLIB	System libraries
IGIFORT	Fortran compile
HEWL	Link editor

4.8 Installation of the MVMA 2-D on Non-MTS Systems. *, ***

The installation of the MVMA 2-D Model on non-MTS systems involves four general areas of difficulty. These are:

- 1) adaptation or substitution of special routines;
- 2) incompatibilities in Fortran library routines;
- 3) use of direct access datasets or indexed Input/Output; and
- 4) effects of differing word length.

These four problem areas are explored in succeeding subsections.

4.8.1. Special Routines. Eleven special routines are used in the MVMA 2-D Model. These routines are listed and described in Table 122. Table 122 also contains references to Tables 123 through 128 which detail the MTS implementation of these special routines for purposes of illustration. These routines are usually included in more than one version on our model distribution tapes with the hope that one of the versions of each routine will prove adequate or at least easy to adapt. Table 122 also describes each version of each routine.

TABLE 122. Special Routines in the MVMA 2-D Model

Routine Name*	Description	Versions Available and Comments
1. ABDUMP	Produce a post mortem dump and abort execution.	<ol style="list-style-type: none">a. The MTS version links to the ERROR system routine described in Table 123.b. The JCL version leaves ABDUMP an "undefined" symbol in the link edit step, which causes a system error return when called.c. Other systems may simulate this by any combination of instructions which cause a system error.

* Many obsolete pages from this section have been removed.

** Subroutines used in MVMA 2-D through Version 5 but not required in Version 6 include: DBS, EXTIME, LAND, LOR, SHFTL, SHFTR, SIOC, SYSTEM.

*** Also see page 770.1.

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2. DEBUG

Unpack the hexadecimal debug control word into 16 debug switches. -

- a. In MTS, done using bitwise logical functions described in Table 125.
- b. In JCL, done with an assembler routine.
- c. In other systems, may be done directly by Fortran logical statements or by an assembler routine.

3. FDATER

Return current day's date in Fortran A-format internal code.

- a. In MTS, done by linking to system routine TIME described in Table 126.
- b. In other systems, may be simulated by linking to appropriate system routine or by dummyming the routine using code presented in Table 128.

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Table 123. * SUBROUTINE DESCRIPTION: ERROR

ERROR

SUBROUTINE DESCRIPTION

Purpose: To terminate execution with an error indication.

Location: Resident System

Alt. Entry: ERROR#

Calling Sequence:

Assembly: CALL ERROR

FORTRAN: CALL ERROR

Description: Returns control to MTS to terminate execution. The comment "ERROR RETURN" is printed. In batch mode, a dump is automatically given if \$ERRORDUMP or \$SET ERRORDUMP=ON was specified.

Execution of the terminated program may be restarted from the point of suspension by the \$RESTART command.

* Reference 28

NOTE:

Original pages 759 to 766 are obsolete in Version 6 and have been removed.

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Table 126* SUBROUTINE DESCRIPTION: TIME

TIME

SUBROUTINE DESCRIPTION

Purpose: To allow the user easy access to the elapsed time, CPU time used, time of day, and the date in convenient units.

Location: *LIBRARY

Calling Sequences:

Assembly: CALL TIME, (key, pr, res)

FORTRAN: CALL TIME(key, pr, res)

Parameters:

key is the location of a fullword integer describing what quantities are desired from the subroutine. The available choices are:

- 0 the CPU, elapsed, supervisor, and problem state time are initialized (see below).
- 1 the CPU time is returned in res.
- 2 the elapsed time is returned in res.
- 3 the CPU time is placed in the first word of res and the elapsed time in the second word of res.
- 4 the time of day is returned in EBCDIC in the form "HH:MM.SS" where "HH:M" is placed in the first word of res and "M.SS" is placed in the second word of res.
- 5 the date is returned in EBCDIC in the form "MMM DD, 19YY" where "MMM" is placed in the first word of res, "DD," is placed in the second word of res, and "19YY" is placed in the third word of res. If "DD" is less than 10, the leading zero is replaced by a blank.
- 6 the time of day is placed in the first and second words of res (see key=4) and the date is placed in the third, fourth, and fifth words of res (see key=5).
- 7 the supervisor time is placed in res.
- 8 the problem state time is placed in res.
- 9 the supervisor time is placed in the first word of res and the problem state time is placed in the second word of res.
- 10 the date is returned in EBCDIC in the form "MM-DD-YY", where "MM-D" is placed in the first word of res and "D-YY" is placed in the second word.

* Reference 28

11 the time of day is placed in the first and second words of res (see 4 above) and the date is placed in the third and fourth words (see 10 above).

The CPU time and elapsed time (key=1,2, or 3) are in milliseconds relative to a global arbitrary, past origin. The supervisor and problem state times are in timer units relative to a global arbitrary, past origin. One timer unit is $1/(256*300)$ seconds or about 13.3 microseconds. Calling TIME with a key=0 resets these time origins locally to the time status at the call on TIME. These time origins are local to the program currently executing; they do not carry over to another separate program execution. TIME must be reinitialized when used with another program execution.

pr is the location of a fullword integer indicating whether the returned quantities are to be placed in res or printed or both. The choices are:

- 0 the values are returned as described above.
- <0 the values are returned and are also printed on SPRINT.
- >0 the values are only printed on SPRINT and are not returned. Thus the res argument is not needed.

res is the location of a fullword integer variable or vector in which the results are placed.

Examples:

Assembly: CALL TIME, (KEY, PR, RES)

```
.  
.  
KEY DC F'6'  
PR DC F'0'  
RES DS 5F
```

The time of day and date are placed in RES.

FORTRAN: CALL TIME(5,1)

The date is printed on SPRINT.

CALL TIME(0)

```
.  
.  
CALL TIME(2,-1,TIM)
```

The elapsed time since the call on TIME(0) is printed and placed in TIM.

Note: TIM must be declared INTEGER*4 in the above examples.

TABLE 128. Code for Dummy FDATER (Special Routine)

```
      SUBROUTINE FDATER (A,B)
C      DUMMY DATE ROUTINE
      DIMENSION A(3), B(2)
      DATA BLANK/1H /
      B(1) = BLANK
      B(2) = BLANK
      A(1) = BLANK
      A(2) = BLANK
      A(3) = BLANK
      RETURN
      END
```

4.8.2 Fortran Library Routines. Fortran libraries are fairly well standardized throughout the industry. Usually if there are incompatibilities, it is in spelling of routine names or much less commonly in calling sequences. Table 129 presents a list of all Fortran library routines used by the MVMA Two-Dimensional Model together with a short description of each routine. Short inspection of this table should reveal any incompatibilities.

TABLE 129. FORTRAN LIBRARY ROUTINES

Routine Name	Description
1. ABS	Real absolute value of a real argument.
2. AINT	Sign of argument times real largest integer less than or equal to absolute value of real argument.
3. AMAX1	Real maximum of two or more real arguments.
4. AMIN1	Real minimum of two or more real arguments.
5. AMOD	Real remainder of the first real argument divided by the second real argument, or argument one modulo argument two.
6. ATAN2	Real two argument arctangent, where the first argument is the ordinate of point and the second is the abscissa.
7. COS	Real cosine of real argument.
8. FLOAT	Convert argument from integer to real.
9. IABS	Integer absolute value of an integer argument.
10. ISIGN	Integer product of the magnitude of the first argument with the sign of the second.
11. MAX0	Integer maximum of two or more integer arguments.
12. MAX1	Integer maximum of two or more real arguments.
13. MIN0	Integer minimum of two or more integer arguments.
14. SIGN	Real product of the magnitude of the first argument with the sign of the second.
15. SIN	Real sine of real argument.
16. SQRT	Square root of real argument which cannot be negative.

MVMA 2-D CRASH VICTIM SIMULATION MODEL

INSTALLATION PROCEDURE

The MVMA 2-D model has historically been a mainframe computer code, and it is used on many different kinds of mainframes. (Model development work has been done on IBM and Amdahl mainframes.) It is now being used on a variety of smaller computers as well--primarily on an assortment of VAX machines. With no, or minimal, modification, the FORTRAN 77 source code provided on this magnetic tape should compile to object code that is ready to run on mainframes and on VAX and other smaller computers for which FORTRAN 77 compilers are available.

GENERAL PROCEDURE:

1. REVIEW THE DESCRIPTION OF TAPE CONTENT -- Unless otherwise specified, the mag tape is 9 track, 6250 BPI, fixed block, and unlabeled. The content of the tape, file by file, is described in a tape description file--the first file on the tape. A printout of the tape description file has also been provided to you. Review this description. You will see that the tape contains approximately 40 files (or more) and that they consist of documentation, source code, MVMA 2-D input data sets, and MVMA 2-D run outputs. The block size and record length for each file, as well as the sequence I.D. in columns 73-80 of records in source code files, are specified.
2. RESTORE TAPE FILES TO DISK STORAGE -- Refer to the tape description information just described for blocking and record length, and restore all files from the tape to disk storage.
3. READ ALL DOCUMENTATION FILES -- It is important to read ALL documentation files before beginning preparation of run modules. Information in some of the documentation files may have bearing on the procedure you will follow. One file to pay particular attention to is the one described: "How to Run the MVMA 2-D CVS Model." That file will make clear to you the program flow, processor by processor, and the communication between processors via external files.
4. STRIP SEQUENCE I.D. FIELD -- All source code files have a sequence I.D. in columns 73-80 of each record. While most compilers have an option which will allow the presence of characters in that field, source code files of 80 characters per record are unnecessarily large--approximately three times as large as files with the sequence I.D. field stripped off. (Trailing blanks will usually be automatically stripped also.) Therefore, sequence I.D.'s should be stripped. A small FORTRAN 77 program for this purpose is provided on the tape. It simply reads in the 80-character records (one record at a time) and then writes back (to a different file) the first 72 characters of each record.

5. CHECK "OPEN" AND "CLOSE" STATEMENTS -- FORTRAN 77 "OPEN" and "CLOSE" file statements appear in the code where needed. They reference device numbers only, not explicit file names. (Before MVMA 2-D is run, the attachment of existing files of adequate size to the proper devices must already have been accomplished by use of appropriate operating system commands.) The "OPEN" and "CLOSE" statements should be found by searching the MVMA 2-D source code modules with an editor program. It is unlikely, but should it be determined that they are not of proper format for use on your system, they should be modified appropriately.

Other code that is possibly system dependent is also marked and can be found by searching for the string "NON-VS".

6. NAME THE BLOCK DATA'S -- Some linkers will require BLOCK DATA subprograms to be assigned names and to be declared by an EXTERNAL statement. (This is normally NOT required.) The "IN" and "OUT" processors have BLOCK DATA's. See the documentation file regarding naming BLOCK DATA subprograms if this is necessary on your system.

7. REPLACE SUBROUTINE PROFLE BY ALTERNATE CODE -- Alternate code for Subroutine PROFLE (in GO) may be required for your FORTRAN 77 compiler. This subroutine is not now used and may be replaced if desired or if necessary by a dummy subroutine which is included as a documentation file on this tape.

8. COMPILE THE "IN", "GO", "OUTP", AND "OUT" PROCESSORS -- MVMA 2-D CVS Version 6 code must be compiled with a FORTRAN 77 compiler. A test compilation of the source code for all processors may locate code that will require special attention for your compiler. No special attention beyond what has been described above is anticipated for any standard FORTRAN 77 compiler.

9. LINK THE OBJECT MODULES -- Run your linker program to obtain executable libraries for the IN, GO, OUTP, and OUT processors. Include your system utilities library in the link.

10. INSERT REPLACEMENTS FOR UNIVERSITY OF MICHIGAN SYSTEM SUBROUTINES -- If the linker determines that object modules are missing, they will probably be system subroutines. See Volume 3, pages 755-770 for information about MTS system subroutines ERROR and TIME, for which you may have equivalent system subroutines that could be linked by changing the name of the subroutine in the UMTRI code and revising code in Subroutines ABDUMP and FDATE to reflect different definitions of arguments. Re-link after adding missing object modules to your executable libraries.

11. MAKE A TEST RUN OF THE MODEL -- Referring to the documentation file "How to Run the MVMA 2-D CVS Model" (described above) and to pages 747-754 of Volume 3 (if pertinent), prepare a set of command statements for running all four processors on your computer system. Make a test run of the "IN" processor; use the MVMA 2-D data set "DEMOMAT" from the tape and compare your printout against the DEMOMAT 6/30/88 printout file on the tape. Then, in succession, run the

"GO", "OUTP", and "OUT" processors. Resolve any problems that occur and repeat this step as necessary.

Note from "How to Run the MVMA 2-D CVS Model" that between the OUTP and OUT runs you must compile a short source code program generated by OUTP. This will be a subroutine for OUT called Subroutine MAINF; it must be linked with the executable library for OUT before OUT can be run.

One further thing to note is that you will normally provide input data sets only to IN and OUT. (Input directly to GO is possible only in the control of auxiliary printout.) All data required by GO and OUTP are read by them from external files previously written (by IN and GO). The DEMODAT data file is almost entirely comprised of input data for IN, viz., cards numbered 100 to 1000. Input data required by OUT, viz., cards numbered 1001 to 1600, will be found at the end of the DEMODAT data file.

12. CHECK OUTPUT AGAINST MTS OUTPUT -- You must verify that your installation of MVMA 2-D code produces the same simulation results as obtained on MTS by UMTRI. Compare your output from the DEMODAT run with MTS output which is provided in a file on the tape. Results should be in exact, or very nearly exact, agreement. Resolve any problems that are evidenced by this run.

Run the model for all other data sets on the tape for which MTS output is provided. Verify that your results satisfactorily match the MTS results.

Successful verification of model installation should be obtained before applications work is begun. If there is any question about what constitutes successful verification, you should contact UMTRI.

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```
C   PROGRAM TO STRIP SEQUENCE I.D. FROM 80-CHARACTER RECORDS
C
C   0 = INPUT FILE
C   1 = OUTPUT FILE (STRIPPED)
C
    CHARACTER A*80, B*72
    EQUIVALENCE (B(1:1), A(1:1))
  10 READ(0,100,END=300) A
 100 FORMAT(A80)
    WRITE(1,200) B
 200 FORMAT(A72)
    GO TO 10
 300 STOP
    END
```

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SYSTEM SUBROUTINES

Two system dependent subroutines are called by the MVMA 2-D model in its use on the IBM mainframe at the University of Michigan. These are Subroutine ERROR and Subroutine TIME. During model installation on your computer, you must link object code for equivalents for those routines with the rest of the object code.

Subroutine ERROR is called by Subroutine ABDUMP, which is present in both IN and GO. Subroutine TIME is called by Subroutine FDATE in IN. University of Michigan MTS system subroutine ERROR causes immediate (abnormal) termination of a run. Subroutine TIME returns date and time. Appropriate replacements of calls to these routines in ABDUMP and FDATE must be made, or dummied code can be used for ERROR and TIME.

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"OPEN" AND "CLOSE" STATEMENTS

Fortran 77 "OPEN" and "CLOSE" file statements appear in the code where needed. They reference device numbers only, not explicit file names. Before MVMA 2-D is run, the attachment of existing files of adequate size to the proper devices must already have been accomplished by use of appropriate operating system commands. Should it be necessary for the "OPEN" and "CLOSE" statements to be modified for use on your system, they can be found in the MVMA 2-D source code modules by searching with an editor program.

Other code that is possibly system dependent is also marked and can be found by searching for the string "NON-VS".

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BLOCK DATA Information for VAX/VMS

The VAX/VMS Fortran linker will not be able to find BLOCK DATA (in "IN" and "OUT") unless the BLOCK DATA is named. To accommodate this requirement, some users will find it necessary to: 1) append names to the BLOCK DATA statement of the BLOCK DATA routines in "IN" and "OUT"; 2) define the names via EXTERNAL statements in the main program for "IN" and in the main program for "OUT" (written by the Output Pre-Processor).

Example:

```
        BLOCK DATA BKDTIN
.....
.....
(block data routine of "IN")
.....
.....
        END

C      DUMMY MAIN PROGRAM FOR INPUT SECTION FOR MVMA 2-D
.....
.....
        DEFINE FILE 8(12000,80,U,LCOUNT)
        EXTERNAL BKDTIN
        CALL INMVMA
        STOP
        END

        BLOCK DATA BKDTOT
.....
.....
(block data routine of "OUT")
.....
.....
        END

C      (Output Pre-Processor code)
.....
        WRITE(2,9996)
9996 FORMAT('          EXTERNAL BKDTOT'/'          CALL OUTMVM')
        WRITE(2,9995)
9995 FORMAT('          STOP'/'          END')
.....
        END
```

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INFORMATION PERTAINING TO SUBROUTINES GETFLI AND GETFLO

Subroutine GETFLI in "IN" is called by Subroutines INPUT, INPUTB, and CSURF for the purpose of converting A-format input data into real or hexadecimal data, as necessary. Subroutine GETFLO in "OUT" is similarly called by OUTMVM. (GETFLI and GETFLO are identical except for name. They get a specified field from the current input card.)

These routines in their implemented form make use of VS Fortran internal READ statements. For use with some other Fortran 77 compilers it may be necessary to replace the internal READ's by DECODE statements if only the DECODE feature is available. Commented DECODE statements (i.e., with "C") are included in the GETFLI and GETFLO code, and the subroutines can be used by leaving either the READ's or the DECODE's uncommented.

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REPLACEMENT CODE FOR SUBROUTINE PROFILE OF "GO"

This is code for a dummied version of SUBROUTINE PROFILE. It may be used if your compiler does not allow some of the transfer statements in the complete code. The complete code is not needed since the Advanced Airbag System cannot be used in the current release.

```
      SUBROUTINE PROFILE(KBC,THETA1,NINT,ITIME,*)
      IMPLICIT REAL*8(A-H,O-Z)
      IF (1.EQ.2) GO TO 9999
      RETURN
9999 RETURN 1
      END
```

INFORMATION ABOUT SUBROUTINE DEBUG

Subroutine DEBUG of the "GO" Processor is called only if special debug printout has been requested by the user through the inclusion of 104/105 Cards in the data set. Since interpretation of debug printout requires intimate understanding of the MVMA 2-D program code, most users will never have need for Subroutine DEBUG. Fortran 77 users are not expected to have any problems with the provided version of Subroutine DEBUG, but if there is a problem, you may find it satisfactory to simply generate a dummy module for your link step from the following code:

```
      SUBROUTINE DEBUG(J,IBUG)
      IMPLICIT REAL*8(A-H,O-Z)
C      THIS IS A DUMMIED VERSION OF SUBROUTINE DEBUG.
      RETURN
      END
```

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4.8.3 Direct Access Data Set. The MVMA Two-Dimensional Model makes use of two direct access data sets for storing the packed binary tables of input, controls, and output. This approach is useful in that it allows efficient access to information produced in a different sequence than required. In other words, these data sets are used to sort information into the needed order. The OPEN statement is used in all four processors to initialize this type of I/O.*

In systems which do not have this feature or another feature to which conversion is easy, this feature can be simulated by modifying the WRITE statements to include the record number as the first item in each record with the remaining length as the second item of each record and by replacing the READ statements by calls to a routine which reads the entire data set and returns information from the last record with the record number sought. In some systems, it may be wise to introduce a sort between processors carried out on record number which eliminates all except the last record with a particular record number. This would enable the reading routine to be simplified.

All references to logical device numbers are via variables. In the case of all such variables, the definition occurs in routine INMVMA of IN and is carried through by means of direct access data set NU and the generated main programs. If it is necessary to change the l.d.n.'s, the appropriate substitution statement in INMVMA need only be found and modified. In addition, any change for NU must also be made in the OPEN statement in IN.

* The role of the OPEN statement was served by the DEFINE FILE statement in Version 5 and earlier Fortran IV codes.

4.8.4 Differing Word Length. Three effects of differing word length which could cause problems in installation are discussed in succeeding paragraphs. These problems are precision and range of numbers, control of debugging switches and certain debug printouts, and character handling within the model.

***** Precision and Range of Numbers. In MTS, the MVMA Two-Dimensional Model makes use of thirty-two bit integers and of reals with eight bits of characteristics and fifty-six* bits of mantissa. The integer calculations deal with relatively small numbers, and it is doubtful that more than sixteen to eighteen bits are ever needed. Little problem with integer range is expected.

In the case of reals, fifty-six bits of mantissa is more than adequate precision for the operation of the model. It is felt that less than twenty-four bits would yield precision problems.* Eight bits of characteristic support a range of from 10^{-78} to 10^{-75} in reals. A range of from 10^{-20} to 10^{-20} is more than adequate for the calculations in this model. It is possible that there may be some constants outside this range used for starting searches for maxima and minima, but these can be safely put into this range.

***** Explicit Use of Hexadecimal Numbers. In MTS, hexadecimal numbers are used explicitly within the model for input of debug controls, for obtaining peculiar recognizable constants, and for certain debug printouts which show the binary form of quantities. These applications affect some DATA and FORMAT statements, mainly in IN, GO, and OUTP, and will be located by attempting to compile the processors. The only application which might pose a problem is debug control. The debug control word is thirty-two bits long and is understood as sixteen two-bit switches packed together in one word. These control words are read in with corresponding effective simulated times, carried through to GO, and unpacked into the sixteen switches when the effective time is reached during the execution of GO. Since the input card format allows eight columns per field, a direct switch to octal would imply change in the input card format. An alternative is to continue to

* "GO" uses double precision reals; "IN" and "OUT" use single precision reals.

read the hexadecimal values as A-format and write a routine to convert into binary. If more than one word is required to hold thirty-two bits, then the storage of this information will require reworking wherever it appears in the model.

***** Character Handling. Character type variables are manipulated with standard Fortran 77 functions.

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PART 5. REFERENCES

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Appendix A Examples of the Use of Packing Tables

Several sections of the third volume of this report (Sections 4.1.2.1, 4.1.2.2, 4.1.2.4, 4.2.2, 4.2.3, 4.3.2, 4.3.3, 4.4.3, 4.4.4, 4.5.2, and 4.5.3) provide general information about packing techniques and the use of external binary files. Those sections include description of the specific applications of these methods throughout the model. However, they do not provide step-by-step explanations, which might be helpful to an untutored user faced with a difficult debugging task. This appendix is provided to fill this void.

Since the techniques are used again and again in similar ways throughout the model, the examples at which we will look are restricted to the G0 processor. If packing is understood here, it will be understood everywhere. This is also the processor with which the user will most likely need to deal.

Imagine that a post mortum dump has occurred in a run of the G0 processor and that the external binary files have also been dumped. For convenience, we will make use of a symbolic dump of G0 provided by the Symbolic Debugging System available under MTS. There is no essential difference between this type of dump and a hexadecimal dump, but the symbolic dump is much easier to read. For the external files, only an ordinary hexadecimal dump will be available for use in this appendix.

A.1 The Chain to Ellipses

Table 58 shows that KCON is always first in IQ. Table 59 shows that the first eight locations in KCON give the KCON indices of the entries which describe all ellipses attached to the eight body segments. Figure A-1 shows one actual case.

Relative Hex Address	Array	Contents	Decimal(D)	Contents	Hex(H)
(RA)	Indices(I)				
000000	IQ (1)	'F'	+54		00000036
000004	IQ (2)	'F'	+56		00000038
000008	IQ (3)	'F'	+0		00000000
00000C	IQ (4)	'F'	+58		0000003A
000010	IQ (5)	'F'	+60		0000003C
000014	IQ (6)	'F'	+63	←	0000003F
000018	IQ (7)	'F'	+67		00000043
00001C	IQ (8)	'F'	+69		00000045

Fig. A-1 Body Segment Portion of Standard Area of KCON

Body segment three has no ellipses attached since KCON(3) is 0. However, let us follow the chain for body segment six (each of the others is completely similar). Since KCON(6) equals 63, we find the body segment six entry beginning at KCON(63) as shown in Fig. A-2.

RA	I	D	H
0000F8	IQ (63)	'F' +3 ←	00000003
0000FC	IQ (64)	'F' +165	000000A5
000100	IQ (65)	'F' +181 ←	000000B5
000104	IQ (66)	'F' +198	000000C6

Fig. A-2 Control Section for Body Segment Six

Table 60 gives the layout of this type of entry. We see that there are three ellipses attached to body segment six and that they are further described in entries occurring at KCON index 165, 181, and 198 respectively. The order of these entries is the order they were encountered in the data. Let us follow further with the second of these ellipses.

Fig. A-3 shows this portion of KCON. Note that (IKC=)181 is the internally used identification for this ellipse, serving the double function of a unique integer "name" and supplying access information as well.

RA	I	D	H
0002D0	IQ (181)	'F' +58 ←	0000003A
0002D4	IQ (182)	'F' +0	00000000
0002D8	IQ (183)	'F' +6	00000006
0002DC	IQ (184)	'F' +7	00000007
0002E0	IQ (185)	'F' +0	00000000
...	
0002EC	IQ (188)	'F' +0	00000000
0002F0	IQ (189)	'F' +3	00000003
0002F4	IQ (190)	'F' +0	00000000
0002F8	IQ (191)	'F' +2	00000002
0002FC	IQ (192)	'F' +1	00000001
000300	IQ (193)	'F' +195	000000C3
000304	IQ (194)	'F' +0	00000000

Fig. A-3 Ellipse 181 Control Entry

The description of this type of entry is found in Table 62. We see that the real information will be found in STOMAT beginning at index 58. Further the ellipse is rigid and attached to body segment six (this information is provided to make it possible to start with the ellipse i.d. and go back up the chain). The name of this ellipse is found at index seven in KELLNM. Table 58 shows KELLNM is dimensioned eight by NELLs and the last half of Section H of the Packing Dictionary produced by IN conveniently shows Table 58 in numeric form. Fig. A-4 shows this portion of the Packing Dictionary which also appears in its original setting on the third page of Table 49.

INTEGER ARRAYS				
NAME	REG.	IND.	LENGTH	OFFSET BEG.
KCON		1	589	0
→ KACT		590	1125	589
KMIG		1715	C	1714
KMUG		1715	0	1714
IBCNT		1715	0	1714
→ Mstor		1715	126	1708
→ KELLNM		1841	80	1832
KCONAM		1921	48	1916
KREGAM		1969	72	1960
KREGNS		2041	45	2035
KCI		2086	C	2085
KOT		2086	0	2085
IDELL		2086	0	2085
KOTT		2086	0	2085
JOT		2086	C	2085

Fig. A-4 IQ Layout Section of Packing Dictionary

We see that KELLNM begins at index 1841 in IQ with an offset beginning of 1832. Looking back at Section 4.1.2.2, we see the location of this entry (I=1 and J=7) is computed from the offset beginning as follows.

$$\text{Loc (KELLNM(1,7))} = 1832 + 1 + 7 * 8 = 1889$$

This portion of IQ is presented as Fig. A-5.

RA	I	D	A-Format(A)	H
001D80	IQ(1889)	'F' -926562861	HEEL	C8C5C5D3
001D84	IQ(1890)	'F' +1077952576		40404040
...		
001D9C	IQ(1896)	'F' +1077952576		40404040

Fig. A-5 KELLNM Entry Seven

This entry says the sixteen-character ellipse name is "HEEL" followed by twelve blanks and the sixteen-character material name is sixteen blanks.

IQ (188) or relative index eight for the ellipse entry in KCON states that this ellipse is a true circle. The next two words indicate that there are three allowed or disallowed region interactions with this ellipse and none with other ellipses. Since in this case both KHIB and LHIB are zero, these will be interpreted that ellipse 181 may contact three regions and no other ellipses.

The rest of the ellipse control entry states that the friction class is two, that the maximum semiaxis is one, and that the entry containing the i.d.'s of regions for which interactions are allowed begins at IQ (195). This section appears as Fig. A-6.

RA	I	D	H
000308	IQ (195)	'F' +311	00000137
00030C	IQ (196)	'F' +510	000001FE
000310	IQ (197)	'F' +353	00000161

Fig. A-6 List of Allowed Region Contacts for Ellipse 181, "HEEL"

These words are the beginning indices of the three regions which the ellipse is allowed to hit. We will follow this part of the trail further in the next section. Now let us turn to the real information for this ellipse, which begins at STOMAT (58) according to Table 62 and IQ (181) in Fig. A-3. Table 57 shows that STOMAT is first in RQ. Fig. A-7 presents this portion of RQ.

RA	I	D	H
0000E4	RQ (58)	'E' 8.56999969	41891EB8
0000E8	RQ (59)	'E' 0.	00000000
0000EC	RQ (60)	'E' 46.870224	422EDEC7
0000F0	RQ (61)	'E' -2.04653835	C120BE9F
0000F4	RQ (62)	'E' 1.43999863	41170A3C
0000F8	RQ (63)	'E' 1.19999981	41133333
0000FC	RQ (64)	'E' .719999313	40B851E0

Fig. A-7 Ellipse 181 Real Information Entry in STOMAT

Table 68 gives the layout of this type of entry and since ellipse 181 is a true circle, there are only seven words in this entry. The first four words give the location of the center of ellipse 181 in the body segment six system as (8.57,0) and in the inertial system (at time of dump) as (46.87,-2.05). The next three words give three useful computed quantities based on the circle radius, 1.2.

Section A of the Packing Dictionary contains a summary of the important beginning indices for all ellipses. Section A is presented as Fig. A-8 and as a portion of page one of Table 49.

A. ELLIPSES					
LINK NO.	NAME	KCON B.I.	STOMAT B.I.	MATL B.I.	NAME IN
1	HEAD	71	1	0	1
2	THORAX	88	8	106	2
4	HIP	111	20	128	3
5	THIGH	133	27	0	4
5	KNEE	149	39	0	5
6	SHANK	165	46	0	6
→ 6	HEEL	181	58	0	7
6	TOE	198	65	0	8
7	ELBOW	214	72	0	9
8	HAND	228	79	0	10

Fig. A-8 Ellipse Section of Packing Dictionary

Here we see that Ellipse 181 is the second ellipse attached to body segment six, has the name "HEEL", has a real entry beginning STOMAT (58), is rigid, and has its name stored in entry seven of KELLNM. These few lines cover all ten ellipses which are present in this run.

A.2 The Chain to Contact Line Segments

In locations 23 through 25 of KCON are the number of regions specified with respect to the vehicle system, the number of regions specified with respect to the inertial system, and the number of materials, respectively. The control sections for each of these three items follow immediately thereafter. This is all documented in Table 59. Figure A-9 presents an actual case (without the material control section).

RA	I	D	H
000058	IQ (23)	'F' +9	00000009
00005C	IQ (24)	'F' +0	00000000
000060	IQ (25)	'F' +19	00000013
000064	IQ (26)	'F' +244	000000F4
000068	IQ (27)	'F' +274 ←	00000112
00006C	IQ (28)	'F' +311	00000137
000070	IQ (29)	'F' +353 ←	00000161
000074	IQ (30)	'F' +378	0000017A
000078	IQ (31)	'F' +408	00000198
00007C	IQ (32)	'F' +438	000001B6
000080	IQ (33)	'F' +468	000001D4
000084	IQ (34)	'F' +510	000001FE

Fig. A-9 Region Portion of KCON Standard Area

This case has nine regions attached to the vehicle and none to the ground. Following the number of materials (19) are nine words which are the beginning

indices for the nine regions. As in the case of ellipses, this index serves both as internal i.d. and access information. Materials will be taken up in the next section. We will follow both region (KKC=) 274 and region 353 further for illustrative purposes.

Fig. A-10 shows the region entry for region 274.

RA	I		D	H
000444	IQ (274)	'F'	+199	000000C7
000448	IQ (275)	'F'	+269	0000010D
00044C	IQ (276)	'F'	+2	00000002
000450	IQ (277)	'F'	+0	00000000
000454	IQ (278)	'F'	+1	00000001
...	
000460	IQ (281)	'F'	+1	00000001
000464	IQ (282)	'F'	+7	00000007
000468	IQ (283)	'F'	+2	00000002
00046C	IQ (284)	'F'	+289 ←	00000121
000470	IQ (285)	'F'	+300	0000012C
000474	IQ (286)	'F'	+1	00000001
000478	IQ (287)	'F'	+0	00000000
00047C	IQ (288)	'F'	+0	00000000

Fig. A-10 Region 274 Control Entry

The layout of this entry is shown in Table 63. The real information for this region starts at STOMAT (199). This region is made of material 269. The name of this region will be found in entry two of KREGNM. Permanent deformation is determined by parallel displacement. Neither multiellipse nor multisegment force apportioning is used. The region friction class is one. No cavity analysis is used. The region is specified relative to the vehicle (backward pointer in case of starting with this entry). This region is made up of two line segments: segment 289 and segment 300. No migration is allowed. Region information is to be printed in vehicle coordinates. The last word indicates that this region can be contacted by at least one ellipse.

Looking now at the region real information, we find its format laid out in Table 69. Fig. A-11 presents the entry for region 274.

RA	I	D	H
000318	RQ(199)	'E' 0.	C0000000
...	
000330	RQ(205)	'E' 0.	00000000
000334	RQ(206)	'E' 15.9676895	41FF7BA8
000338	RQ(207)	'E' 28.5276794	421C8716
00033C	RQ(208)	'E' 32.7676849	4220C487
000340	RQ(209)	'E' -4.96000004	C14F5C29
000344	RQ(210)	'E' -9.92000008	C19EB852
000348	RQ(211)	'E' -10.6400003	C1AA3D71
00034C	RQ(212)	'E' -.320284963	C051FE32
000350	RQ(213)	'E' .947321296	40F283A6
000354	RQ(214)	'E' -.326030314	C05376B9
000358	RQ(215)	'E' 0.	00000000
00035C	RQ(216)	'E' 0.	00000000
000360	RQ(217)	'E' 15.4399996	41F70A3D
000364	RQ(218)	'E' -4.96000004	C14F5C29
000368	RQ(219)	'E' 32.2400055	42203D71
00036C	RQ(220)	'E' -10.6400003	C1AA3D71
000370	RQ(221)	'E' 0.	00000000

Fig. A-11 Region 274 Real Information Entry

The mass compliance and bending properties of this region are zero. The inertial Δx is zero since this region does not migrate. The inertial positions of the three endpoints for this two-segment region are (15.97, -4.96), (28.53, -9.92), and (32.77, -10.64) respectively. The next three words (RQ(212) through RQ(214)) are the sine, cosine, and value of the region baseline angle (used only for Category 2 printout). Since there is no migration, XSUM, ZSUM, and Inertial Δz (the last item, RQ(221)) are all zero. The four values RQ(217) through RQ(220) are the coordinates of the two extreme endpoints of the region given in the coordinate system specified in the region control entry. In this case, (15.44, -4.96) and (32.24, -10.64) are the endpoints in vehicle coordinates.

Now, returning to the region control entry (Fig. A-10), let us follow the chain for line segment (JKC=) 289. This type of entry is laid out in Table 64. The specific case is presented as Fig. A-12.

RA	I	D	H
000480	IQ (289)	'F' +222	000000DE
000484	IQ (290)	'F' +274	00000112
000488	IQ (291)	'F' +0	00000000
00048C	IQ (292)	'F' +2	00000002
000490	IQ (293)	'F' +1	00000001
...	
000498	IQ (295)	'F' +0	00000000
00049C	IQ (296)	'F' +1	00000001
0004A0	IQ (297)	'F' +266	0000010A
...	
0004AB	IQ (299)	'F' +266	0000010A

Fig. A-12 Line Segment 289 Control Entry

The real information entry begins STOMAT (222). The region of which this line is a part is region 274 (another backward reference). There are no forces on this segment at the time of the dump. The segment name will be found in entry two of KCONAM. KCON (296) specifies that the line segment does not move with respect to the coordinate system in which its positions are specified (in this case, the vehicle). The last three words are beginning indices in STOMAT of segment position entries, and their values are identical for this case since the segment does not move within the coordinate system in which it is defined.

The line segment real information is described in Table 70 and presented as Fig. A-13.

RA	I	D	H
000374	RQ (222)	'E' 5.	41500000
000378	RQ (223)	'E' .163999975	4029FBE7
00037C	RQ (224)	'E' 1.	41100000
000380	RQ (225)	'E' -1.	C1100000
000384	RQ (226)	'E' 12.5600004	41C8F5C3
000388	RQ (227)	'E' 4.96000004	414F5C29
00038C	RQ (228)	'E' -14.2848053	C1E48E90
000390	RQ (229)	'E' 0.	00000000
000394	RQ (230)	'E' 14.2848053	41E48E90
000398	RQ (231)	'E' 0.	00000000
00039C	RQ (232)	'E' 15.4399996	41F70A3D
0003A0	RQ (233)	'E' 0.	00000000
0003A4	RQ (234)	'E' 4.96000004	414F5C29
0003A8	RQ (235)	'E' 0.	00000000
0003AC	RQ (236)	'E' 182.355194	42B65AEE
0003B0	RQ (237)	'E' 0.	00000000
0003B4	RQ (238)	'E' 4.96000004	414F5C29
0003B8	RQ (239)	'E' 0.	00000000
0003BC	RQ (240)	'E' -12.5600004	C1C8F5C3
0003C0	RQ (241)	'E' 13.5038958	41D80FF5
0003C4	RQ (242)	'E' 0.	00000000
0003C8	RQ (243)	'E' 0.	00000000

Fig. A-13 Line Segment 289 Real Information Entry

The first three of these quantities are input data items and the rest are computed quantities used by the routine CNTACT. We will not take up this entry in detail because this entry leads no further and the correspondence between actual case and typical format should be clear by now.

Fig. A-14 presents the lone segment position entry for segment 289. The layout is Table 71.

RA	I		D	H
000424	RQ (266)	'E'	-.999999931E-03	BE418937
000428	RQ (267)	'E'	15.4399996	41F70A3D
00042C	RQ (268)	'E'	-4.96000004	C14F5C29
000430	RQ (269)	'E'	28.	421C0000
000434	RQ (270)	'E'	-9.92000008	C19EB852

Fig. A-14 Line Segment Time Point Entry

Since only one time point is specified, the time value is set negative for safety's sake.

Let us now return to Figure A-9 and start forward again with region 353. Fig. A-15 presents the region control entry. Note that as per Table 63, the entry is shorter because this region is made up of only one line segment (see Fig. A-10 for comparison).

Fig. A-16 presents the line segment control entry for line segment 367. We will not examine the real information for this case. Referring again to Table 64, we see that Fig. A-16 indicates that four time points have been

RA	I		D	H
000580	IQ (353)	'F'	+353	00000161
000584	IQ (354)	'F'	+348	0000015C
000588	IQ (355)	'F'	+4	00000004
00058C	IQ (356)	'F'	+0	00000000
000590	IQ (357)	'F'	+1	00000001
000594	IQ (358)	'F'	+1	00000001
000598	IQ (359)	'F'	+2	00000002
00059C	IQ (360)	'F'	+1	00000001
0005A0	IQ (361)	'F'	+7	00000007
0005A4	IQ (362)	'F'	+1	00000001
0005A8	IQ (363)	'F'	+367	0000016F
0005AC	IQ (364)	'F'	+1	00000001
0005B0	IQ (365)	'F'	+0	00000000
0005B4	IQ (366)	'F'	+0	00000000

Fig. A-15 Region 353 Control Entry

RA	I	D	H
0005B8	IQ (367)	'F' +368	00000170
0005BC	IQ (368)	'F' +353	00000161
0005C0	IQ (369)	'F' +0	00000000
0005C4	IQ (370)	'F' +6	00000006
0005C8	IQ (371)	'F' +1	00000001
...	
0005D0	IQ (373)	'F' +0	00000000
0005D4	IQ (374)	'F' +4	00000004
0005D8	IQ (375)	'F' +390	00000186
0005DC	IQ (376)	'F' +405	00000195
0005E0	IQ (377)	'F' +390	00000186

Fig. A-16 Line Segment 367 Control Entry

specified for this line segment. The four segment position entries are stored contiguously with the first entry beginning STOMAT (390) and the last beginning STOMAT (405). Fig. A-17 shows this block of four time point positions. Each such entry is described by Table 71.

RA	I	D	H
000614	RQ (390)	'E' 0.	00000000
000618	RQ (391)	'E' 47.3000031	422F4CCD
00061C	RQ (392)	'E' 1.10000038	4111999A
000620	RQ (393)	'E' 54.6999969	4236B333
000624	RQ (394)	'E' -5.60000038	C159999A
000628	RQ (395)	'E' .399999991E-01	3FA3D70A
00062C	RQ (396)	'E' 47.3000031	422F4CCD
000630	RQ (397)	'E' 1.10000038	4111999A
000634	RQ (398)	'E' 54.6999969	4236B333
000638	RQ (399)	'E' -5.60000038	C159999A
00063C	RQ (400)	'E' .799999833E-01	40147AE1
000640	RQ (401)	'E' 47.3000031	422F4CCD
000644	RQ (402)	'E' 1.10000038	4111999A
000648	RQ (403)	'E' 47.8999939	422FE666
00064C	RQ (404)	'E' -5.60000038	C159999A
000650	RQ (405)	'E' .299999952	404CCCCC
000654	RQ (406)	'E' 47.3000031	422F4CCD
000658	RQ (407)	'E' 1.10000038	4111999A
00065C	RQ (408)	'E' 47.8999939	422FE666
000660	RQ (409)	'E' -5.60000038	C159999A

Fig. A-17 Block of Segment Position Entries for Line Segment 367

The four time points specify positions in the region input (vehicle) system at times 0, 40 ms, 80 ms, and 300 ms. Specified times span the time period of the run.

As in the case with ellipses, the Packing Dictionary contains a summary of the most important beginning indices for regions and lines. Fig. A-18 presents Section B of the Packing Dictionary which is seen also as a part of page one of Table 49.

B. CONTACT REGIONS AND SEGMENTS

NAME	KCON	B.I.	STDMAT	B.I.	MATL	B.I.	NAME	IND	W.R.T.	SYSTEM
SEAT BACK	244		135		269			1		7
BACK LINE	258		150		269			1		
▶ SEAT CUSHION	274		199		269			2		7
→ CUSHION LINE 1	289		222		269			2		
CUSHION LINE 2	300		244		269			3		
FLOOR	311		276		348			3		7
SEAT BOTTOM	326		299		348			4		
FLOORBOARD	337		321		348			5		
▶ TOEPAN	353		353		348			4		7
▶ TOEBOARD	367		368		348			6		
KNEE BAR	378		410		403			5		7
KNEEBAR LINE	392		425		403			7		
ROOFHEADER	408		489		433			6		7
LR	422		504		433			8		
WINDSHIELD	439		531		463			7		7
LW	452		546		463			0		
INSTRUMENT PANEL	468		573		505			8		7
MID IP	483		596		505			10		
LOWER IP	494		618		505			11		
DASH	510		680		535			9		7
DASHLINE	524		695		535			12		

Fig. A-18 Section B of Packing Dictionary

Region and line information is interspersed. The region is listed ahead of the line(s) which make it up and is distinguished by the presence of an indication in the "W.R.T. SYSTEM" column. Here "7" means vehicle relative input and "0" means inertial relative input. For regions, the name index is of the entry in KREGNM and in KREGNS which controls output of region quantities. For lines, the name index is of the entry in KCONAM.

A.3 The Chain to Materials

Looking back of Fig. A-9 and Table 59, we see that IQ (25), which is the number of materials specified for the run, is 19. Immediately following the region portion of the KCON standard area is the material portion of the KCON standard area. This is presented as Fig. A-19. Table 59 covers the entire KCON standard area.

RA	I	D	H
000088	IQ (35)	'F' +106 ←	0000006A
00008C	IQ (36)	'F' +128	00000080
000090	IQ (37)	'F' +269	0000010D
000094	IQ (38)	'F' +348	0000015C
000098	IQ (39)	'F' +403	00000193
00009C	IQ (40)	'F' +433	000001B1
0000A0	IQ (41)	'F' +463	000001CF
0000A4	IQ (42)	'F' +505	000001F9
0000A8	IQ (43)	'F' +535	00000217
0000AC	IQ (44)	'F' +540	0000021C
0000B0	IQ (45)	'F' +545	00000221
0000B4	IQ (46)	'F' +550	00000226
0000B8	IQ (47)	'F' +555	0000022B
0000BC	IQ (48)	'F' +560	00000230
0000C0	IQ (49)	'F' +565	00000235
0000C4	IQ (50)	'F' +570	0000023A
0000C8	IQ (51)	'F' +575	0000023F
0000CC	IQ (52)	'F' +580	00000244
0000D0	IQ (53)	'F' +585	00000249

Fig. A-19 Material Portion of KCON Standard Area

As stated before, this entry always immediately follows the last region entry in the KCON standard area and is always KCON (25) long. Each word is the beginning index of one of the material control entries.

Let us follow the chain forward for material 106. This could be done from the control entries for ellipses and line segments, but here we will proceed directly from the material table of contents in the KCON standard area. As before, the KCON beginning index of the control entry doubles as a unique internal identifier and access to information. Fig. A-20 shows the control entry for material 106.

RA	I	D	A	H
0001A4	IQ (106)	'F' +91		0000005B
0001A8	IQ (107)	'F' -1010252318	CHES	C3C8C5E2
0001AC	IQ (108)	'F' -472595997	TMAT	E3D4C1E3
0001B0	IQ (109)	'F' -750763968	L	D3404040
0001B4	IQ (110)	'F' +1077952576		40404040

Fig. A-20 Material 106 Control Entry

The description of this entry is in Table 61. We see that the real information entry begins STOMAT (91) and that the name of this material is "CHESTMATL". Fig. A-21 presents the STOMAT real information entry, which is described in Table 66.

RA	I		D	H
000168	RQ (91)	'E'	0.	00000000
...	
000170	RQ (93)	'E'	0.	00000000
000174	RQ (94)	'E'	100.	42640000
000178	RQ (95)	'E'	101.	42650000
00017C	RQ (96)	'E'	0.	00000000
000180	RQ (97)	'E'	0.	00000000
000184	RQ (98)	'E'	.100000024	4019999A
000188	RQ (99)	'E'	-1.	C1100000
00018C	RQ (100)	'E'	5.	41500000
000190	RQ (101)	'E'	107.	426B0000
000194	RQ (102)	'E'	2.	41200000
000198	RQ (103)	'E'	-107.	C26B0000
00019C	RQ (104)	'E'	0.	00000000
...	
000204	RQ (106)	'E'	0.	00000000

Fig. A-21 Material 106 Real Information Entry

For this case $\delta_A = \delta_B = \delta_C = 0$, $\delta_D = 100$, $\delta_F = 101$, $F_{max} = 0$ and $\beta = 0$.

The G-ratio is .1 and R-ratio is specified in Table 1. FOREPS is 5. Relative index 11 (STOMAT (101)) is a backward reference to the material name (see Fig. A-20). The Inertial Spike Curve is specified as a polynomial described in Table 67 and stored starting STOMAT (107). In this case, all six values are identically zero and will not be shown. The three λ 's are all zero. The Static Curve is given in Table 2.

Following the chain forward, we are interested in the two tables. The table controls are all in MSTOR which according to Table 58 is dimensioned MSTOR (6, NUMTAB) and according to Fig. A-4 has an offset beginning of 1708. The addressing rule (Section 4.1.2.2) reveals that the control entries for Tables 1 and 2 begin at IQ (1715) and IQ (1721) respectively. Fig. A-22 shows this MSTOR area.

	RA	I	D	H
→	001AC8	IQ(1715)	'F' +4	00000004
	001ACC	IQ(1716)	'F' +1	00000001
	
	001AD4	IQ(1718)	'F' +1	00000001
	001AD8	IQ(1719)	'F' +0	00000000
	001ADC	IQ(1720)	'F' +0	00000000
→	001AE0	IQ(1721)	'F' +7	00000007
	001AE4	IQ(1722)	'F' +15	0000000F
	001AE8	IQ(1723)	'F' +1	00000001
	001AEC	IQ(1724)	'F' +15	0000000F
	001AF0	IQ(1725)	'F' +0	00000000
	001AF4	IQ(1726)	'F' +0	00000000

Fig. A-22 Control Entries for Tables 1 and 2

Table 82 describes each of these entries. Table One has four points and begins in STOR(1) while Table Two has seven points and begins STOR(15). In both cases, the scan type is non-periodic, piecewise linear so according to Table 83, we expect $4 * 4 - 2 = 14$ and $4 * 7 - 2 = 26$ words in the real entry respectively. Looking at Table 57, we see that STOR is one-dimensional. The first half of Section H of the Packing Dictionary (presented as Fig. A-23) shows that STOR's offset beginning is 4104. The real entries (STOR) for Tables One and Two are presented as Fig. A-24 and Fig. A-25, respectively.

H. VARIABLE-LENGTH STORAGE LAYOUT

REAL ARRAYS			
NAME	BEG. IND.,	LENGTH	OFFSET BEG.
STOMAT	1	1132	0
STOACT	1133	2292	1132
CONOUT	3425	584	3424
TACC	4009	27	4008
ACC	4036	27	4035
MDOT	4063	0	4062
BTIM	4063	0	4062
TEMPDS	4063	0	4062
TTIM	4063	0	4062
PERM	4063	0	4062
DELTAP	4063	0	4062
BAGUL	4063	0	4060
STH	4063	0	4062
STQMIG	4105	0	4104
STQMUG	4063	42	4062
ADUM	4105	0	4104
→ STOR	4105	418	4104
HX111	4523	0	4522
HTX11	4523	0	4522
EDGE	4523	0	4522
DD1	4523	0	4522
DD2	4523	0	4522
SS	4523	0	4522
FF	4523	0	4522
PFN	4523	0	4522

Fig. A-23 Real Array Portion of Section H of Packing Dictionary

RA	I	D	H
004020	RQ(4105)	'E' 0.	00000000
004024	RQ(4106)	'E' .100000016E-01	3F28F5C3
004028	RQ(4107)	'E' .300000012	404CCCCD
00402C	RQ(4108)	'E' 1.350000038	4115999A
004030	RQ(4109)	'E' 1.	41100000
004034	RQ(4110)	'E' .639999986	40A3D70A
004038	RQ(4111)	'E' .5	40800000
00403C	RQ(4112)	'E' .449999988	40733333
004040	RQ(4113)	'E' -35.9999847	C223FFFF
004044	RQ(4114)	'E' -.482758582	C07B9611
004048	RQ(4115)	'E' -.476190485E-01	BFC30C31
00404C	RQ(4116)	'E' 1.	41100000
004050	RQ(4117)	'E' .644827545	40A5136B
004054	RQ(4118)	'E' .514285684	4083A83A

Fig. A-24 Real Entry for Table One

RA	I		D	H
004J58	RQ (4119)	'E'	0.	00000000
00405C	RQ (4120)	'E'	.100000016E-01	3F28F5C3
004060	RQ (4121)	'E'	.500000007E-01	3FCCCCCD
004064	RQ (4122)	'E'	.300000012	404CCCCD
004068	RQ (4123)	'E'	.399999976	40666666
00406C	RQ (4124)	'E'	1.10000038	4111999A
004070	RQ (4125)	'E'	4.25	41440000
004074	RQ (4126)	'E'	0.	00000000
004078	RQ (4127)	'E'	1125.	43465000
00407C	RQ (4128)	'E'	1460.	435B4000
004080	RQ (4129)	'E'	1350.	43546000
004084	RQ (4130)	'E'	1260.	434EC000
004088	RQ (4131)	'E'	1260.	434EC000
00408C	RQ (4132)	'E'	12600.	44313800
004090	RQ (4133)	'E'	112499.938	451B773F
004094	RQ (4134)	'E'	8375.	4420B700
004098	RQ (4135)	'E'	-440.	C31B8000
00409C	RQ (4136)	'E'	-900.000244	C3384001
0040A0	RQ (4137)	'E'	0.	00000000
0040A4	RQ (4138)	'E'	3600.00024	43E10001
0040A8	RQ (4139)	'E'	-0.	80000000
0040AC	RQ (4140)	'E'	1041.25	43411400
0040B0	RQ (4141)	'E'	1482.	435CA000
0040B4	RQ (4142)	'E'	1620.	43654000
0040B8	RQ (4143)	'E'	1260.	434EC000
0040BC	RQ (4144)	'E'	-2700.00146	C3A8C006

Fig. A-25 Real Entry for Table Two

As shown in Table 83, abscissas are followed by ordinates and then by slopes and finally by intercepts. The Packing Dictionary summarizes the important indices for materials and for tables. Fig. A-26 shows Section D, which is about materials, and Fig. A-27 shows Section E, which is about tables.

D. MATERIALS		
NAME	KCON B.I.	STCMAT B.I.
CHESTMATL	106	91
HIPMATL	128	113
SEAT MATERIAL	269	177
FMATL	348	837
SHEET METAL	403	467
RMATL	433	759
WINDSHIELD GLASS	463	787
IPMAT	505	815
CASHMATL	535	727
6% WEBBING #1	540	859
6% WEBBING #2	545	881
NO STRENGTH	550	903
JOINT MATA	555	931
JOINT MATB	560	959
JOINT MATC	565	987
JOINT MATD	570	1015
JOINT MATE	575	1043
JOINT MATF	580	1071
JOINT MATG	585	1099

Fig. A-26 Section D of the Packing Dictionary

E. TABLES

NO.	NO. PTS.	REC. IND.	SCAN TYPE	NAME
1	4	1	1	CGR
2	7	15	1	CSTAT
3	6	41	1	SSEAT
4	3	63	1	GRSHEET
5	7	73	1	GRSHEET
6	6	99	1	SSHEET
7	3	121	1	DGR
8	5	121	1	DGR
9	4	149	1	CSTAT
10	5	163	1	WGR
11	5	181	1	WGR
12	3	199	1	IPGR
13	5	209	1	IPGR
14	14	227	1	IPSTAT
15	2	281	1	FGR
16	2	287	1	FGR
17	12	293	1	FSTAT
18	5	339	1	GBELT1
19	5	357	1	GBELT1
20	6	375	1	SBELT1
21	6	397	1	SBELT2

Fig. A-27 Section E of the Packing Dictionary

A.4 The Chain to Interactions

Storage of information about contact interactions is controlled by the standard area of KACT. This standard area is composed of a total of INTRAC words made up from nine-word entries of the format described in Table 75, one for each active interaction and region. INTRAC occurs in Labelled COMMON "PACK" which is shown as Fig. A-28.

```

DUMP OF SECTION PACK          VA=60FFC0  RF=60FFC0  LEN=000040  SI#=0080

  RA      SYMBOL  TYPE  VALUE                                HEX VALUE
000000  LENMAT    'F'  +1132                               0000046C
000004  LENA CT    'F'  +3424                               00000D60
000008  LENOUT    'F'  +4008                               00000FA8
00000C  LENSUG    'F'  +4062                               00000FDE
000010  LENKON    'F'  +589                                0000024D
000014  LENKAT    'F'  +1714                               000006B2
000018  LENKUG    'F'  +1714                               000006B2
00001C  IUSEM     'F'  +1126                               00000466
000020  IUSEA     'F'  +3037                               00000BDD
000024  IUSEO     'F'  +4008                               00000FA8
000028  IUSES     'F'  +4062                               00000FDE
00002C  IUSEK     'F'  +589                                0000024D
000030  IUSEKA    'F'  +1525                               000005F5
000034  IUSEG     'F'  +1714                               000006B2
→ 000038  INTRAC    'F'  +396                                0000018C
  
```

Fig. A-28 Dump of Labelled COMMON "PACK"

In this case, the standard area of KACT consists of 396 words made up from 44 entries. From Table 58 we see that KACT is one-dimensional and from Fig. A-4 that its offset beginning is 589. We will consider the first interaction of the ellipse-line type and later we will consider the first region type of entry. Fig. A-29 shows the ellipse-line interaction.

RA	I	D	H
000934	IQ (590)	'F' +88	00000058
000938	IQ (591)	'F' +258	00000102
00093C	IQ (592)	'F' +1133	0000046D
000940	IQ (593)	'F' +3425	00000D61
000944	IQ (594)	'F' +986	000003DA
000948	IQ (595)	'F' +91	0000005B
00094C	IQ (596)	'F' +177	000000B1
000950	IQ (597)	'F' +1	00000001
000954	IQ (598)	'F' +1	00000001

Fig. A-29 Interaction 88-258 Control Entry

Interactions are internally identified by the internal i.d.'s for the ellipse and contact line involved. Glancing back at Fig. A-8 and Fig. A-18, we see that this interaction is the THORAX ellipse attached to the Upper Torso against the BACK LINE segment of the SEAT BACK region. The first two words name the ellipse and region involved. The third word gives the beginning index in RQ of the real interaction information entry in STOACT. Since KACT is used during each time step throughout the run, the RQ index is stored directly in KACT rather than the index in STOACT, i.e., STOACT (1) in this case. This is true of most other references in KACT. Word four contains the index in RQ of the entry in CONOUT. Word five contains the index in IQ of the integer information entry in KACT. Words 6 and 7 point to the real information entries of the two materials involved. Word eight gives the record number in data set MV in which the last output information was written. Word nine is a control used to properly initialize outputting of MV.

Starting forward on the chain and looking first at the integer information entry presented as Fig. A-30 and described by Table 76, we note that since shared deflection is employed for this case the full twenty-four words are used.

RA	I	D	H
→ 000F64	IQ (986)	'F' +3	00000003
000F68	IQ (987)	'F' +3	00000003
000F6C	IQ (988)	'F' -2	FFFFFFFFE
000F70	IQ (989)	'F' +107	0000006B
000F74	IQ (990)	'F' +1155	00000483
000F78	IQ (991)	'F' +1155	00000483
000F7C	IQ (992)	'F' +1	00000001
000F80	IQ (993)	'F' +1	00000001
000F84	IQ (994)	'F' +2	00000002
000F88	IQ (995)	'F' +2	00000002
000F8C	IQ (996)	'F' +0	00000000
000F90	IQ (997)	'F' +0	00000000
→ 000F94	IQ (998)	'F' +3	00000003
000F98	IQ (999)	'F' +3	00000003
000F9C	IQ (1000)	'F' -3	FFFFFFFFD
000FA0	IQ (1001)	'F' +193	000000C1
000FA4	IQ (1002)	'F' -3	FFFFFFFFD
000FA8	IQ (1003)	'F' -3	FFFFFFFFD
000FAC	IQ (1004)	'F' +0	00000000
000FB0	IQ (1005)	'F' +0	00000000
000FB4	IQ (1006)	'F' +1	00000001
000FB8	IQ (1007)	'F' +1	00000001
000FBC	IQ (1008)	'F' +0	00000000
000FC0	IQ (1009)	'F' +0	00000000

Fig. A-30 Integer Information Entry for Interaction 88-258

There are twelve words of identical information for each material. Each entry contains the current and previous values of many of the control parameters in the load-deflection mechanism. The real information entry (STOACT) is similar and is described in Table 77. Fig. A-31 shows only the first few words, some words at the end of the first material and at the beginning of the second material, and the last few of the second material. (No purpose would be served by including all 83 words of the entry.) Sections for the two materials are marked by brackets.

RA	I		D	H
0011B0	RQ (1133)	'E'	590.	4324E000
0011B4	RQ (1134)	'E'	.999999931E-03	3E418937
0011B8	RQ (1135)	'E'	.999999931E-03	3E418937
0011BC	RQ (1136)	'E'	.555248989E-04	3D3A38DA
0011C0	RQ (1137)	'E'	.555248989E-04	3D3A38DA
...	...			
001254	RQ (1174)	'E'	.562151545E-04	3D3AF224
001258	RQ (1175)	'E'	.562151545E-04	3D3AF224
00125C	RQ (1176)	'E'	.401266702E-01	3FA45BDD
001260	RQ (1177)	'E'	.401266702E-01	3FA45BDD
...	...			
0012A4	RQ (1194)	'E'	0.	00000000
...	...			
0012F3	RQ (1215)	'E'	0.	00000000

Fig. A-31 Portions of Real Information Entry for Interaction 88-258

Table 78 describes the ellipse-line CONOUT entry and Fig. A-32 presents the entry for this case.

RA	I		D	H
003580	RQ (3425)	'E'	.401266702E-01	3FA45BDD
003584	RQ (3426)	'E'	-.564172924	C0906DA3
003588	RQ (3427)	'E'	6.26571083	4164405A
00358C	RQ (3428)	'E'	.559255257E-01	3FE5122A
003590	RQ (3429)	'E'	.298713088	404C7876
003594	RQ (3430)	'E'	-.349717498	C0598716
003598	RQ (3431)	'E'	9.45105648	41973787
00359C	RQ (3432)	'E'	-19.5585175	C2138E9B
0035A0	RQ (3433)	'E'	1.39814186	41165ECA
0035A4	RQ (3434)	'E'	3.48925114	4137D3F9
0035A8	RQ (3435)	'E'	.555248989E-04	3D3A38DA
0035AC	RQ (3436)	'E'	-.125668803E-02	BE525BBA

Fig. A-32 CONOUT Entry for Interaction 88-258

This entry stores the output quantities from this interaction until they are recorded in the binary file MV. CONOUT is always in internal units and the binary files are always in exterior units.

The only branch we have not followed is the one to the binary files (the last two words of Fig. A-29). We will take this matter up in the final section of Appendix A. First let us return to the standard area of KACT and look at the first region entry, included here as Fig. A-33.

RA	I	D	H
00097C	IQ (608)	'F' +244	000000F4
000980	IQ (609)	'F' +0	00000000
000984	IQ (610)	'F' +0	00000000
000988	IQ (611)	'F' -3449	FFFFFF287
00098C	IQ (612)	'F' +0	00000000
...	
000994	IQ (614)	'F' +0	00000000
000998	IQ (615)	'F' +1	00000001
00099C	IQ (616)	'F' +1	00000001

Fig. A-33 Region 244 Interaction Control Entry

This entry is described by Table 75. The only two branches forward for this type of Interaction Control Entry are to CONOUT (word four) and to KREGNS (word eight). These two entries are presented as Fig. A-34 and Fig. A-35 respectively. Note that the entry index is relative to KREGNS, i.e., it is necessary to go the route through Table 58 and Fig. A-4 to find the entry. Table 80 and Table 85 describe these two entries respectively.

RA	I	D	H
0035E0	RQ (3449)	'E' 2.	41200000
0035E4	RQ (3450)	'E' -.381469727E-05	BC400000
0035E8	RQ (3451)	'E' 32.4907227	42207DA0
0035EC	RQ (3452)	'E' 0.	00000000
0035F0	RQ (3453)	'E' 0.	00000000
0035F4	RQ (3454)	'E' -.953674316E-06	BC100000
0035F8	RQ (3455)	'E' 0.	00000000
0035FC	RQ (3456)	'E' -.953674316E-06	BC100000
003600	RQ (3457)	'E' 0.	00000000
003604	RQ (3458)	'E' 6.19999886	41633332
003608	RQ (3459)	'E' -25.8000031	C219CCCD
00360C	RQ (3460)	'E' 15.4399986	41F70A3C
003610	RQ (3461)	'E' -4.96000004	C14F5C29
003614	RQ (3462)	'E' 0.	00000000
...	
003630	RQ (3469)	'E' 0.	00000000

Fig. A-34 CONOUT Entry for Region 244

RA	I	D	I
001FE0	IQ(2041)	'F' +5	00000005
001FE4	IQ(2042)	'F' +7	00000007
001FE8	IQ(2043)	'F' +1	00000001
001FEC	IQ(2044)	'F' +1	00000001
001FF0	IQ(2045)	'F' +0	00000000

Fig. A-35 KREGNS Entry for Region 244

The CONOUT Entry stores the information which makes up the Category 2 and 3 printouts, and KREGNS controls their recording in binary file MU.

A.5 Examination of Binary File Content

Occasionally it is necessary to examine the binary files in order to isolate a bug in a particular processor. All the records written to the binary files by INP, IN, and OUTP are covered by the INP debug switch. If it is not feasible to rerun with INP debug "on", then Binary Format Sections in each of these three processors can be used to find this information. Let us suppose we are interested in finding where the variable section entries are stored in the binary file NU. We must then begin by examining arrays ICBEG and LEAD. According to Table 47 this information is found in record numbers $INSX + 1$, $INSX + 2$, $INSX + 6$, $INSX + 32$, and $INSX + 33$. According to Table 18, $INSX$ is found as the second item in record number one. Fig. A-36 shows a hex dump of record number one from which we see that $INSX = 25_{16} = 37$. (The MTS method of recording Fortran unformatted output prefixes two control words to every record.)

DUMP OF T8 (.001) ON MON OCT 09/78 AT 15:52:56

RECORD=1, LINE=.001, LENGTH=38

```
00 0000 00580000 00540000 00500142 00000025 00000118 00000263 000005EC 00000000
32 0020 000005F0 000005F2 000005F2 000005F2 000005EA 00000695 000006E9 00000715
64 0040 0000066B 00000644 0000046C 0000060E 00000629 00000644
```

Fig. A-36 Record Number One of File NU

Fig. A-37 shows a hex dump of record number $INSX + 1 = 38$ through record number $INSX + 6 = 43$. Fig. A-38 shows record numbers 69 and 70. This same information will be found summarized in Sections C and D of the Binary Index Summary presented as Fig. A-39 and shown in context in Table 50.

RECORD=38, LINE=.038, LENGTH=88

```
0 0000 00580000 00540000 00000000 00000000 0000000A 0000000C 00000009 00000002
32 0020 00000002 00000004 0000000E 00000007 00000009 00000112 00000000 00000000
64 0040 000000D2 000000D4 000000DE 000000D8 000000EA 000000DC
```

RECORD=39, LINE=.039, LENGTH=88

```
0 0000 00580000 00540000 000000DE 000000E0 000000E2 000000E4 000000E6 00000000
32 0020 00000000 00000000 00000008 000000EA 000000EC 000000EE 000000F0 000000F2
64 0040 000000F4 000000F6 000000F8 000000FA 000000FC 000000FE
```

RECORD=40, LINE=.04, LENGTH=88

```
0 0000 00580000 00540000 40404040 40404040 40404040 40404040 40404040 40D4E5D4
32 0020 C140F260 C440E3E4 E3D6D9C9 C1D340C5 E7C1D4D7 D3C5407B F1404040 40404040
64 0040 40404040 40404040 40404040 40404040 E2C5D740 F2F66B40
```

RECORD=41, LINE=.041, LENGTH=88

```
0 0000 00580000 00540000 C7D440C8 E8C2D9C9 C440C9C9 40C4E4D4 D4E84040 4DD7D9C5
32 0020 D3C9D4C9 D5C1D9E8 40C4C1E3 C15D4040 404040D2 D5C5C540 C2C1D940 40404040
64 0040 40404040 D6C3C34B 40C3D6D4 D74B40C4 C9E2D7D3 4B404040
```

RECORD=42, LINE=.042, LENGTH=88

```
0 0000 00580000 00540000 F3F3D4D7 C840C6D9 D6D5E340 C2C1D9D9 C9C5D940 40404040
32 0020 B5D640C2 C5D3E3E2 40404040 40404040 40404040 40404040 40404040 40404040
64 0040 40404040 F1F9E7F6 F1F27AF0 F47AF5F0 4040F760 F7F75D40
```

RECORD=43, LINE=.043, LENGTH=88

```
0 0000 00580000 00540000 00000000 00000000 00000000 00000000 00000100 00000132
32 0020 00000104 00000106 00000002 00000003 00000000 41100000 41100000 41100000
64 0040 41100000 00000000 00000001 00000466 00000240 00000000
```

Fig. A-37 Main ICBEG Section of File NU

RECORD=69, LINE=.069, LENGTH=84

```
0 0000 00540000 00500000 00000000 00000000 00000000 00000000 00000000 0000022B
32 0020 0000022B 00000230 00000235 0000023A 0000023F 00000244 00000244 0000022B
64 0040 0000022B 00000249 00000000 4111999A 00000000
```

RECORD=70, LINE=.07, LENGTH=48

```
0 0000 00300000 002C0000 00000000 00000000 00000000 00000000 00000100
32 0020 0000010A 0000010C 0000010E 00000110
```

Fig. A-38 LEAD and the Rest of ICBEG in File NU

C. BEGINNING RECORD NUMBERS FOR VARIABLE POSITION SECTIONS:
 BELT= 0, STEER CCL= 0, BAG= 0, CNTCT CONTRL= 71, CNTCT VALS= 101
 TABLE CONTRL= 158, TABLE VALS= 163, ACCEL= 184, TABLE NAMES= 187
 ELLPS NAMES= 190, LINE NAMES= 195, REG. NAMES= 198, REG. CONTRLS= 203
 INTERACTION CONTRCLS= 274

D. BEGINNING RECORD NUMBERS FOR OUTPUT CATEGORIES:

CATEGORY	RECORD NUMBER	CATEGORY	RECORD NUMBER
1	206	24	239
2	7	25	240
3	9	26	242
4	274	27	244
5	0	28	246
6	209	29	248
7	210	30	250
8	212	31	252
9	214	32	254
10	216	33	0
11	218	34	0
12	220	35	0
13	222	36	0
14	224	37	256
15	226	38	258
16	228	39	260
17	230	40	262
18	0	46	264
19	0	47	266
20	0	48	268
21	232	49	270
22	234	50	272
23	236		

Fig. A-39 Sections C. and D. of the Binary Index Summary

It should be noted that the run shown in Fig. A-39 had only two time points for printout whereas the run shown in Table 50 was a full run of forty-one time points.

Now that we have the locations of quantities in the binary file, let us begin by looking at the first part of the standard area of KCON. On the third page of Table 47, we see that KCON begins at record number LEAD (3). Section C of the Binary Index Summary prints NCR, twelve values of LEAD, and γ_p in explanatory form. In Fig. A-39, we see "CNTCT CONTRL = 71" which is an explanatory name for "KCON" and gives the value of LEAD (3). Fig. A-40 shows record numbers 71 through 73. Looking back at Figs. A-1, A-9, and A-19, we see that this is the same information.

RECORD=71, LINE=.071, LENGTH=88

```
0 0000 00580000 00540000 00000036 00000038 00000000 0000003A 0000003C 0000003F
32 0020 00000043 00000045 00000000 00000000 00000000 00000000 00000000 00000000
64 0040 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
```

RECORD=72, LINE=.072, LENGTH=88

```
0 0000 00580000 00540000 00000000 00000000 00000009 00000000 00000013 000000F4
32 0020 00000112 00000137 00000161 0000017A 00000198 000001B6 000001D4 000001FE
64 0040 0000006A 00000080 0000010D 0000015C 00000193 000001B1 000001D4 000001FE
```

RECORD=73, LINE=.073, LENGTH=88

```
0 0000 00580000 00540000 000001CF 000001F9 00000217 0000021C 00000221 00000226
32 0020 0000022B 00000230 00000235 0000023A 0000023F 00000244 00000249 00000001
64 0040 00000047 00000001 00000058 00000001 0000026F 00000002 00000000 00000000
```

Fig. A-40 KCON Standard Area in File NU

If we are interested in printed output of category one or five through fifty, ICBEG contains the beginning record number for each corresponding printout category. ICBEG is printed in explanatory form as Section D of the Binary Index Summary. Fig. A-41 gives the output results of Category One.

RECORD=206, LINE=.206, LENGTH=48

```
0 0000 00300000 002C0000 00000000 00000000 421DFFFF C11B3332 00000000 00000000
32 0020 00000000 00000000 00000000 00000000 00000000 00000000 00000000
```

RECORD=207, LINE=.207, LENGTH=48

```
0 0000 00300000 002C0000 41100000 408716BC 421DF749 C1166665 00000000 00000000
32 0020 00000000 00000000 00000000 00000000 00000000 00000000 00000000
```

Fig. A-41 Category One Output in File NU

Categories two, three, and four are handled differently. KREGNS, which controls categories two and three, is described in Table 85. In Table 47 we see that KREGNS corresponds to LEAD (12) and in Fig. A-39 we see that "REG. CONTRLS = 203". Fig. A-42 presents KREGNS as recorded in the binary file NU.

RECORD=203, LINE=.203, LENGTH=88

```
0 0000 00580000 00540000 00000005 00000007 00000001 00000001 00000000 0000000D
32 0020 0000000F 00000002 00000002 00000000 00000011 00000013 00000002 00000004
64 0040 00000000 00000015 00000017 00000001 00000006 00000000
```

RECORD=204, LINE=.204, LENGTH=88

```
0 0000 00580000 00540000 00000019 0000001B 00000001 00000007 00000000 0000001D
32 0020 0000000F 00000001 00000008 00000000 00000021 00000023 00000001 00000009
64 0040 00000000 00000025 00000027 00000002 0000000A 00000000
```

RECORD=205, LINE=.205, LENGTH=28

```
0 0000 001C0000 00180000 00000029 0000002B 00000001 0000000C 00000000
```

Fig. A-42 KREGNS in File NU

Category four is controlled by INTACT, which is described by Table 84. The beginning record number for INTACT is found as the magnitude of ICBEQ (4) and is printed both as the last item in Section C of Fig. A-39 and for Category Four of Section D (possibly negative). NINTAC is the second dimension of INTACT and according to Table 47 is the eighth item of record number 38. Thus, from Fig. A-37, we see that NINTAC equals 4. The INTACT table from the binary file follows as Fig. A-43.

RECORD=274, LINE=.274, LENGTH=28

```
0 0000 001C0000 00180000 00000001 00000002 00000001 00000001 00000001
```

RECORD=275, LINE=.275, LENGTH=28

```
0 0000 001C0000 00180000 00000001 00000003 00000001 00000001 00000003
```

RECORD=276, LINE=.276, LENGTH=28

```
0 0000 001C0000 00180000 00000001 00000003 00000002 00000002 00000009
```

RECORD=277, LINE=.277, LENGTH=28

```
0 0000 001C0000 00180000 00000001 00000004 00000002 00000002 0000000B
```

Fig. A-43 INTACT in File NU

Looking at the first KREGNS entry we remember that the numbering of entries in KREGNS is the same as the numbering in KREGNM and so we can use Section B of the Packing Dictionary (see Fig. A-18) to identify this as region 244. Likewise looking at the first INTACT entry, we see that this is an ellipse-line interaction involving ellipse KELLNM (2) and line KCONAM (1). Glancing back at Fig. A-8 and Fig. A-18, we see that this is

interaction 88-258. We also see that Category Four begins at record number one of MV, that Category Two begins at record number three of MV, and that Category Three begins at record number five. The layout of the Category Four record is the same as the corresponding CONOUT entry (see Table 78 and Fig. A-32). Categories Two and Three both come out of the corresponding CONOUT entry (see Table 80 and Fig. A-34) with all of the Category Two Entry followed by the Category Three Entry in the CONOUT Entry. Fig. A-44 presents the dump of this portion of MV.

DUMP OF E9 (.001) ON MON OCT 09/78 AT 15:53:29

RECORD=1, LINE=.001, LENGTH=64

```

0 0000 00400000 003C0000 3FA5A0CC BE100003 41652FEC 00000000 404C7856 00000000
32 0020 418EC4DD C2138EF6 41165E7C 4137D411 00000000 4216CBEB 3D3AF224 39309EE8

```

RECORD=2, LINE=.002, LENGTH=64

```

0 0000 00400000 003C0000 3FA45BDD C0906DA3 4164405A 3FES122A 404C7876 C0598716
32 0020 41973787 C2138EFB 41165ECA 4137D3F9 00000000 C2AB369B 3D3A38DA BE525BBA

```

RECORD=3, LINE=.003, LENGTH=64

```

0 0000 00400000 003C0000 40262686 BE100094 421A456C 00000000 40D9478D 00000000
32 0020 41DE7EE7 C180D34A C12BD242 413A8D3D 00000000 4216CBEB 3DF4DD88 3A951EEC

```

RECORD=4, LINE=.004, LENGTH=64

```

0 0000 00400000 003C0000 4026166A C08416F9 421A399C 401628D7 40D94707 C01F223E
32 0020 41E6FCF7 C180D45C C12ED363 413A8C69 J0000000 C2AB369B 3DF44F3D BE49046C

```

RECORD=5, LINE=.005, LENGTH=44

```

0 0000 002C0000 00280000 41200000 BC700000 4220986A 00000000 00000000 00000000
32 0020 00000000 00000000 00000000

```

RECORD=6, LINE=.006, LENGTH=44

```

0 0000 002C0000 00280000 41200000 BC400000 42207DA0 00000000 00000000 BC100000
32 0020 00000000 EC100000 00000000

```

Fig. A-44 Interaction 88-258 Category Four and Region 244 Categories Two and Three in File NU

The two sequential data sets are described by Table 86 and Table 88 for MU and NP respectively. The tables show a typical entry for each time. The NP entry can have from two to five records per time point. In this case there are two. Fig. A-45 and Fig. A-46 present data sets MU and NP in their entirety. Note that NP has a time point for every plot time and MU has a time point for every integration time step while all other output quantities have a time step for every print time.

```

DUMP OF E7 ON MON OCT 09/78 AT 15:54:00
RECORD=1, LINE=1., LENGTH=36
  0 0000 00240000 00200000 00000000 C033091B 40FADC1D 40807A09 C0AC8213 C089CEA3
 32 0020 C11A0352
RECORD=2, LINE=2., LENGTH=36
  0 0000 00240000 00200000 3E418937 407C5CD0 40759AEC 41E0798E 412119CE 415368A7
 32 0020 4111EC49
RECORD=3, LINE=3., LENGTH=36
  0 0000 00240000 00200000 BE418937 BE418937 BE418937 BE418937 BE418937
 32 0020 BE418937
<<<<<< END OF FILE >>>>>>

```

Fig. A-45 Dump of File MU

DUMP OF E10 ON MON OCT 09/78 AT 15:54:22

RECORD=1, LINE=1., LENGTH=292

0	0000	01240000	01200000	0C000000	41B509F3	41B494B9	41D0A645	41E811C0	4212CFEE
32	0020	4221B4C9	41AE73FC	4212AD44	41AE73FC	C21F9EB6	C21C5711	C1F03DCB	C1BF240A
64	0040	C19689A9	C1EAE8F8	C21881E0	C211BFFA	C21881E0	41CF0EC4	C222186E	C03309B6
96	0060	00FAD0C5	40FAD0C5	C03309B6	41C33333	C2156666	40216A3A	C0FDC0F5	40FDC0F5
128	0080	40216A3A	41DC5C02	C1D7B0E8	406E360A	C0E70FCC	40E70FCC	406E360A	42121F98
160	00A0	C19D08C3	40DC95BC	C031EE04	4081EE04	40DC93BC	421A8AC9	C1C2554A	40F150F5
192	00C0	4055745B	C055745B	40F150F5	42284843	C181B4E4	40B504F6	C0B504F0	40B504F0
224	00E0	40B504F6	41EAD470	C2153A1E	40C134A9	C0A7F379	40A7F379	40C134A9	42187807
256	0100	C2120DAF	40FFA630	3FD65E2D	BFD65E2D	40FFA630	00000000	00000000	41100000
288	0120	00000000							

RECORD=2, LINE=2., LENGTH=176

0	0000	00E00000	00AC0000	41633333	C219CCCD	41F70A3D	C14F5C29	41F70A3D	C14F5C29
32	0020	421C0000	C19EB852	42203D71	C1AA3D71	421F3333	C1800000	421F3333	C0D70A3D
64	0040	42310000	C0D70A3D	422F4CCD	4111999A	4236B333	C159999A	42286666	C1D33333
96	0060	4226E666	C2106666	42123333	C22E6666	421C0000	C229B333	421BCCCD	C2294CCD
128	0080	4233999A	C21A4CCD	422CE666	C21B4CCD	422BB333	C1FE6666	422ECCCD	C1CCCCCD
160	00A0	4236B333	C159999A	4236B333	C214199A				

RECORD=3, LINE=3., LENGTH=292

0	0000	01240000	01200000	3E418937	41BD7EE7	41BD07E3	41D91892	41F08321	42135721
32	0020	42223BF8	41E6E667	42133470	41B6E6C4	C21F9EAE	C21C5719	C1F03E35	C1BF2403
64	0040	C1968AFB	C1EAEBC1	C21881CD	C211BFED	C21881E8	41D7811F	C2221862	C0330CA6
96	0060	00FADBC4	40FADBC4	C0330CA6	41CBA5D3	C215666D	4021696C	C0FDC0F6	40FDC0F6
128	0080	4021696C	41E4CDD9	C1D7B11C	406E31E2	C0E711DE	40E711DE	406E31B2	4212A6A9
160	00A0	C19D09DE	40DC9646	C081E9B5	4081E9B5	40DC9646	421B11F2	C1C25582	40F151B8
192	00C0	40557234	C0557234	40F151B8	4228CF72	C181E4C8	40B504DE	C0B50507	40B50507
224	00E0	40B504DE	41F34701	C2153A0E	40C13522	C0A7F2EF	40A7F2EF	40C13522	4218FF33
256	0100	C2120DA1	40FFA633	3FD65B22	BFD65E22	40FFA633	408716BC	00000000	41100000
288	0120	00000000							

RECORD=4, LINE=4., LENGTH=176

0	0000	00E00000	00AC0000	416BA49E	C219CCCD	41FF7BA8	C14F5C29	41FF7BA8	C14F5C29
32	0020	421C8716	C19EB852	4220C487	C1AA3D71	421FBA49	C1800000	421FBA49	C0D70A3D
64	0040	42318716	C0D70A3D	422FD3E3	4111999A	42373A49	C159999A	4228ED7C	C1D33333
96	0060	42276D7C	C2106666	4212BA49	C22B6666	421C8716	C229B333	421C53E3	C2294CCD
128	0080	423420B0	C21A4CCD	422D6D7C	C21B4CCD	422C3A49	C1FE6666	422F53E3	C1CCCCCD
160	00A0	42373A49	C159999A	4236BA49	C214199A				

RECORD=5, LINE=5., LENGTH=292

0	0000	01240000	01200000	3E418937	41BD7BD7	41BD07E3	41D91892	41F08321	42135721
32	0020	42223BF8	41E6E667	42133470	41B6E6C4	C21F9EAE	C21C5719	C1F03E35	C1BF2403
64	0040	C1968AFB	C1EAEBC1	C21881CD	C211BFED	C21881E8	41D7811F	C2221862	C0330CA6
96	0060	00FADBC4	40FADBC4	C0330CA6	41CBA5D3	C215666D	4021696C	C0FDC0F6	40FDC0F6
128	0080	4021696C	41E4CDD9	C1D7B11C	406E31E2	C0E711DE	40E711DE	406E31B2	4212A6A9
160	00A0	C19D09DE	40DC9646	C081E9B5	4081E9B5	40DC9646	421B11F2	C1C25582	40F151B8
192	00C0	40557234	C0557234	40F151B8	4228CF72	C181E4C8	40B504DE	C0B50507	40B50507
224	00E0	40B504DE	41F34701	C2153A0E	40C13522	C0A7F2EF	40A7F2EF	40C13522	4218FF33
256	0100	C2120DA1	40FFA633	3FD65E22	BFD65E22	40FFA633	408716BC	00000000	41100000
288	0120	00000000							

RECORD=6, LINE=6., LENGTH=176

0	0000	00E00000	00AC0000	416BA49E	C219CCCD	41FF7BA8	C14F5C29	41FF7BA8	C14F5C29
32	0020	421C8716	C19EB852	4220C487	C1AA3D71	421FBA49	C1800000	421FBA49	C0D70A3D
64	0040	42318716	C0D70A3D	422FD3E3	4111999A	42373A49	C159999A	4228ED7C	C1D33333
96	0060	42276E7C	C2106666	4212BA49	C22B6666	421C8716	C229B333	421C53E3	C2294CCD
128	0080	423420B0	C21A4CCD	422D6D7C	C21B4CCD	422C3A49	C1FE6666	422F53E3	C1CCCCCD
160	00A0	42373A49	C159999A	4236BA49	C214199A				

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Fig. A-46 Dump of File NP